PM-05

Proceedings of the

PM-05 > Fifth Scientific Conference on

# Project Management

*Advancing Project Management for the 21st Century*

*"Concepts, Tools & Techniques for Managing Successful Projects"*

**29-31 May 2010**
**Heraklion, Crete, Greece**

**Edited by**
**John-Paris Pantouvakis**

**National Technical University of Athens**
**Centre for Construction Innovation**

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**Fifth Scientific Conference on**

# Project Management (PM-05)

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*"Concepts, Tools & Techniques for Managing Successful Projects"*

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Moevenpick Resort & Thalasso Hotel,
Heraklion, Crete, Greece

***Editor***

John-Paris Pantouvakis

***Coordinated by the***

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# *Foreword*

Welcome to PM-05, the 5th Project Management (PM) Conference in the series that we have been organizing in Greece since 2001. In designing PM-05 we have integrated our experiences with most of your suggestions from previous PM conferences in order to organize the best possible event for the professional, the academic, the researcher, the student and their respective organizations.

In PM-05, our keynote speakers will set the scene for the subsequent conference sessions. Brigitte Schaden, the President of IPMA (International Project Management Association) will explain how IPMA moves forward and brings the benefits of project management to professionals and organizations. Mirek Skibniewski, Professor at the University of Maryland, USA will address the important technological issue of ERP integration in project management. Roland Gareis, Professor at the Vienna University of Economics and Business and Managing Director of RGC will provide a glance of his experience in designing project and programme performing organizations. David Pells, the managing editor of PM-Forum, will provide invaluable information on the origins, whereabouts and future aims of this very important project management portal.

In addition, PM-05 as all previous Conferences in the series, will be based upon peer reviewed papers. Academics, researchers, industrialists, professionals, policy makers and assessors, concerned with projects and programmes in every sector (construction, IT & telecommunications, public government, NGOs, international & EU funded projects etc) contributed with their knowledge and experience. You will find some ninety papers in the proceedings, authored by people originated from more than twenty countries in the five continents. These papers summarize the efforts, developments, knowledge and experiences of a wide spectrum of individuals and organizations from around the world. You will find both academic papers and professional presentations in the proceedings. PM-05 embraced both academia/research and practice/profession and more importantly aimed at the interaction of the two "worlds"!

The PM-05 will also include tutorials on specific topics. The tutorials aim at highlighting, informing and setting you thinking on important questions of relevance. For example, what is an international professional organization, such as IPMA, is doing to advance project management? What is the importance of project management certification and when and why should one aim for being awarded a project management certificate? Can we view project management differently so that it may deliver results in a decision-less environment? Finally, what are the major challenges and opportunities for project management (and project managers) in the next decade? Views, speculations, interaction and (hopefully) answers will be found at these tutorials led by renowned experts, such as the President of the IPMA, the Vice-President of IPMA for Certification, the Director of the Performance Based Studies Research Group (PBSRG) at the Arizona State University and the Vice President of the Association for Project Management (APM).

Equally, the PM-05 Conference is the ideal background to discuss the further advancement of the discipline through research and development. A PhD Workshop, led by the Director of Post Graduate Research Training at the 6-star rated University of Salford, UK will attempt to provide invaluable information and guidance.

Are papers, presentations, tutorials and workshops enough for project management? I think they are not. In managing a project, you need to make use of all information "generating" sources and of all information transfer mechanisms that may include verbal communications, interaction and tacit knowledge! How, for example, do you exactly capture the philosophy, power and simplicity of "*Bistamundi*"? In this conference, you may find that social events are particularly focusing on project managers and their respective personal advancement needs that cannot be addressed through formal learning, reading and attending of structured presentations. In addition, Crete, an island with rich history and

unique cultural heritage forms an almost ideal setting for further personal development. So, watch out for the social events of the Conference; they may be more interesting and rewarding than you may have originally envisaged…

In all, we have set up a balanced Conference with both formal papers and structured tutorials; you will gain a lot by attending the Conference and the parallel activities as we all know that information is not always easily captured in printed materials.

I really hope that you will consider the event useful to your professional and research careers and that you will find the time to discuss and exchange ideas on projects and project management with your colleagues during the conference.

This event could have never been possible without the contribution of many people; the organizer FREI SA, who looked after all organizational issues; the renowned invited speakers who took the time and put the effort to address the event; the tutorials and workshop chairs who contributed with their knowledge, acquaintances and skills; the authors and the reviewers of the papers. Many supporters for their wishful thinking and support. Appropriate acknowledgment should be made to all of the above. However, I must reserve my most heart-felt appreciation for you, the conference participants who made the whole venture possible and worthwhile. Thank you!

And if you enjoy PM-05, please have in mind that we may have even bigger and better plans for the future! The next conference in the series, PM-06 will be held in Athens, in early November 2012 in conjunction (hopefully) with the 26th IPMA World Congress. We really hope that you will book the first week in November of 2012 for a most exciting and rewarding project management event!

With best regards and wishes for a successful Conference in Heraklion, Crete and the future,

**John-Paris Pantouvakis, Ph.D.**
PM-05 Conference Chair,
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National Technical University of Athens
PM-Greece Association - An IPMA Member.

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**Panas, A.,** National Technical University of Athens, Greece

# PM-05 > *Cooperating Journals*

*The following journals will publish selected papers from the PM-05 Conferece:*

1. **Automation in Construction**, Elsevier, Editor in Chief: Professor Miroslaw SKIBNIEWSKI, Univesity of Maryland, U.S.A.

2. **International Journal of Construction Project Management** (*Vol. 3, Issue 1, March 2011*), Nova Publishers, Special issue Editor : Dr. Yiannis XENIDIS, Aristotle University of Thessaloniki, Greece.

3. **International Journal of Project Organisation and Management** (*Vol. 4, Issue 2, March 2011*), Inderscience Publishers, Special issue Editor : Dr. Kleanthis SIRAKOULIS, Lecturer, Technological Education Institute of Larissa, Greece.

4. **Built & Human Environment Review Journal**, (International Journal dedicated to postgraduate research), Open Journal Systems, University of Salford, Guest Editor: Dr. Monty SUTRISNA, University of Salford, UK.

5. **PM World Tomorrow Journal**, www.pmforum.org, Editor : Professor Dean KASHIWAGI, Arizona State University, USA.

6. **International Journal of Information Technology Project Management**, IGI Global, Special Issue Editors: Prof. Pandelis IPSILANDIS and Dr. Kleanthis SIRAKOULIS, Technological Education Institute of Larissa, Greece.

7. **Russian Project & Programme Management Journal**, Grebennikov, Guest Editor : Alexander TOVB, SOVNET & IPMA VP Certification.

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* Papers in Gray are professional presentations (Full paper has not been reviewed).

**Fifth Scientific Conference on**

# Project Management (PM-05)

*Advancing Project Management for the 21st Century*

*"Concepts, Tools & Techniques for Managing Successful Projects"*

29-31May 2010
Moevenpick Resort & Thalasso Hotel,
Heraklion, Crete, Greece

# Keynote Speakers

# Short presentation of the PM-05 Conference Keynote Speakers

**Mag. Brigitte Schaden**

President, International Project Management Association (IPMA)

Managing Director BSConsulting, President of IPMA, International Assessor of IPMA, Chairman of Project Management Austria, Assessor of the Certification Body of PM Austria, First Assessor of the Certification Bodies in Romania & Greece

Degrees on Insurance Mathematics, University of Technology, Vienna, Computer Technology, University of Vienna, IPMA Level B.
Worked in IT in bank, insurance and international trading companies. Manager of Libro AG and Lion.cc Libro Online AG. Member of the Certification Validation Board of IPMA & Past Vice president (certification) of IPMA

IPMA .... moving forward

- Introducing IPMA (Mission, Historical Background, Membership, Excellence Awards, Events (World Congress), Research & Publications, Certification and Standards)
- The profession – project management certification. How the IPMA Certification system supports quality
- Top trends in project management, IPMA achievements and new developments

**David L. Pells**

Managing Editor PM World Today, PMForum, Inc., U.S.A.

Managing Editor of PM World Today and of www.pmforum.org, one of the world's leading online sources of project management news. He is an internationally recognized leader in the field of professional project management, with over thirty years' experience in project management. His professional experience includes a wide variety of programs and projects, including engineering, construction, transit, defense and high technology, and project sizes ranging from small to mega. He advises several major organizations and programs. He served on the board of directors of the Project Management Institute (PMI®) twice, and was awarded PMI's Person of the Year award in 1998 and Fellow Award in 1999. He is also an honorary Fellow of Project Management Associates (PMA), the Indian National PM society, and of the Russian Project Management Association SOVNET. He has published and spoken widely on Project Management worldwide

PMForum - The Untold Story..."

Launched by PM visionary David Curling in Canada in the early 1990s, www.pmforum.org is the world's first and oldest website devoted to professional project management. It remains one of the world's best known and most popular sources of project management news and information. With global networks of academic and professional advisors, international correspondents, authors, ambassadors and readers, This presentation will tell the PMForum story – where it came from, how it is evolving and what the future holds. PMForum bridges the professional worlds of AIPM, APM, IPMA, PMAJ, PMI, SOVNET and other professional bodies, providing a global perspective on the state of the project management profession, current trends and the likely future. PMForum's mission remains "connecting the world of project management". This presentation will tell the story and reveal how that is possible.

**Professor Roland Gareis**

Vienna University of Economics & Roland Gareis Consulting, Austria

- Managing Director of Roland Gareis Consulting GmbH Vienna and Roland Gareis Consulting srl Bukarest
- Professor for project management, Vienna University of Economics and Business Administration Projekt-Management Group.
- Academic Director Professional MBA Project & Process Management, Vienna University of Economics and Business Administration.

Designing Project & Programme Organizations

- Projects (and programmes) can be perceived as comprehensive tasks, as temporary organizations, or as social systems. The perception of projects influences the way how projects are managed, how their complexity is coped with. A systemic-constructivistic project management approach will be presented. The consequences for designing project organization charts, project roles, project communication structures will be shown.
- New organizational models for projects such as empowerment are introduced to optimize project performance.
- Specifics regarding the design of programme organizations are the relationships between the project owners, project managers and the programme owner and the programme manager, the responsibilities of the programme office, programme team meetings etc.

**Professor Miroslaw Skibniewski**

A. James Clark Chair Professor, University of Maryland, U.S.A.

Department of Civil and Environmental Engineering at the University of Maryland. Prior faculty member at Purdue University. M.Eng. from Warsaw University of Technology, and M.S. and Ph.D. from Carnegie-Mellon University. Prior to his academic career, he worked in the industry as an engineer engaged in design quality reviews, construction related claims, value engineering, forensic engineering and industrial safety investigations.

He has received many awards including the NSF Presidential Young Investigator Award from President Ronald Reagan (1986), Honorary Professorship from Warsaw University of Technology (2005) and Moscow State Industrial University (2006). He is also a Foreign Member of the Russian Academy of Engineering. He is an author or co-author of over 150 technical publications and of more than 100 invited research presentations worldwide.

ERP Systems for Project-Based Firms: Costs, Benefits & Implementation Challenges

Enterprise Resource Planning (ERP) systems are configurable enterprise-wide information system services that integrate information and information-based processes within and across functional areas in an organization. They have been widely adopted in many organizations. This paper analyzes and presents the costs and benefits of ERP systems for project-based industries, which have lagged behind other major industries in adopting ERP systems due to their project-centric nature and the high stakes involved in ERP implementation. The challenges during the process of ERP implementations are also identified as part of the effort to understand the implied costs of an ERP system. The evidence of the costs and benefits is drawn from previous studies and the analysis of the prevailing working practices in project-based firms. The classification of the costs and benefits can be used to enable executives in project-based firms to make informed decisions on their ERP system investments.

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# Abstracts

*AA094*

## Critical Review of the Current Public-Private-Partnerships Legal Framework in Greece with Respect to Legal Risks Management

Elsa Adamantidou
*(Legal Adviser of Public Procurement Monitoring Unit Rechercher in Centre of International and European Economic Law, Greece)*

Yiannis Xenidis
*(Lecturer, Aristotle University of Thessaloniki, Dept of Civil Engineering, Greece)*

Panos Papaioannou
*(Professor, Aristotle University of Thessaloniki, Dept of Civil Engineering, Greece)*

### Abstract
Success of Public Private Partnerships (PPPs) heavily depends on the host country's legal and regulatory framework. Legal risks are primarily connected to inefficiencies of legal agreements and documents and lack of specific and clear provisions and regulations. This paper presents an inventory of legal risks based on literature review and compares it to the current legal framework for PPPs in Greece aiming at highlighting the latter's strengths and weaknesses with regard to the management of risks. The results of the analysis indicate several strengths of the current legal framework, while the major weaknesses are the vagueness in certain cases, which allows for various interpretations and the negligence in the enforcement of laws and regulations.

*AA055*

## A Risk Assessment and Management Framework to Support Project Delivery

Agyakwa-Baah, A. B.
*(Postgraduate, Sheffield Hallam University, Sheffield, United Kingdom)*

Chileshe, N.
*(Senior Lecturer, University of South Australia, Adelaide, Australia)*

Stephenson, P.
*(Professor, Sheffield Hallam University, Sheffield, United Kingdom)*

### Abstract
Risk factors associated with construction projects have a major impact on issues related to cost, time and quality of project delivery. Unexpected events result in either positive or negative outcomes often causing deviations from project plans and making construction projects particularly prone to risk. Despite the extensive research on risk management in the construction industry, there is limited literature dealing specifically with project risk in developing countries. It is against this background that this study investigates the use of risk assessment and management processes in organisations. Data were collected from construction professionals working with construction clients (both private and public), consultants, and contractor organisations within the Ghanaian construction sector. The survey data were used to examine the differences in the levels of agreement between the three stakeholders. The research findings indicated that although project stakeholders are aware of risk factors associated with construction projects, there is a need for the benefits of using risk management processes to be emphasised and communicated. Based on the research findings a risk assessment and management framework was established to support future successful delivery of construction projects in developing countries.

*AA086*

## Critical Success Factors for Risk Assessment and Management Processes Implementation: Perceptions of Construction Professionals in Ghana

Agyakwa-Baah, A.
*(Postgraduate, Sheffield Hallam University, Sheffield, United Kingdom)*

Chileshe, N.
*(Senior Lecturer, Research Education Portfolio Leader, University of South Australia, Adelaide, Australia)*

Stephenson, P.
*(Professor, Sheffield Hallam University, Sheffield, United Kingdom)*

### Abstract
Despite the extensive research on risk management in the construction industry, there is limited literature dealing specifically with the identification of critical success factors necessary for the deployment of risk assessment and management processes in developing countries. It is against this background that this study attempts to elicit the perception of construction professionals on CSFs appertaining to risk assessment and management processes within the Ghanaian construction industry. Data was collected from 34 contractors, 46 consultants, and 23 clients (private and public) within the Ghanaian construction industry. Response data was subjected to descriptive statistics and subsequently analysis of

variance (ANOVA) and other non-parametric tests were used to examine the differences in the identification of the critical success factors. The research findings indicated that among the critical success factors, 'Management style' and 'team work and communications' were ranked as the most important whereas 'goals and objectives of the organisations' and 'customer requirements' were considered to be the least important. There was a disparity of the ranking of the 10 critical success factors among the groups; however the differences were not statistically significant. The study also established a number of managerial implications in that the identified critical success factors could be used as a 'road map' for the successful implementation of risk assessment and management processes in developing countries.

*AA080*

## Management of Communication Risks: Evidence from international projects case study

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Sviatlana Anop
*(Research engineer, Royal Institute of Technology (KTH), Stockholm, Sweden)*

### Abstract

The realization of project requires collaboration between many different participants. The majority of interactions happen on the project management team level. The general believe is that teams/groups can achieve more efficiency if they use effective instruments of risk management in their communication process. The aim of this study is to investigate how the level of communication risks varies between different project group development stages and how project manager can help project group to reach the maximum effectiveness of communication. The study analyzes different communication barriers that project group meets while working at project. The investigation was performed by using qualitative analysis method in four different projects of an engineering and consulting company involved with mining industries in South Africa. Interpersonal relationships were measured by FIRO model and communication risks were evaluated by a typical risk analysis method. Results of investigations show that communication risks are directly affected by the stage of group development and different factors of group development tend to synchronize with each other. The total amount of risks tends to decrease as group moves from one stage to another on the FIRO model. For improving communication process in project groups the dynamic nature of FIRO model should be considered. The risks will not be settled down unless the group stands in "Openness" stage and the group development stage is vulnerable to any changes; the environmental effects should be carefully followed for preventive action.

*W010*

## Evaluation of the Standardised form of contract at Sultanate of Oman

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*(Director of Post Graduate Research Training, School of the Built Environment, University of Salford, UK)*

### Abstract

The use of standardised forms of contracts has been generally considered practical and economical in the construction industry. Originally produced in the 1980s, the standardised form of construction contract for government works is the only standard contract document available and recognised for public works in the Sultanate of Oman. In Oman, government contracts for the construction of public works are required by statuary law to be fixed-price contracts awarded through competitive bidding. The standardised form of contract has never really been reviewed and updated. Unfortunately, there is limited research in the Omani construction industry particularly in the contractual management field. Based on this, a PhD research has been set up intending to evaluate the use of the standardised form of construction contract in Oman and to formulate recommendations of necessary improvement to incorporate the contemporary and future needs and trends in the Omani construction industry. This paper discusses the background and rationale of conducting the research followed by the research methodology applied in this study. The earlier stages findings are also presented followed by discussion. The paper is concluded by summarising the progress and findings so far as well as the further stages of this research guided by the findings.

*AA037*

## Framework for Managing Complexity of Interconnections in Projects

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Francis T. Edum-Fotwe
*(Loughborough University, UK)*

Anthony Thorpe
*(Loughborough University, UK)*

Abstract
Interconnections and boundaries between the various project parties have been identified as an area which requires careful consideration. Complexity is caused by interconnections and this could lead to a reduction in performance if the resulting interface is not purposefully and efficiently managed. Understanding the characteristics of complexity of interconnections, and how these affect organising projects and the management style will enable the development and implementation of innovative project actions and tools that will support the management of complexity through the respective processes. The authors present results from a study of UK construction organisations to shed more light on the influences of complexity generated by the interconnections. The results from the study have significant implications for the way project teams are put together and managed, and enabled the introduction of a framework for managing complexity of interconnections in projects.

*AA058*

## Project Managers and Designers: Required or Enabling Cognitive Skills and Personality Characteristics

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Fevronia Z. Striagka
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Glykeria P. Kalfakakou
*(Professor, Aristotle University, Thessaloniki, Greece)*

Abstract

This study is discussing the personality characteristics, cognitive abilities and body of knowledge that synthesize the profile of successful project managers and designers. The paper determines the principal characteristics and skills which enable engineers in the construction industry to excel either as project managers or as designers. Our hypothesis suggests that personality characteristics and cognitive abilities could potentially function as prerequisites or enablers in a career path. Behavioural characteristics and skills are identified through a series of focus groups' questionnaire surveys. Statistical analysis of the answers highlight personality characteristics and cognitive abilities. The results are then compared to findings from literature. Finally, appropriate psychometric tests are proposed in order to quantify these characteristics and skills. This methodology could standardize the selection procedures and implement similar approaches in improving and managing human resources in Greek construction industry.

*AA077*

## Modelling as a Soft Skill for the Assembly and Usage of a Project Compendium via Sensemaking Concepts and its Software Application

Steve Armstrong
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Abstract
This paper takes a systems view in order to explore and illustrate the relationships between the factors and actors that have an influence upon the course of action as the project plan is realized. An understanding of the issues relating to a project's risks, requirements and resources is the basis for a successful implementation of a plan to meet the time, cost and quality criteria. So, the ability to use qualitative models would be a potential component in revising the competency baseline now that complexity has a greater influence on projects (e.g. performing project health checking). From the recent set of case studies and interviews, it is viewed that Project Compendium components can be used to manage project knowledge effectively. They help to ensure transparency, availability and accessibility of information that is a potential contribution to project success, assuming they have an adequate level of quality within the context.

*AA097*

## Construction Superintendents need Leadership

William W. Badger
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Avi Wiezel
*(Associate Professor, Arizona State University, USA)*

Daniel Adams
*(Graduate Student, Arizona State University, USA)*

Peter Bopp
*(Retired, Dupont, USA)*

Abstract
This paper presents a method of profiling the leadership skills of construction field superintendents and relating these skills to the success of their project. The leadership competencies of 43 superintendents were assessed utilizing a self-evaluation "Field Construction Superintendent Questionnaire" (FCSQ) complemented by a "Project Manager Questionnaire" (PMQ) that provided an independent performance evaluation from the superintendent's project manager. Analysis of the data collected from the FCSQ and the PMQ shows significant correlation between the leadership competency levels and the job performance levels of the Field Construction Superintendents. The data collected allowed to asses the importance and need of leadership as well as management skills for superintendents. Not surprisingly, the effectiveness of management skills dominates the job performance of a construction superintendent but it is the degree of applied leadership skills that make the difference between average and exceptional performance (Great Superintendents). Participants were ranked based on their leadership scores. Interviews conducted with the participants' company executives found a 90 percent accuracy rate in the ranking when compared to performance and profits generated by the participants.

*AA012*

## An MCDA Approach for Project Selection in Public Sector

Evangelos Bellos
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Dimitra Voulgaridou
*(R.A., University of the Aegean, Chios, Greece)*

Konstantinos Kirytopoulos
*(Assistant Professor, University of the Aegean, Chios, Greece)*

Dimitrios Panopoulos
*(Researcher, National Technical University of Athens, Greece)*

Abstract
Effective and efficient selection of projects is a crucial issue for every organization and should be aligned with its vision and strategies. The decision making process is highly complex, especially for public organisations, as it encompasses various, often conflicting criteria. Moreover they have to consider a much larger picture than private organisations and many scholars argue that public investment decisions fall into the category of constrained optimisation problems. The present study develops and proposes an approach for the prioritization of public projects, based on the Analytic Network Process (ANP), which is further validated through a real case example concerning the project selection process of a Greek municipality. The results indicate that social and political criteria dominate the decision making process, while the ANP documents the results in such way that they can be communicated to various stakeholders, ensuring public trust and establishing a system of transparency in public administration.

*AA007*

## Measuring Performance and Implementing Improvements (Case study)

Ioannis Bras
*(Managing Director, Superior Services, Greece)*

Abstract
The period between 1999-2002 a first-hand applied research was based in one of the biggest corporations in England (UK) in the Project Management field. The target was to create the suitable tools, techniques and methodologies in a practical measurable environment where departments of the company which affect the effectivity and viability of a project to be analyzed so that their effectiveness can be measured and ways and mechanisms of improvement can be found. It was decided that the start would be made from a project of a budget of € 270 million whose cause was the research and construction of a nuclear laboratory in Shellafield UK. The department initially chosen to be examined and ways of measuning effectiveness to be found, but also methodology of optimizing the services offered, was the Information Technology department since it offered its services to more than 400 engineers. The paper will cover the concept design, the methodology and tools used as well as the results of the improvements acted out in the period of two semesters when the research was held.

*AA002*

## Effectiveness of Risk Management: Barriers and Solutions

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Abstract
The effectiveness of risk management within the UK construction industry is discussed. A semi-structured questionnaire was used in collecting both qualitative and quantitative data. 113 construction professionals were sampled who included project managers, clients, quantity surveyors, and contract experts. 46 replies were received, representing a 40% response rate. The quantitative data were analysed by descriptive statistics while the qualitative data were synthesised by the content-identification of opinions made. Results of the analyses showed that most respondents use a structured approach; and manage risks throughout the different phases of a project. They also feel that the risk management process is fairly okay but some barriers were identified, e.g. making a late start, using inexperienced personnel, not fully pro-active, etc. In view of these, solutions for improvement were proffered such as providing adequate training, not circumventing some steps in the process, etc.

*AA015*

## A Research Framework for Developing a Performance Evaluation Model for Target Cost Contracts in Construction

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*Albert P.C. Chan,*
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*The Hong Kong Polytechnic University, Hong Kong)*

*Joseph H.L. Chan*
*(Research Associate, Dept.of Building and Real Estate,The Hong Kong Polytechnic Univ., Hong Kong)*

Abstract
The aims of this research study are to establish an Overall Performance Index (OPI) and to develop a performance evaluation model for projects with Target Cost Contracts (TCC) in Hong Kong. Four rounds of Delphi questionnaire survey will be launched to identify the Key Performance Index (KPIs) for TCC projects and investigate their corresponding weightings. A composite OPI will then be complied for evaluating the performance level of TCC construction projects. Quantitative Indicators (QI) and Fuzzy Quantitative Ranges (QRs) pertinent to each KPI will be determined to minimise the subjective interpretation and value judgment to enhance the reliability and practicality of the model. The proposed model is expected to be developed into an online computerised system to enable industrial practitioners to measure, assess and compare the performance levels of their own TCC projects for benchmarking purposes.

*AA104*

## Delivering the Design Services and Other Professional Services

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Kenneth Sullivan
*(Ass. Professor, Arizona State University, U.S.A.)*

Dean Kashiwagi
*(Professor, Arizona State University, Tempe, U.S.A.)*

Abstract
Design Services have been not meeting the value and expectations of the clients and their project managers. A research project has studied the impact of the low bid award environment on construction practices, and has proposed that designers' current practices and expectations are price based and not performance based. The authors also propose that the qualification based system is a price based system and should be replaced by a best value system which includes a best value selection process such as the Performance Information Procurement System (PIPS.) The new design model will give control and risk management capability back to designers by utilizing a weekly risk report (WRR) and the risk management plan (RMP.) The new PM model managing design firms will create transparency; will give the advantage to the higher performing professionals. The researcher interviewed over 400 designers to validate the concepts of the new designer model.

*AA038*

## Does the use of Partnering Lead to Improved Project Performance?

Pauline Corbett
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Jonathan Wright
*(Quantity Surveyor, Carillion PLC, Wolverhampton, UK)*

Abstract
The objective for this study is to ascertain whether the adoption of partnering and other construction best practice principles lead to improvements in the project outcomes and deliverables on UK construction projects where financing is from public funds. A series of pilot interviews are carried out with client, main and subcontractor representatives to address this question. The main findings from the pilot research are that the use of partnering is seen as having a positive impact on projects in terms of time, cost and end quality, albeit not to the levels expected. The use of partnering also leads to the project team embracing other best practice tools. However results indicate one barrier to partnering realising its full potential is the lack of trust within in the construction industry and this stops the sector fully committing to more open project relationships as best practice principles envisage.

*W003*

## Decision Support System (DSS): A Strategic Tool for the Affordable Housing Industry

Imad Dawood
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Jason Underwood
*(Research Institute of the Built and Human EnvironmentUniversity of Salford, UK)*

Abstract
The housing industry in the Developing World and for long time has suffered from underinvestment, the lack of knowhow and the lack of sufficient strategies and policies. This in turn, led to a total failure in performance, accumulative massive housing demand and underachieving. Consequently, and because of the massive growth in the world's population, especially the Islamic World, people in the poorest countries have been the most affected and forced to live in slums and shanty towns which some worldwide have millions of occupants. This research paper presents a scientific approach to assist governments and decision makers in the Islamic World setting up most sufficient and effective strategies and policies on the mega-level (country level) for the housing industry. The final outcome of this research will produce a Decision Support System Model (DSS) which could be used by decision makers to setting up holistic, realistic and achievable strategies and policies based on the scientific interpretation of the interface of the DSS Model. The DSS Model operates using five engines and one interface to identify, calculate and compare between Financial Sources (Government, PFI, International Fund and Grants) and Total Cost of several variables such as, Know How (Local and Foreign), Labour (Local and Foreign), Training (Local PM and Skilled Labour), Building Materials (Local and Import), Land (Urban and Rural). This in turn gives a clear idea to governments on their financial sources, the total cost of the whole housing project, regulation and legislations necessary and required to facilitate and support the housing industry, etc. The research methodology will consist of two parts; literature review which shed light on DSS Model in terms of definition, stages, purposes, mechanism, how it functions, etc. The second will introduce Interpretive Structural Model (ISM), which is used previously in a different stage of research to identify and prioritise Housing Industry Variables and DSS Model. Finally, the DSS Model will be examined and tested using different scenarios for validation. The findings will be stated in the concluding section.

*W004*

## Research Methodology Explained

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Jason Underwood
*(Research Institute of the Built and Human Environment (BuHu).University of Salford, UK)*

Abstract
Research Methodology is one of the nightmares a researcher has to endure. It is so confusing and misleading because it is derived from philosophy. Philosophy itself is hard to comprehend and explain even by experts in the field. The reason is that philosophy was first explored in the 5th Century BC by the infamous Greek philosophers such as Aristotle, Socrates, and Plato who are regarded as the fathers of philosophy. Scholars and Experts in the field of Research Methodology have invested so much time and effort attempting to draw a clear picture of the Process of Research Methodology which is derived from Philosophy. However, most attempts or perhaps models of research are still hard to comprehend, understand and follow. In the light of this, Saunders et al (2003, 2006) have introduced great Models namely The Research Process Onion, which is widely used by researchers to justify their research. However, Saunders Research Process Onion Models (2003, 2006) can be greatly improved by including and

positioning Epistemology and Ontology on the model. This attempt will draw a clearer picture about research process and make it easier to understand and follow by researchers. The outcome of this research is expected to produce a comprehensive Research Methodology Model which is broader, clearer and links and displays the relations and hierarchy among philosophical and technical terms and domains such as Axiology, Epistemology, Ontology, Research Philosophy, Research Approach, Research Strategy, Research Choices, Time Horizons and Data Techniques.

*AA113*

## First five years of conducting the Management in Civil Engineering group of courses within the Professional Study Programme and the Polytechnic Graduate Professional Study Programme in the Polytechnic of Zagreb

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*(Polytechnic of Zagreb - Department for Civil Engineering, Zagreb, Croatia)*

Domagoj Šojat, B.Eng.C.E.
*(Student at the Polytechnic of Zagreb - Department for Civil Engineering, Zagreb, Croatia)*

Abstract
The Polytechnic of Zagreb organised two study programmes, a 3-year Professional Study Programme and 2-year Polytechnic Graduate Professional Study Programme, and within those study programmes it embedded a group of courses about Management in Civil Engineering. With this paper we will try to review some of the basic success indicators of that group of courses, e.g. enlisted students, finished students, average grades, etc. We will also try to review the results of the survey conducted among the students of both study programmes who took the fore mentioned group of courses. The survey regarded the student opinion on education conduction and their general grades of the study as a whole. The results will show the students general opinion about these groups of courses, and it will show that the basic success indicators point to a well balanced and concerted group of courses about Management in Civil Engineering within both study programmes.

*AA093*

## Generation of Rework: An Organisation's Perspective

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Arun Bajracharya
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Abstract
Rework can be taken as undesirable outcome in projects. Organisations use different approaches to respond and deal with rework during execution of projects. Some of the organisations might be well-prepared to deal with it as a part of project, whereas, others might be ignorant about it. In fact, the complexity of rework often deludes organisations which are even prepared to handle it. Understanding of the physics of rework is crucial but it needs to be first understood how organisations perceive and tackle it in real life. This paper intends to present the rework and its source that is understood at the ground level by project team members in an organisation which works with power system projects in the United Arab Emirates. A qualitative approach has been used to explore the understanding of rework in the organization. Semi-structured interviews were taken with the project team members who deal with rework practically and are interested to find proper solutions to mitigate it. The interview data were processed and assembled in terms of a theoretical framework that represents their interpretation of rework. It was found that "failure in quality" and "change from the side of customer" are the two primary sources that are responsible for generating rework in the projects. The understanding is practical but its adequacy is definitely worthwhile to be further investigated.

*AA010*

## A computer-aided conceptual cost estimating system for prestressed concrete road bridges

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Sergios Lambropoulos
*(Associate Professor, Centre for Construction Innovation, National Technical University of Athens, Greece)*

John-Paris Pantouvakis
*(Associate Professor, Centre for Construction Innovation, National Technical University of Athens, Greece)*

Abstract
The need for an environmentally friendly design of

modern motorways increases the construction of bridges, which has exhibited substantial overruns above estimated costs. Therefore, easy to use, inexpensive and accurate methods for conceptual cost estimating are needed. Conceptual cost estimates are made before the project's detailed plans and specifications are known and rely on the conceptual design of the project. Even though they present the lowest expected accuracy, they are used by all the key people involved in the construction process. This paper presents a computer-aided cost estimating system for prestressed concrete road bridges, which provides estimates of the material quantities and cost of all bridge elements. It relies on a database incorporating actual data collected from recently constructed bridges and exploits material estimating models already developed for bridge superstructure and foundations. The respective models for bridge piers are presented in this paper. Different configurations are devised from short to long-span bridges, accounting for the major deck construction methods and foundation systems. The system can be easily used to provide different cost estimates to the owner, designer and contractor during the project's early stages, since all the required input data consists of basic design parameters that are known during the preliminary study of each particular bridge. By allowing reliable cost estimates in a short time, the proposed computer-aided system represents a useful decision making tool.

*AA074*

## Implementation of The Entropy Concept on Construction Projects Under Financial Constraints

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Dr. Symeon Christodoulou
*(Associate Professor, University of Cyprus, Department of Civil and Environmental Engineering, Nicosia, Cyprus)*

Evangelos S. Tezias
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### Abstract
The paper investigates the relationship between entropy (disorder) and financially-constrained projects, through a case-study project (a highway project in Cyprus). The work builds on previous and ongoing research at the University of Cyprus and at the Democritus University of Thrace. A number of mathematical models describing the aforementioned relationship are developed, with an emphasis on the effect of financial disorder on the progress of a project. The purpose of this endeavour is to optimize the allocation of the monetary resources to the project activities in such manner that will produce a lower measure of financial entropy and a higher profit. Modelling and evaluation of the proposed method is performed by use of commercially available software. The entropy-based approach results in an optimal solution that satisfies the initially stated purpose of simultaneously reducing the level of entropy and increasing the profitability of the project.

*W002*

## The Use of the Construction Registers to Improve the Competitiveness of Small, Medium & Micro Enterprise Contractors

Gasa B, Winston S.

### Abstract
This abstract outlines the research focus aimed as demonstrating that the South African construction industry's use of the Construction Register Service (CRS), would improve the competitiveness of Small, Micro and Medium Enterprises (SMMEs). The CRS was developed by the Construction Industry Development Board (CIDB) with the intent of offering a basis for sustainable development, improved delivery, performance and empowerment. The study expands the industry's knowledge base in as far as it relates to enhanced performance and competitiveness of construction SMMEs. The research limits itself to the levels of contractors registered between grades 2 and 5 with a view to establish a benchmark for contractor competitiveness within those bands. The research's unit of study is at company level drawing from a reflection on the SMMEs active in industry. The research deals with a real problem in industry and therefore the theoretical underpinnings of an epistemologically objectivist paradigm have been employed in the study.

*AA048*

## A review of spatial considerations in project scheduling

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Yiannis Xenidis
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Abstract
Project scheduling is considered as a study of the relations between activities and time, it is well known, however, that for certain types of projects spatial considerations (e.g. site layout, facility planning, site congestion etc) should also be taken into account. In this paper a literature investigation is performed with the purpose of indentifying all methodologies and techniques that take into account "space" as an entity in producing construction schedules and the practical implications of this approach are discussed. It is argued that it is mainly a lack of perception and not a scarcity of tools that by and large lead to spatial considerations not being taken into account in most project time schedules.

*AA022*

## Visualising Time: a GIS Approach

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Abstract
This paper presents a methodology for visualizing in 3D the scheduling time data associated with the construction of a linear/ repetitive project. The Repetitive Scheduling Method (RSM) algorithm is used to provide the time data which then are visualized in a Geographical Information Systems (GIS) environment. A three storey building is modeled with this methodology to illustrate the applicability of the concept and to underline the benefits of the spatial and time data integration. This visual understanding of the project allows efficient schedule communication among the interested parties, although the methodology has still opportunities for improvement mainly in the field of software package integration on a single platform.

*AA041*

## Conceptual Modeling of Cause and Effect Relationships among Crisis Elements in Projects Using Fuzzy Cognitive Maps

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Dimitrios M. Emiris
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Abstract
During the project lifecycle, special treatment is required for crises, which may be prompted by the sudden trigger of internal or external perturbations, or they may be generated and become self-enforcing over time until a certain threshold-limit is reached. Crisis management, therefore, emerges as an essential systematic process, inherent in project management, which involves attempts to predict or identify potential crises that an organization may encounter, take precautions to prevent them, or minimize their effects. The variety of crisis types inhibits the generation of a unified treatment of crises; instead, it is more appropriate to isolate and group the most common crisis situations and their characteristics and aim to depict the relationships between crisis causes and effects. In this work, we not only identify and verify these relationships but we also solicit the negative / positive effects between them and we assign a weight in it. To achieve this, we use the theory of Cognitive Maps (CMs) (based on qualitative reasoning) and its extension to Fuzzy Cognitive Maps (FCMs). Generally, the basic elements of a CM are simple, the concepts used are represented as nodes, and the causal relationships between these concepts are represented as directed arrows. Each arrow is characterized by a weight, a real value that indicates the effect of the causal relationship between nodes. The inputs and outputs of our model concern the basic characteristics of crisis and the ways of managing them. The main deliverable of our work is the representation, using FCMs, of the relationships between crisis triggers and impacts, and the provision of a model of cross-correlations and interactions that can forecast the crisis outcomes depending on various confrontation strategies. We deepen our modeling by analyzing all the phases in the crisis "lifecycle" and, namely, pre-crisis, main crisis, re-establishment and learning, and model their inherent relationships. The resulting model provides an explanatory overview of the project crisis management mechanisms, useful for both the theorist and the practitioner.

*AA032*

## Two-Party Risk Assessment and Allocation Model

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Abstract
Over the past few decades, numerous research efforts have been undertaken concerning the allocation of construction risks. Nevertheless, industry participants remain concerned over the current practice of risk allocation/misallocation within construction contracting. Based on this problem, a research product that would aid contracting parties in determining how each risk can best be identified, assessed, and allocated was developed. The risk allocation model is called the "Single-Party Risk Assessment Worksheet" and is to be used internally to facilitate risk alignment within each party's organization. The results are later compared in the "Two-Party Risk Assessment Worksheet" in order to begin the cooperative assessment and allocation process. This paper presents the risk assessment tools developed and the details of the worksheets.

*ITPM1*

## The use of Project Management Systems in Road Construction Projects
## The case of the EGNATIA motorway

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Abstract
The Egnatia Motorway (670 Km) is one of the most important modern infrastructure projects for the transportation of goods between North and Central European countries with South East Europe, the Balkans and the Middle East. To handle the complexity and adverse character of the project, EGNATIA ODOS A.E. the company responsible for the administration of the project, has established a standard Project Management system which covers the whole range of project activities, i.e. Design, Construction, Supervision, Operation and Maintenance of the road. In this paper we briefly describe the individual information systems used throughout the life-cycle of the project and emphasize in the use of the Project Information System (PR.IN.S. or PIS). An overview of the company EGNATIA ODOS S.A. is provided in the beginning followed by a chart of the particular systems and software applications that were used during the various phases of the project. Among these systems, whether in-house or outsourced, a basic function that is common to almost all is the need for timely and reliable reporting that is essential for decision making. And this requirement can only be fulfilled if the data collected is accurate. To achieve this goal EGNATIA ODOS S.A. has early realized that data must be collected in the source. However, the staged implementation of disparate systems created a silo-like data structure. Same information was entered in different systems, by different people – reporting to different organizations, in different time slots. The Project Information System provides a common platform that allows for early collection of data in the source (owner) so that all subsequent users have the same data available through interfaces to individual systems.

*W008*

## Absence of Corporate Environmental Disclosure (CED) in Libya: A Research Note

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Abstract
Corporate Social and Environmental Disclosure (CSED) was one of the main topics of argument in the literature, particularly in the 1970s and 1980s. Since the early 1990s, the emphasis has been shifted to Corporate Environmental Disclosure (CED) rather than Corporate Social Disclosure (CSD). CED practice has become a topic of investigation among accounting academic researchers in both developed and developing countries. The literature has identified that the level of practices in CED in developing countries is lagging behind the developed countries. However, it is worth mentioning that pressures for CED vary from country to country and from region to region, especially between developing and developed countries. This paper presents an in-depth investigation of group of stakeholders' perceptions towards CED in Libya and concentrates upon the absence of CED in Libya. It has identified disincentives for CED in Libya. Evidence is collected from in-depth interviews with thirty interviewees from six groups of stakeholders namely: Decision Makers, Local Government, Financial Institutions, Shareholders, Managers, and Employees. The findings suggest that there is a strong consensus between the six groups surveyed on a number of disincentives for CED.

*AA082*

## Construction contracts, project delivery methods and roles of the project stakeholders. The case of Khalifa port project in Abu Dhabi

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Abstract
The main subject of this paper is to investigate and review the main construction contracts used in international environment, the project delivery methods and the roles of the project stakeholders. The greatest part of information and data were collected with the assistance of the "Archirodon Construction (Overseas) CO. S.A.", more specifically with the assistance of the department based in United Arab Emirates (U.A.E.). The first author stayed with the aforementioned company in U.A.E. for three months in the frame of his diploma Thesis. In the case of Khalifa Port in Abu Dhabi a brief presentation of the involved "actors" is made and the role of each one is described. Responsibilities are recorded and presented, as a result of a "structured questionnaire" survey with key personnel and the contract documents analysis. It appears that in certain positions the civil engineer is spending more time on issues not purely related to the main civil engineering discipline. Particularly, working in management positions in international construction the civil engineer requires a good knowledge of financial and legal issues.

*AA102*

## The Decision-less Environment of the Future PM

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Dean Kashiwagi
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Abstract
Project managers (PM) routinely make decisions in managing projects. Decisions are made when the project manager does not have sufficient information. Decision making increases risk, and usually forces an increase in project management, direction, and control. The future PM model is one where decisions, direction, control, and risk are minimized. Decision making will be forced to the lowest level, where the expert has been hired to minimize risk. The new model is one of observation instead of using technical expertise, and one of quality assurance rather than direction and management, and leadership based rather than information based. The new decision-less environment is being developed at the Performance Based Studies Research Group (PBSRG) at Tempe, AZ in the areas of the delivery of construction, IT, food services, sports marketing, and document control. The decision-less environment has a new contract model, a new risk model, a new outsourcing model, and a new project management model which manages a system instead of a technical function/service.

*AA103*

## New Contract Model for Project Management

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Abstract
A new contract model has been developed which changes a project manager's (PM) responsibilities from writing and enforcing a contract, to transferring the responsibility of writing and administering the contract to the vendor. The new environment changes the PM's role from management, direction, and control, to quality assurance. Quality assurance is ensuring the vendor has a quality control and risk management plan. The new model is based on the assumption that the client cannot control the vendor through the contract. The control mechanism is deleted, and the vendor creates a contract document that minimizes risk. The contractual document, which must be approved by the client's PM and legal, includes a risk managing mechanism called the risk management plan (RMP) and a weekly risk report (WRR.) The new contractual mechanism is the expert contractor's mechanism to document and minimize risk and transactions.

*AA105*

## Strategic Plan for the Implementation of a New PM Model

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Abstract
The University of Minnesota has been implementing the best value Performance Information Procurement System (PIPS) for the last four years. PIPS uses a new project management model which transfers risk and control to the vendor, and minimizes the client's PM activities. The performance of the vendors has increased and the number of transactions has been minimized, however, many of the project managers have resisted the new PM model. The resistance of the PMs has resulted in the analysis of the strategic plan to implement the new project management model. The result of the analysis is that the strategic plan must concentrate on the development of the core team of visionaries and not on the implementation of the new PM model. The tactical plan on the mechanics of the new PM model is also required, but is not as important as nurturing the core team of visionaries who are leading the change. The strategic plan ensures the sustainability of the new PM model.

*W009*

## Evaluating IT as Source of Competitive Advantage in Engineering and Construction Organisations

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Benny Raphael
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Abstract
Many studies have suggested that Information Technology resources do offer strategic advantages to organisations and enhance their competitiveness through efficient and cost effective delivery of the organisations' value chains. However, because most of these studies were carried out through imprecise and unstructured theoretical constructs the empirical results were equivocal. Thus, the inconsistencies in the outcomes of research on IT business value were ascribed to difficulties associated with modelling the payoffs of IT investment, mode of data analysis, industrial context, and choice of dependent variables as some of the major reasons. The paper adopts multi-theoretical concepts of process-based, resource-based views and microeconomics theory as the research framework to present a non-parametric model for evaluating the impact of information technology utilization in gaining competitive advantage in engineering and construction organisations. A pilot survey was conducted to verify the model value chain and empirically tested the concept.

*AA112*

## PROMETHEUS *Construct*: A Societal and Environmental Responsibility Framework for Medium, Small and Very Small Construction Companies

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Iliana Adamopoulou
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Abstract
The issues of Societal and Environmental Responsibility are related to the holistic approach of Sustainable Development and remain at top level of priority for theoretical and applied research. The framework PROMETHEUS addresses these issues, oriented to Greek Medium, Small and Very Small, private owned Companies, valorising a number of elements from recognized and widely in use models of Business Excellence and frameworks for Corporate Social Responsibility. It is constructed to be friendly and easy-to-use for owners / managers of all levels of formal managerial education. In this paper a specialised version "PROMETHEUS *Construct*" of the framework is presented, targeting the sector of construction projects. The businessperson records key elements of the permanent organisation and project methods, in the form of questionnaires, and then uses the toolbox, which includes material such as charts and tables, to help him towards the goal of leading the business in continuous improvement of Economic, Social /Societal and Environmental Results.

*NGO1*

## Guidelines and Project Management Handbook for Greek Non Governmental Organizations (NGOs)

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Abstract
"APOPLOUS" was the outcome of a project assigned

by the Coordination Committee of "the Campaign of 800 Greek NGOs", with the purpose of constructing a set of "Values for Organization, Conduct and Practice" for Greek NGOs. The main objective of the present study was to construct a comprehensive, easy-to-use project management tool for Greek NGOs, as the second add-on to "APOPLOUS". An additional objective was to facilitate Greek NGOs to be certified under the Greek ELOT 1429 & 1431-3 Standards for the "Managerial Capability of Organizations implementing Projects of Public Interest", thus ensuring their candidature for European Union co-financed Projects. The authors based their study on the latest International Competence Baseline version in use of the International Project Management Association and specifically on the Austrian and the Greek National Baselines. The guidelines and the standardised handbook contained in the add-on, were used in a pilot phase by a selected sample of NGOs and their feedback is included in the presented version.

*AA064*

## Reengineering Project Scheduling with Knowledge Management

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Vassilis Stavrou
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Elena Rokou
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### Abstract
The aim of this paper is to provide an effective method for schedule reengineering and optimisation through knowledge acquisition and corporate memory creation. The core problem of schedule development is about defining each activity's duration as well as the right dependencies among project activities. Project – oriented organisations specialised in one or more domains due to their experience can have highly accurate project schedules and thus improved efficiency. The first part of the proposed method consists of monitoring all the existing processes related to the projects execution and the corresponding knowledge acquisition through monitoring project results. The second part handles the creation of a corporate memory in the form of a schedule prototype, along with all the needed processes in order to update it after each project's completion. The paper is illustrated with a case study concerning the implementation of the method on a project in the construction sector.

*AA040*

## PM-PEDIA: An Open-Learning, Expert-Based, Mind-Mapping Tool for Project Management Education

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Dimitrios M. Emiris
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### Abstract
Efficient and coherent education in PM needs to couple the standards incorporated in systematic yet concise methodologies (such as the ICB® or the PMBOK®), with elaborated documentation, examples and evaluation tools, in order to corroborate the learning material. A challenge in this attempt is that PM an inter-disciplinary field and as such, the existing literature is vast and dispersed in various media (books, articles, internet, etc.) Bringing the knowledge elements from standards (which are mostly guidebooks) and textbooks together in a form acceptable by learners and teachers, by maintaining the completeness and integrity of scientific concepts, is a challenging task.

*SPM01*

## Lessons Learned from the Development of a Project Management Suite

Pavlos Laoutaris,
*(Task Force co-ordinator, MOU SA, Athens, Greece)*

### Abstract
The paper inquires the project of the integration of the Information Systems of a large Greek public Organisation by the development of a System aiming to interconnect these of the Organisation with the Monitoring Information System (MIS) of the Ministry of Economy, Competitiveness and Shipping. It was implemented in Athens from October 2009 until March 2010. The system consists of five sub-systems. Each one is responsible for a number of tasks and contains a large number of entities. Main objective is the process tracing, step by step, and their assessment, according to the theory and the commonly accepted procedures of project management. The first step to approach the context of the project was to briefly depict the structure, the functions and the culture of the Organisation. The following step was to list down all the project management sub-processes, as

mentioned below, and assess each one individually, using a scale from "poor" to "excellent". Project Start (Objectives, organization, environment, planning the scope, scheduling, and risk management), Project coordination, Project controlling, Resolving discontinuities and Project close down. The main conclusion is that there was not given enough effort during the start process of the project. More specifically, the selection of the project team and the risk assessment were relatively unsuccessful.

*AA054*

## Comparative Evaluation of Project Management Standards

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### Abstract

The increasing number and complexity of engineering projects require the implementation of systematic management procedures for effective project execution. Among existing project management standards, PMBOK and PRINCE2 have prevailed. PRINCE2 appears more suitable for disciplined environments with strong leadership while PMBOK may be more appropriate for organisations not emphasizing on a strong hierarchy. Such standards can be effective in large or well structured organisations but not so effective in organisations without experience, ability or motivation to invest much in project management. A guide that may be used to assist organisations in developing a project management method internally is presented. The guide is structured upon a detailed questionnaire that aims to reveal the general directions for developing a management method that meets the organisation needs, to suggest practical implementation plans and actions, to help organising the management documentation, and to provide incentives for further investigation and development. The proposed guide is flexible, directly applicable, adapted to the organisation needs, and promotes people creativity and participation.

*AA067*

## Construction Productivity: From Measurement to Improvement

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### Abstract

The subject of productivity is one of the broadest, most complicated, and therefore vague subjects related with constructions. Much research has been done for creating techniques which can efficiently measure productivity, and even more suggestions for its improvement can now be found in related literature. This paper aims to introduce current techniques and methods for measuring construction productivity along with their critique, and potential ways to improve their use. In order for the present work to be completed, people with great experience from construction industry and academia were interviewed and an extended literature review has been conducted. The data analysis reveals some unique issues that can lead to productivity loss, and also provide engineers with the current industry and academia trends on improving productivity in constructions. The results of that research can help the engineering community understand the seriousness of the construction productivity problem, and provide engineers with techniques and recommendations to face that problem.

*W005*

## Student Difficulties in Conducting PhD Level Research - The Aristotle University of Thessaloniki Case Study

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### Abstract

The Greek academic community seems to be well informed about the problems surrounding undergraduate level studies but the unique situation of graduate programs still remains quite unknown. This paper aims to make the first step towards a valuable discussion about the unique situation of the Greek University PhD programs, and explore the quality, feasibility and general philosophy which surrounds research at the PhD level. In order to extract conclusions about the research situation in Greece, a statistical survey was conducted among doctoral students of the Aristotle University of Thessaloniki. Students were asked to express their views on the research difficulties they face, by answering multiple choice questions and also by making text comments. The data analysis reveals some unique problems in conducting doctoral research, and also illustrates the need to transform the current PhD research philosophy into an educational method more applicable to the current academic needs of Greek Universities.

*W006*

## The Difficulty of Introducing the Main Subject of a PhD Research

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### Abstract
It is widely accepted that the definition and selection of a PhD research project is a very important and complex procedure. Particularly in Greece, where PhD studies are mostly supported by private (student) funds, doctoral studies have become not only a difficult but also a very expensive process. This paper examines the Aristotle University of Thessaloniki case study in order to explore the difficulties a doctoral student has to overcome for defining and organizing a PhD research project. To extract conclusions, a survey among active doctoral students was conducted. The generated results can help us find the roots of the problem of designing and defining the subject of a PhD research. The data analysis provides findings which try to answer questions about communication issues between PhD student and supervisors, the difficulty of organizing and designing PhD research projects, and the feasibility of making one's ideal research come to life.

*AA020*

## Assessing the Procurement Process In Greece's Construction Projects

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Konstantinos Vatalis
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### Abstract
The aim of this research is to assess the application of recent Legislation towards sustainable procurement in Greece with special attention to the construction industry. A questionnaire survey of twenty seven experts (construction managers, industrial and academics) was carried out in order first to investigate the awareness level and the constraints of sustainable procurement practices, second to record the procurement practices implemented in the Greek construction industry third to obtain experience of the above issues concerning procurement practices in the Greek construction industry. The findings indicate that although sustainability criteria are recognised as essential their use is limited.

*W011*

## A Multi-Faceted Approach to Construction Scheduling Research

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John-Paris Pantouvakis
*(Associate Professor, Centre for Construction Innovation, National Technical University of Athens, Greece)*

### Abstract
Although extensive research has been conducted for the development of an algorithmic project scheduling methodology allowing optimal resource allocation and cost control, it has been realized that in real-life situations a pure analytical approach may not be enough. In the current complex and multi-cultural project execution environment behavioural and contextual issues should also been taken into account. As such, issues relating to the organizational structure, personnel training, negotiation skills and the legal, financial and political context may affect project scheduling beyond the modelling abilities of pure algorithmic approaches. To this extent, the aim of this paper is to review the effectiveness of various research methods in the construction project scheduling process. In particular, the adequacy of quantitative and qualitative research methods in issues pertaining the algorithmic formulation, behavioural issues and contextual aspects of construction scheduling is examined. Special attention is paid to the differences between the analytical formulation of the problem and human factors in the project context. It is concluded that a multi-faceted methodological approach is required consisting of both quantitative elements and qualitative ones based upon the fundamentals of social and economic sciences.

*AA117*

## Uncertainty in Scheduling Multiple Projects

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*Sergios Lambropoulos*
*(Associate Professor, Centre for Construction Innovation, National Technical University of Athens, Athens, Greece)*

Abstract
Whereas there is ample research literature available on uncertainty in single projects, research on studying uncertainty in a multi-project environment is scarce. As such, this paper aims at establishing a framework for modelling uncertainty in scheduling multiple projects. The primary focus is determining the feasibility of the fuzzy set theory application in the modelling of scheduling uncertainty in the contemporary dynamic project execution environment. Issues such as duration uncertainty, resource availability and multiple project objectives are examined. It is concluded that the proposed methodology could be particularly useful in practical applications.

*ITPM4*

## An Integrated Information System for Monitoring Construction Works

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Abstract
There is an undeniable global tendency towards implementing centralized project monitoring with the use of advanced information systems in large projects. This trend is mandated by issues such as the geographical dispersion of projects, the numbers of contractors and the total amount of works. In this respect, the integrated information system that was utilized to monitor the construction works of the project of the Egnatia Motorway in Greece is presented. Reference is made to the software, hardware, information technology architecture, quality procedures and personnel training for the successful implementation of the system. Special mention is made to the data structures that are utilised (work breakdown structure, organizational breakdown structure, resource breakdown structure, and enterprise breakdown structure). In addition, comments are made from the experiences drawn from the implementation of the system. Overall, it is concluded that the system facilitates a central focal point for corporate scheduling and cost control.

*AA046*

## Prediction of Earthmoving Trucks Deterioration Using Discriminant Analysis

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Abstract
Predicting the condition of construction equipment is a crucial matter for the building industry since it directly affects the company's investment planning thus resulting in considerable financial effects. Accurate predictions could be useful for the planning of future requirements concerning equipment maintenance, replacement or procurement as well as for ongoing earthmoving operations. Towards the above, this research implements a stochastic model based on discriminant analysis and evaluates its effectiveness. In particular, discriminant analysis is applied to data provided by two large Greek Construction Companies and attempts to classify the vehicles in several predefined condition levels, according to their characteristics of age, kilometers traveled to date and maintenance status. The results demonstrate that the performance of the prediction model is strongly dependent on the maintenance policy of the company, which forms the most substantial factor for further evaluation in the course of an effective total cost management.

*SPM02*

## An Integrated Approach to Monitoring/Performance Assessment of Operational Programmes Co-financed by the European Union

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Aggelos Koutsomichalis,
*(General Director, EEO Group, Athens, Greece)*

Konstantinos Kloudas,
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Abstract
The main aim of the present paper is to present a simple but efficient tool for monitoring schedule and absorption performance at all levels required (from the individual contract to the whole programme) in order to facilitate timely and adequate corrective actions by the implementation of European co-funded programmes and assessing the capability of the beneficiaries to implement their projects on time and on budget. The schedule and the cost (absorption) of each programme level examined (e.g. contract, project, etc.) are

integrated and recorded in a time-phased budget (performance measurement baseline). Moreover, the actual time-phased absorption is recorded during programme implementation. Based on the above, absorption and schedule performance is assessed against the set targets through the definition and use of a small number of performance indicators. According to the values of these indicators, project, programme and beneficiaries performance are classified into an adequate effectiveness (risk) scale. Results of the practical implementation and use of the method will be presented for three case studies (2 in Greece and 1 in Cyprus). This approach is easily implemented in existing Management Information Systems or in widely used project management software packages (e.g. MS Project, Oracle Primavera etc.) and does not require extensive knowledge of project management.

*AA075*

## A New Approach to Assessing Malaysian Contractor Satisfaction Levels

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### Abstract
The extent of poor project outcomes is a recurring issue for construction industries worldwide. One of the main causes of these and project failure seems to be the inability of contractors to provide a high level of service quality to the project team. In Malaysia, design failures have also been identified as a further contributory factor. To overcome this, different types of subjective performance measurement have been progressively developed. These approaches are typically concerned with client satisfaction, customer satisfaction, home buyer satisfaction and occupant satisfaction, but very seldom consider contractor satisfaction. This paper examines the implications of this, and what is involved in developing satisfaction measures based on contractor perception instead of the typical sole concern with client performance. As a result, other attributes such as participants' performance, business performance, project performance, external factors and contractor characteristics are also examined. Several potential attributes are derived from interviews among Malaysian contractors, namely: performance (direct attributes) and contractor characteristics (indirect attributes) that possibly influence contractor satisfaction levels. These attributes are then developed to improve the existing conceptual framework. The developed framework is expected to help the project team in performing projects more efficiently, maintaining service quality and improving relationships between participants. In addition, the findings of the paper should assist contractors enhance competitiveness, improve their image and create more job opportunities in the future.

*AA111*

## Low Energy And Passive Housing Standards In Europe

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### Abstract
Implementation of building energy ratio for new buildings resulted with a need to establish standards and certificates suitable for different building codes, geographical locations and building traditions of a specific nation or region. For Europe most highlighted energy rating indexes are "EPBD" ("Energy Performance of Building Directive"), with British version "BER" ("Building Energy Rating"), German "Energie-Pass" and Swiss "Minergie®", as well as for USA "LEED". Also well known are standards for extremely low energy buildings as "PassivHaus", "Minergie®P-Eco", "Zero Energy" and "klima:aktiv". By the directive of the European Union all the buildings on the market that are being built, sold, or rented need to be certified. Gained certificate and annual energy consumption data could be presented to anyone interested, which will intensively affect the market. This article is presenting different energy rating certificates with specific energy consumption data which enables the energy consumption comparison of different buildings. The article also presents the comparison of low energy building standards as: "PassivHaus", "Minergie®" and "LEED".

*PRC1*

## Modelling with Uncertainty for Control Tasks

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Abstract
This study presents appropriate methods for control modelling with uncertainty for the analysis of management activities and the certification that they meet the performance standards. Dealing with and understanding the effects of uncertainty are important tasks for the project controlling. Reducing the effects of some forms of uncertainty (initial conditions, low-frequency disturbances) without catastrophically increasing the effects of other dominant forms (sensor noise, model uncertainty) is the primary job of the feedback control system. Closed-loop stability is the way to deal with the (always present) uncertainty in initial conditions or arbitrarily small disturbance. This paper outlines the methods available in the control theory and their applicability on management systems

*AA014*

## The Relationship Between Construction Conflicts Arising Between Oil Companies and Poverty of Host-Communities in the Niger-delta region of Nigeria

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Abstract
The purpose of this paper is to examine the nature of project conflict between oil companies and host-communities in which they operate in Nigeria's oil-rich Delta region, with a particular focus on the place of poverty in fuelling the lingering conflict and the difficulty in curbing the conflictual situation. The method is essentially a review of various available relevant literature and deductive arguments that will give insights to whether poverty can be a catalyst to conflicts between oil companies and host communities. The paper concludes that poverty of host-communities to a project is usually at the heart of many project conflicts arising between operating companies and host-communities. The paper usefully points out the pervasive poverty in the Niger-delta region of Nigeria; and how poverty has continued to ignite serious conflict among all stakeholders in the region with grave consequences.

*AA118*

## The Sustainability Dimension in IPMA Competence Baseline Contextual Elements at Project and Programme Levels

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Abstract
The objective of this paper is to open up a discussion regarding (a) the attributes of sustainability affected by the project/programme manager (PM), (b) the PM's potential for enhancing sustainability through the contextual competence elements of ICB and (c) the PM's potential for affecting the natural, social, human, manufactured and financial capitals at the project and programme levels. It is suggested that, in project/programme management, sustainability refers to three dimensions: (1) The *survivability* of the project as an operational and productive structure within a programme; (2) the *survivability* of the programme as sets of related projects; and (3) the *social acceptability* of the impacts (economic, social, cultural, and environmental) from the project's implementation process and products and the programme's evolvement. Two *study tables* are proposed as a basis for further study. T*he PM's* role in enhancing sustainability is often more crucial at the project rather than at the programme and the portfolio levels.

*AA052*

## The Role of Health, Safety and Green Principles in Estimating Construction Productivity: An Empirical Framework

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Abstract
The current approach to construction health and safety (H&S) and green building underestimates the role of production practices and focuses mainly to the

formulation of general guidelines and best-practice policies. This paper adopts a different approach in that it integrates workers' health as expressed by their thermal comfort and environmental parameters in productivity estimation. An empirical framework is presented to evaluate the relationship of the Predicted Mean Vote index to operational efficiency. Process mapping and simulation-based analysis is used for the creation and comparative analysis of productivity models. An exemplar investigation of formwork operations illustrates the applicability of the proposed approach. The main conclusion from the study is that the implementation of the empirical framework enables the creation of foresight in planning construction operations by analysing productivity variations compared to baseline estimates. It is believed that such an approach provides a more realistic representation of construction operations and improves the accuracy of the estimating process.

*W012*

## A Critical Review of Published Research on Construction Productivity

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### Abstract
Despite the large number of published papers in the area of construction productivity, a critical review of contemporary thinking with a discussion of the implications to current researchers is rarely attempted. As such, this paper investigates the subject based upon published papers in major peer-reviewed journals during the last decade. Eighty-nine papers published in both construction journals and broader management science journals have been analysed. The research taxonomy identified three major fields: Archival studies, empirical research and simulation proposals. In terms of the methodological structure followed, three major categories have been recognized: Experimental frameworks, data collection techniques and modeling proposals. The main conclusion is that the selection of the research methodology in published journal papers has been an intuitive decision, grossly relating upon the researcher's ontological and epistemological stance. However, general guidelines on the selection of the most appropriate methodology in relation to the research objectives are also discussed herein.

*AA044*

## Factors influencing Project Risk Management Decision Making

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### Abstract
Most investment decisions are characterized by irreversibility and uncertainty about their future rewards. Understanding the nature and magnitude of cost overruns in projects is often considered to be one of the most important challenges facing project managers. The application, therefore, of Project Risk Management (PRM) is widely regarded as in important skill-set in a PM's portfolio. Today's highly volatile economic environment presents new challenges for those seeking to develop robust strategies to respond to events that are likely to impact project budgets. This paper reports on an ongoing doctoral research project in collaboration with Rolls-Royce PLC. The project aims to explore opportunities for improving the management of budget contingency in relation to effective corporate risk management strategy. Initial findings suggest that senior managers recognise the importance of an effective risk management process. However, there is a great opportunity of improving the process of how risk management data can and should be used. Two projects were studied with respect to major difference in the use of risk data. Findings indicate the importance of a top-down risk management approach. The awareness of senior managers needs to be increased. To do this, risk has to be translated into profit through budget contingency.

*AA121*

## Collaboration Procurement Methods in Construction Projects-Greek Construction Industry Clients' Perspective

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Abstract
Traditionally the construction industry characterized by adversarial relationships, the lack of cooperation among project participants and the fact that construction companies and clients focus mainly on the reduction of project cost and neglect the value, are some reasons for the poor performance of construction projects. This research aims to investigate the Greek construction industry, from clients' perspective, in order to present the most common project delivery methods used, the problems faced, the usage of collaborative tools and the motivation factors that could lead clients to establish collaborative relationships. The empirical data were collected through a questionnaire to a population of 19 Greek Construction clients'. Findings confirm the traditional method's extensive usage in Greek construction industry both from public and private firms/organizations. As a result the problems that are reported are similar with the common problems that characterized traditional procurement method. This paper suggests that although Greek construction clients are familiar to some extend with collaboration tools and have some knowledge of the benefits of collaboration in project performance, they need strong incentives, such as cost reduction, to establish collaboration relationships.

*AA045*

## A Framework for the Implementation of a Knowledge Management Platform in the Greek Construction Industry

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Abstract
Contemporary construction organisations realise that managing the acquired knowledge in a more structured manner results in considerable improvements in their working practices and business performance. This paper describes a framework for establishing a knowledge management strategy for construction projects adapted to the Greek construction paradigm. A brief comparative analysis of recent knowledge management models is presented followed by a discussion of the research methodology. The study identified the informational requirements of current knowledge capture mechanisms and developed a knowledge management tool for construction projects. The tool's structure and data requirements are explained. A case study in a Greek design company helped to establish the applicability of the approach. A preliminary evaluation of the knowledge management tool by the end-users suggests that it is a useful template for the systematic capturing and storing of useful knowledge. The main inference emerging from the study is its contribution to the creation of a company-specific knowledge base for future reference, so as to solve recurring problems pertaining to the construction process.

*AA033*

## Correlating Multiple 2D Vision Trackers for 3D Object Tracking on Construction Sites

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Abstract
Tracking methods have the potential to retrieve the spatial location of project related entities such as personnel and equipment at construction sites, which can facilitate several construction management tasks. Existing tracking methods are mainly based on Radio Frequency (RF) technologies and thus require manual deployment of tags. On construction sites with numerous entities, tags installation, maintenance and decommissioning become an issue since it increases the cost and time needed to implement these tracking methods. To address these limitations, this paper proposes an alternate 3D tracking method based on vision. It operates by tracking the designated object in 2D video frames and correlating the tracking results from multiple pre-calibrated views using epipolar geometry. The methodology presented in this paper

has been implemented and tested on videos taken in controlled experimental conditions. Results are compared with the actual 3D positions to validate its performance.

*AA083*

## Working Cultures and Human Resources in the Construction Industry of the Balkan Peninsula

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### Abstract

Factors such as characteristics of the human resources, labour conditions, labour relations and others are referred to as "working cultures". The basic goal of the current paper is to identify and discuss main existing characteristics of the "working cultures" that appear in the Balkan. Moreover to consider how attractive such characteristics are for the development of construction projects in the area.

Based on the analysis, the research concluded that Balkan countries include a variety of labour "fields" under continuous evolution. A S.W.O.T. analysis (from the point of view of a foreign employer and employee) led to the conclusion that these countries appear to have interest both for the potential employer and employee.

*W001*

## *Research Methodological Position for a Doctoral Study on 'Apportioning Liability in Delay Claims'*

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### Abstract

Central to successful resolution of delay based claims is the fair and equitable apportioning of parties' liabilities. However, such fairness and equity in apportioning may be fettered by many factors in contemporary practices adopted by both contractors and clients. The principal goals and rationale of this research are inspired by the need to identify and curb such major obstructive factors. Thus, the research study aims to bring about contractually sound, practical improvements to problematic situations in contemporary practices. Such improvements are expected to produce more equitable, efficient, transparent and less contentious outcomes in delay claims resolution. To achieve the aim and objectives, it is considered necessary to establish a firm methodological position for the research study. This paper has strived to establish such position. In this effort, various ontological, epistemological and methodological stand points are considered. Consequently, the paper has concluded the appropriateness of using the naturalist paradigm in this study.

*AA011*

## Factors Affecting Cost Contingency in International Projects

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### Abstract

Contractors include a reasonable contingency amount as an allowance for potential risks in their bid, especially in international projects, in order to protect themselves against possible failures as the international construction environment is highly influenced by several complex factors such as intense competitiveness due to the existence of numerous competent rivals, unfamiliarity with the country, local conditions, and the client in question, uncertainties in the project environment, etc. The aim of this study is to identify the importance levels of the risk factors that may affect cost contingency amounts in international projects. Review of the literature indicated that there are 59 risk factors, and these factors are categorized into 6 groups, which include; bidding stage-related factors, construction-related factors, finance-related factors, country-related factors, company-related factors, and contract-related factors. Having identified and categorized these factors, a questionnaire was designed and data of 36 construction projects from 14 countries were collected for evaluation of these risk factors.

*AA070*

## Microblogging in Project Management: Improving Project Communication and Documentation with

## Status Information

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Martin Böhringer
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### Abstract
Microblogging represents a significant change in enterprise communication, shifting from a push to a pull model where information consumers subscribe to relevant information sources. Especially scenarios with high degrees in information quantity and complexity may benefit from this approach. This is the case for project management, which can well be supported by microblogging tools. This paper introduces the technology's concept, motivates use cases and discusses two examples as well as available software tools.

*AA076*

## Consulting Company Practice in Providing of Project Management Specialists by Masters Education Program

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Grigory Tsipes
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### Abstract
IBS is a biggest Russian IT system integrator and consulting company - undoubted national leader in this area. As a project oriented modern consulting company it requires a large amount of advanced specialists with high level of competences in all fields of IT, consulting and management, particularly in project management. To provide such specialists IBS established its own Magistracy with Masters Education program in cooperation with worldwide known Moscow Institute of Physics and Technology (MIPT – "Fizteh") and Moscow Institute of Steel and Alloys (MISA). To meet specific requirements of IBS project and product portfolios not only the master's course on project management, but also wider context of all Masters Education program was developed. Special topics of project management are included in various disciplines of the program on information management, economy and finance, strategic and operational management etc.

*AA063*

## Limits to professional Project Management

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### Abstract
This paper considers some of the factors influencing the development of professional project management. Some important limiting factors are identified. It is intended thereby that:

- A more realistic context will be used for developing the profession
- Plans for the profession's development will be more robust
- The global cost-benefit of project management will be enhanced

The content derives from extensive relevant personal experience as well as from wide reading of relevant texts. The topic is broken down into four main elements: external, internal, inherent and future.
The paper is designed for presentation rather than as an academic record of research, although reference is made to previous publications. Although trends and limits are suggested, no firm conclusion is drawn. Rather, further consideration along similar lines is proposed.

*AA016*

## Client's Critical Success Factors in Outsourcing of Construction Projects
## Case Study: Tehran Municipality

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### Abstract
To counter the competitive forces in the market, many firms re-evaluate their work by focusing on core competencies and increasing their outsourcing. Due to the project based nature of the construction industry identifying and evaluating key success factors will help top managers in implementation of successful outsourcing. These organizations primarily aim to finish their projects based on a defined scope of time, budget and quality, while accepted by the final customer. In this paper, a conceptual framework was defined based on literature review and interview with experts' panel. Key factors related to the success of outsourced project were evaluated quantitatively in

one of the largest project-based Iranian organizations, by using a questionnaire for one of their recent construction projects. Results show that successful implementation of outsourcing strategy in construction projects is strongly influenced by the level of coordination with the contractor, the contractor selection, clear project objectives, well defined technical tasks and client's top management support.

*AA091*

## Project Management Societies and Profession

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### Abstract

This paper argues that professions are a form of occupational control. Traditional professions have exercised this control based on a common acceptance of their contribution towards society. However, newer professions, including Project Management, may not share the characteristics of traditional professions but have been able to exercise occupational control by exerting power, influence and status through professional bodies and their occupational strategies. As the use of projects has grown, so too has the view that project workers may be regarded as professionals and join organisations that mimic the structure and ambitions of professional bodies. The influence project management associations can exert can be seen as unhelpful to the overall development of the discipline being seen as restrictive if not coercive. This paper examines three models from which a set of key characteristics needed to establish occupational control is drawn. The main implications for the potential of project management as a profession are centred on adjusting occupational strategy and control.

*AA098*

## Enterprise Resource Planning Systems for Project-Based Firms: Costs, Benefits & Implementation Challenges

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### Abstract

Enterprise Resource Planning (ERP) systems are configurable enterprise-wide information system services that integrate information and information-based processes within and across functional areas in an organization. They have been widely adopted in many organizations and accepted as a *de facto* industry standard for the replacement of legacy systems. This paper analyzes and presents the costs and benefits of ERP systems for project-based industries, which have lagged behind other major industries in adopting ERP systems due to their project-centric nature and the high stakes involved in ERP implementation. The challenges during the process of ERP implementations are also identified as part of the effort to understand the implied costs of an ERP system. The evidence of the costs and benefits is drawn from previous studies and the analysis of the prevailing working practices in project-based firms. The classification of the costs and benefits constitutes a cost and benefit taxonomy which can be used to enable executives in project-based firms to make informed decisions on their ERP system investments.

*AA116*

## Standardizing of Standards in IPM of Construction

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### Abstract

PM including construction nowadays crosses the borders of countries which points to the necessity to overcome borders of technical languages and culture. For it is necessary to unify the quantitive measurement properties of building materials. In the presented model standardized standards of building materials are connected with known technology of matrix coding, scanning and decoding . The model can be used in PM technology starting from the design of building in form of specification of project elements, their functions and resources bearing these functions and on the other side starting from the manufacture of producing specified resources and passing through the supply chain to the building site, including automated control by owner's supervisor. Implementing the BIM makes it possible to automatize over twenty datamation procedures in the project life-cycle.

*AA073*

## Resource-Constrained Scheduling of Construction Projects and Simulation of the Entropy Impact on the Duration and the Cost of a Project

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Abstract
The paper reports on research about the relationship between project resources and the entropy generated during construction, as well as on the development of a related mathematical model. The aim is to optimize the allocation of resources in a resource-constrained project by use of an entropy metric, to study the delays which occur during the project and to relate them with the resources and the entropy in the project. Entropy is hereby defined as the disorder brought about by the fluctuation of resources in the project, and a higher entropy value relates to a higher risk in terms of schedule completion. The case study shows that a significant reduction of time (up to 25.7%) can be achieved by utilizing the entropy method for allocating resources. Furthermore, should a resource-constraint be imposed then the entropy approach results in a schedule that shows a 6.25% improvement in duration (and 8% in profit) over the solution obtained by classical scheduling methods. The reported work builds on previous and ongoing research at the University of Cyprus and the Democritus University of Thrace.

*AA056*

## Skills and Competences of Project Managers

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Abstract
This study aims to diagnose the skills and competences profile of Project Managers in a holistic approach by utilizing a comprehensive framework (ICB–IPMA Competence Baseline Version 3.0, 2006). The Competing Values Model is adopted to operationalize Project Managers' effectiveness, as it shares wider acceptance among researchers. It is constituted from two dimensions (flexibility versus control and internal focus versus external focus), defining four quadrants that address distinct demands in the organizational arena. The Competing Values Model has also been utilised as a device for mapping organizations' leadership profiles and conducting comparative analysis. Furthermore, it may serve as a diagnostic tool, providing guidance to Project Managers in the identification of the key skills and competences that they will need to improve in order to foster individual effectiveness. This preliminary field research (the research is still on-going) is based on a structured questionnaire pilot-tested and adapted to fit to Greek reality.

*AA018*

## Development and Prototype Application of an Oil Spill Risk Analysis in a Coastal Zone

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Abstract
This paper introduces the development of a methodology for performance of oil spill risk analysis in coastal zones through a prototype application. The main objective of the research effort is to develop the basis for a tool that can assess risks due to the occurrence of an oil spill event aiming at assisting to the risk response process. The methodology concerns the processes of probability and consequence assessment. The two processes are accomplished qualitatively with a risk prioritization based on Analytic Hierarchy Process. Being a decision-making technique, Analytic Hierarchy Process can only be used after some appropriate modifications, which transform it into a tool for prioritizing risks with respect to their probability and consequence in different oil spill scenarios. This is an approach that attempts to rationalise the risk analysis stages and to indicate the uncertainties imposed to the problem, hence creating a basis for optimization of the risk analysis results.

*AA013*

## Analysis of Project Performance of a Real Case Study and Assessment of Earned Value and Earned Schedule Techniques for the Prediction of Project Completion Date

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Abstract
The management of a project, especially in the construction industry, is without doubt a subject of high

interest, demanding and complex and in the same time challenging and exciting. In the line process of planning-supervision-control, the last element enables the manager to determine the deviation range of actual practice from the original planning. Developing a construction schedule for a complex viaduct using the software MS Project 2007, and tracking the progress with real dates and durations, the results of Earned Value (EV) and Earned Schedule (ES) techniques are assessed regarding the duration forecasting accuracy schedule performance of a late finish project. The schedule includes complex interrelations, logistics in relation to the effective management of construction equipment and unforeseen events during the construction process. Three different scenarios are examined, from the construction of the whole bridge to a single structural element in order to assess the effectiveness of the methods, their sensitivity to re-baselining, and the contribution of critical tasks to the end result.

*NGO3*

## Social Economy and Certification in the Context of the EQF

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### Abstract

One of the economy sectors, which in the past years has been concentrating the interest of researchers is that of the social economy, contributing to the development of regions and support of groups of the population that are struggling with significant problems of unemployment. The lack of a specialized executive dynamic workforce, and especially the weakness of the typical educational system to adapt to new data and conditions, has led many individuals with insufficient typical qualifications to be active as advisors and/or educators of social economy. The present paper deals with the development of a professional profile of the advisor of social economy and an innovative method of certification of non-formal learning that responds to the directional guidelines of the EU in relation to the recognition of learning outcomes. The research that was conducted, utilizing the Delphi Method on 45 participants in 3 different EU countries revealed a necessity for the certification of informal learning in the specific field. With regards to the methodology of certification, a new, innovative method of correlation of the learning outcomes with the European Qualifications Framework is being proposed. In parallel, the need for further research in the field of social economy, and especially with regards to the methods of exploitation and integration of the suggested methodology to non-governmental organizations, is highlighted.

*AA023*

## Predicting Cost of Prefabricated Housing Using Neural Networks

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*Mirsad Kararić*
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Mladen Radujković
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### Abstract

Political and economic pressures have become an aggravating circumstance for construction companies in achieving basic project management criteria, i.e. cost, time and scope. The construction's low performance only stresses out the need for improving current practices - especially in regard to cost. Therefore, we sought to find a critical set of variables for predicting total cost of prefabricated housing. We applied neural networks on data from more than 30 projects and thus have identify 17 critical variables for the cost prediction. The model was verified on 28 buildings with following performances: 85.7% of predicted values had the deviation lower 5%, while 10.7% had the deviation lower than 10%, in relation to the actual cost. After validating the model on data from 3 buildings, that had been new to the network, the performances were as follows: 83.8% of predicted values had the deviation lower 5%, while 12.9% had the deviation lower than 10%. Therefore this model showed to be very robust. Furthermore, this study has also demonstrated a more efficient and effective way of predicting total cost of building. Thus construction companies can influence project performance during project early phases, and acquire more competitive position on the market. Conclusion brings guidelines for use of the model and gives recommendation for its further development.

*AA100*

## Informal Projects Management with Volunteers Participation

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Abstract
This article presents the results research conducted to identify key elements influencing the success of projects managed in informal way with volunteer participation. The data was collected from several "soft" projects. These projects included organisation of sporting, cultural, and charity events targeting large groups of people. The research involved discussing the following areas:

- roles and activities of volunteers,
- rules for employing volunteers ,
- factors influencing the success of the projects including:
  - the trust as the base of informal projects management,
  - intra-project communication,
  - cooperation
  - team work.

Project risk, reporting, execution control, and the role of project culture as elements influenced on project success were discussed.

*AA028*

## The Greek Legal Framework on Occupational Diseases in Construction: Conformity to Risk Management Standard

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Maria Anastasiou
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Socrates Maggos
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Abstract
This paper investigates the conformity of the Greek legal framework on occupational diseases in construction with the guidelines for application of risk management as described in the Project Management Body of Knowledge, a credible international standard. The aim of this research is to identify specific provisions in the Greek legal framework that require further improvement towards an effective risk management of occupational diseases. To achieve this goal, related laws and presidential decrees are analysed and their provisions are associated – based on content – to the appropriate risk management process. The identification between the levels of compliance of legal provisions with the specifications described in the standard is performed through comparative analysis. The results reveal that the current Greek legal framework addresses the issue of risk management for occupational diseases in an unsystematic and incomplete way. The research identifies certain weaknesses and makes specific suggestions towards a legal framework aligned with the respective international standard.

*AA030*

## The Development of a Robust Resource Constrained Project Scheduling Framework

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Abstract
The literature on resource constrained project scheduling attempts to schedule projects with deterministic activity durations subject to various objective functions and possible additional assumptions. During project execution, however, a project may be subject to considerable uncertainty. Such uncertainty may lead to the actual realized activity durations to substantially deviate from the durations that were initially estimated in the baseline schedule and cause a serious project overdue. This paper offers a framework that deals with the project scheduling problem from the start of a project through to the finish, and therefore provides a whole robust project scheduling strategy which is more tolerant to various uncertainties. Our framework combines the buffer sizing technique, proactive project scheduling approach and reactive project scheduling approach, which are usually implemented at different stages of a given project. The proposed scheduling framework constructed based on these approaches is tested using a large experimental design in order to detect the effectiveness of each procedure.

*AA114*

## Planning, Implementing and Managing Energy Efficiency Projects at Focused Local Level: The RURASU Project Successful Example and the SAVE-AGE Project Objectives

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Abstract
The effort to succeed the EU's commitment of the "20-20-20" initiative-reducing greenhouse gas emissions by 20%, increasing the share of renewable in the energy consumption to 20% and improving energy efficiency by 20%, requires multi-level actions and special projects that should be focused on specific targets. Additionally to the large-scale projects, mainly focused on RES at national level, it is important to provide support and knowledge at local level, especially in the sector of energy efficiency. Local actors and citizens outside major urban areas are often unaware of techniques and measures that could add the maximum potential gains to the overall targets in the energy sector. For this reason, Pieriki Anaptixiaki-local development agency in Greece (Pieriki) has implemented successfully several projects focused on disadvantageous categories of citizens and areas. Moreover, Pieriki is launching, under the coordination of E-zavod (Slovenia), a new transnational project focusing on strengthening energy efficiency awareness among residential homes for elderly people, under the title of SAVE-AGE.

*AA095*
## Reformation of Local Development Agencies Seeking Conservation in their Wider Market

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Abstract
Local development agencies, acting in Greece for almost 20 years, are facing important threats for their existence; the general crisis and the specific new imposed frameworks require immediate actions. Aim of this paper is to analyse this situation and to provide information on the detailed framework that could be adapted in order to succeed conservation. The analysis method is based on actual data and on actual processes that have led to successful conservation results-results that demonstrate the actual need for reformation.

*AA079*
## Projects for the Design of Changes

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Abstract
According to Levy and Merry (1986), changes can be differentiated into first order changes and second order changes. First order changes describe changes in few dimensions of the identity of an organization (e.g. changes in the products & services offered) that might be performed continuously and not necessarily lead to a change of the overall identity of an organization. Second order changes include changes in many dimensions (e.g. the new organizational structures of a company, including impacts on personnel, infrastructure, budget, etc.) and lead to a new paradigm, a change in the identity of a company. In the paper, change will be considered as fundamental, holistic change of an organization, and it will be further differentiated between "radical new positioning" (as consequence of a crises or chance) and "transformation". This "discontinuous" change can happen if strategic alliances are undergone, through the merger of companies, or through existential loss of market shares. Such a change has an impact to all dimensions of an organization and is of high strategic importance. The high complexity of the change demands an appropriate complexity in the design of the process. On the one side, immediate measures must be taken, on the other side, projects respectively programs as temporary organizations can be used for structuring the change.

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# Conference Papers

*AA094*

# Critical Review of the Current Public-Private-Partnerships Legal Framework in Greece with Respect to Legal Risks Management

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## Abstract
Success of Public Private Partnerships (PPPs) heavily depends on the host country's legal and regulatory framework. Legal risks are primarily connected to inefficiencies of legal agreements and documents and lack of specific and clear provisions and regulations. This paper presents an inventory of legal risks based on literature review and compares it to the current legal framework for PPPs in Greece aiming at highlighting the latter's strengths and weaknesses with regard to the management of risks. The results of the analysis indicate several strengths of the current legal framework, while the major weaknesses are the vagueness in certain cases, which allows for various interpretations and the negligence in the enforcement of laws and regulations.

## Keywords
Risk management, Legal risks, Public Private Partnerships

## 1. Introduction

A Public Private Partnership (PPP) is a well known method all over the world employed to deliver projects or offer services to the public. It consists of cooperation between public and private sector partners, with the aim to deliver a service or a facility to the public that is traditionally provided by the public sector. The partners offer their skills and assets and share the various risks associated with the project. The reasons for choosing a PPP as a project delivery method usually lies at legislative, budgetary or public pressures.
The main advantages of PPPs, according to the European Commission, Guidelines for Successful PPPs (European Commission (2003)) are the following:

- Acceleration of infrastructure provision
- Faster implementation
- Reduced whole life costs
- Better risk allocation
- Better incentives to perform
- Improved quality of service
- Generalization of additional revenues
- Enhanced public management

PPPs are associated with a great number of risks, which may cause delays and/or problems to the realization of projects. Risks can be attributed to a number of factors affecting the success of a PPP at different project stages. One very important factor is the legal framework. The comprehensiveness of the legal framework about PPPs can significantly boost or hinder the adoption of the PPP method and create undesired

effects both to the cost of public works and to the related markets. For a classification of legal risks the reader can look at Xenidis and Angelides (2005), Wang et al. (2004), Lensink et al. (2000), Bing et al. (1999), Wang et al. (1999), and Menheere and Pollalis (1996).

This paper reviews the current legislation in Greece that governs the PPP method and attempts to identify strengths and weaknesses with respect to the management of legal risks.

## 2. Legal risks in PPPs

Legal risks constitute those risks that emanate from the uncertainties at the interpretation and negligence in the enforcement of rules of law. The concept of legal risks may address also political, social and organizational risks in the sense that these risks are, also, perceived through documents of legal nature (Xenidis and Angelides, 2005). Based on the previous work by Xenidis and Angelides (2005) a set of 23 risks is presented in Table 1 (these of primarily legal nature are presented in bold). The presented risks may apply to any case of PPP, however not all risks are equally expected in a specific project. Moreover, not all risks are of the same type or generated by the same source (i.e. public or private sector).

| |
|---|
| **Prejudiced and unfair process of awarding the project** |
| Host-country's interference in choosing subcontractors |
| **Overprotective control/supervision by the host government** |
| Disapproval of guarantees by the government |
| Unfavorable changes of host-country's policy |
| Change of host-country's fiscal regime |
| **Expropriation/Nationalization of the project** |
| Lack of political support by the government |
| Lack of political stability |
| Non-cooperation between different public agencies |
| Actions or omissions of the public authorities that prevent the project to be completed |
| Varying focus for the project by the parties involved |
| **Vague and inconsistent clauses and specifications and inaccurate phrasing** |
| **Non-accordance between all contracts in the PPP framework** |
| Language barrier for the contract |
| **Breach of contract provisions** |
| Relatively unknown status of the stakeholders |
| **Unanticipated change of the concessionaire scheme** |
| **Lack of confidentiality and trust in the concession company** |
| Public opposition if environmental or social impacts are questionable |
| Force majeure |
| Public disorder / Riots |
| Terrorism |

**Table 1**: Risks in PPPs

Legal risks may occur and re-occur at different time periods during the project's lifecycle. In order to minimize adverse impacts from risk occurrences, a transparent, fair, and steady legal and regulatory framework coupled with proper application of risk management processes is required. The next sections analytically present the current

framework in Greece and prove the level of compliance with the abovementioned requirement.

## 3. PPP legislative framework in Greece

### ▪ EC rules concerning PPPs

At the European level there is no concrete legislative framework governing PPPs. Instead, the European Commission relies on the experiences of the European Union's (EU) member states, in order to identify the minimum common characteristics of PPPs and, also, to attempt a first codification of the various PPP forms (Commission of the European Communities (2005), Commission of the European Communities (2004), European Investment Bank (2004), European Commission (2003), European Commission (2000)).

The long term partnership between the public and the private sector, the financing from private funds, the allocation of the various risks and, finally, the special new roles undertaken by both the partners from both sectors can be identified as common characteristics in PPPs.

When it comes to codification, PPPs can be classified into a) *institutionalized* partnerships and b) partnerships of *contractual* type. For the former type a new legal entity needs to be established in order to accomplish the PPP goals. This new entity is being established either ad hoc or by partial privatization, meaning that private entities acquire part of the capital of an existing entity of the Public Sector. In both cases, the control of the entity is shared among the partners of Public and Private sector.

In the case of contractual type partnerships, the partnership is established through a special contract. The PPP contract can be either a Concession Agreement between the public and the private sector partners on which the private partners finance and implement a facility or a service and receive user fees as a return, or a Private Finance Initiative (PFI) where the private partner is being paid during the contract period by the public sector. Payments can be either fixed or variable depending on the agreement terms.

### ▪ Greek law 3389/2005

In Greece there was no specific legislative framework for PPPs until 2005. There had been several cases of PPPs but mainly in the form of concession agreements for the Design, Financing, Building, Operation and Maintenance (DBFO) of major infrastructure, passed through parliamentary ratification. Recent examples of such concession agreements include the Rion-Antirrion Bridge, the Athens International Airport, the ATTIKI ODOS Freeway and the new concession motorways of Greece. All of these PPPs have been of contractual type. Further in the past a number of major projects had been realized through PPP initiatives such as the Korinthos Canal, the Electric Power Industry (DEH), etc.

The first specific law providing for PPPs in Greece is L. 3389/2005, further amended by L.3843/2006 (Article 16, Par. 1).

The PPP definition included in L. 3389/2005 speaks about a co-operation contract, from pecuniary interest, among public and private sector entities for the construction of a

facility or the provision of services in areas of responsibility of the public sector partners. It is therefore identical to the general definition given previously in the introduction. However, PPPs, according to L. 3389/2005, can be only of contractual type; in this respect Greek legislation is narrower than the respective legislation of other EU member states.

Given the complexity of the various legal relationships which are created in a PPP agreement, the main PPP contract is accompanied by ancillary agreements with third party entities, governed by the same legislation (i.e. agreement between the concessionaire and the constructor, the concessionaire and the service provider, the loan contracts, the insurance contracts, etc).

According to L. 3389/2005, public sector partners can be the public authorities (ministries, regional authorities), local authorities (prefectural and municipal authorities), other bodies governed by public law and those legal entities under private law, which are fully controlled by public authorities.

Individuals are not allowed to be private partners in a PPP, unless they create a special purpose limited company. Special purpose companies, according to Greek legislation, are those which are established exclusively for specific purposes, in this case for the PPP purposes. Public authorities can establish a special purpose company with other public sector bodies, provided that they do not own 100% of the capital. This means that public entities can be only contractual partners in a special purpose company and not regular shareholders.

Specific restraints are applied to the transfer of the shares of these companies of special purpose in order to secure transparency and direct control over the composition of the shareholders. The lending institutions (i.e. banks) are happy with this because they prefer to have transactions with legal entities that have a specific scope and they are not involved in other businesses.

Based on the above, L. 3389/2005 does not cover institutionalized PPPs, since it does not provide for the establishment of a mixed capital company, neither the transfer of part of a public enterprise to a private legal entity. This is rather a disadvantage of the specific law. Institutionalized PPPs will have to be established through other legal procedures.

## 4. Critical Review of L.3389/05

L. 3389/2005 was initially saluted positively by the legal and business communities of Greece because it was considered to provide a steady legal environment able to encourage the PPP concept and create a reliable market environment. In fact it is still believed that many of its provisions have been to the right direction since they could overcome many legal risks and could speed up investments for the benefit of the country. More specifically the main advantages of this law are the following:

*Central administrative support and guidance for the public authorities*, through the establishment of the Inter-Ministerial Committee for PPP (collective governmental body) and the Special Secretariat for PPP (PPP unit), (art. 4, par. 2d).

*Provision for standardized contracts and ancillary agreements,* to speed up procedures – this goal has not been achieved yet (art. 4, par. 2h).

*Aim to comply with EC rules and general principles of public procurement*; for the 1st time the public procurement general principles have been defined in an article of Greek law (art. 9)

*Clear definition of the applicable legislation*, as sole framework binding the public and private entities, in order to ease the fears of the potential investors and the markets from the vast Greek legislation (art. 17, par. 1)

*Central definition of the procedure to collect the contractual fee*, by providing that the PPP Unit is competent to define the procedure for the private entity to collect the contractual fee, in case that the fee is to be collected directly from the final users of the work or service (art. 19)

*Presumption of administrative permits issuance*, by providing –and for the 1st time in Greek legislation-, that these permits shall be deemed to have been issued, if the authorities responsible for issuing them have not proceeded to issue a written, reasoned refusal to issue the permits within a period of 60 days after the private entity has submitted the application for the permit; that all administrative permits required for the project shall be issued in the name of and for the account of the private entity (art. 20)

*Deadline for the Archaeological Authority to react,* by providing –for the 1st time in Greek legislation- that in the event that archaeological remains are uncovered during construction, the public authority shall, upon being notified by the private, communicate the event to the appropriate archaeological authority, which within 60 days must indicate ways for continuing the project works and proceed to the necessary actions in order to secure the protection of the antiquities (art. 21)

*Provisions for the environmental impact studies and the protection of environment,* by providing that the environmental impact studies required in each project shall be prepared and submitted for approval; they need to be approved before the award of the PPP contract; if the public entity involved, for reasons that could not originally have been predicted, even if special care is applied, imposes additional regulations, it must indemnify the private company for any additional cost or expense it may have sustained; the contract may include measures for increased protection of the natural and cultural environment, as long as these measures have been included in the respective invitation to tender (art. 22)

*Presumption for the expropriations;* the expropriations or the constitution of rights in rem or liens to those properties under the law shall be deemed to serve purposes of obvious public interest and shall be regarded as urgent and of major significance, provided that the official approval of the compulsory purchase includes adequate evidence that the particular expropriation serves objectives of public interest (art. 23)

*Provision for immediate and in order of priority reaction of public utilities companies;* Public agencies and public utility companies are entitled to proceed immediately in order of priority to carry out work and implement measures within their area of responsibility, which are necessary or useful for the smooth and unhindered execution of works or provision of services under this law; if the public agencies and utility companies do not fulfill their obligations, the private may request and the public entity shall be obligated to grant an extension of the deadlines laid down in the contract and the private shall be again entitled to seek redress for any loss it may have sustained as a result of the said delay (art. 24)

*Legal objectives;* the possibility of assignment of claims under the contract (art. 25); the fact that the validity of sureties *in rem* are not compromised by any subsequent bankruptcy (art. 26).

*Financial objectives;* the income tax exemption on accrued interest payable up until the date of commencement of the operation; the special tax regime applicable to financing contribution by a public entity (the amount of aid shall be construed to be a capital subsidy and shall not be subject to VAT, income tax or any other tax, and shall be paid free of any withholdings in favour of any third parties); the return of VAT credit balance within 90 days to third parties under contract with the private entity and finally the possibility for the private entity to transfer and settle accumulated losses against the taxable profits of the next 10 financial years (art. 29)

*Resolution of disputes, by mentioning* that any dispute arising in relation to the application, interpretation or validity of the partnership contracts or ancillary agreements shall be resolved by arbitration; moreover and in deviation from the provisions in force for public sector arbitration, the Contract sets out rules for the appointment of arbitrators, the rules of arbitration to be applied, the place of the arbitration court (or other body), the fees to be paid to the arbitrators (where fees are not specified in the applicable arbitration rules) and the language in which the arbitration shall be conducted; the arbitrators' decision shall be final and irrevocable, and not subject to any further judicial or extra-judicial appeal; it shall be carried out without any requirement of ratification by the regular courts, and the parties involved shall be committed to comply immediately with its terms and conditions (art. 31).

## 5. An overview of the current situation

Until the promulgation of L. 3389/2005, the most important PPP contracts had to be ratified by a specific law. Regardless of this legalization procedure these contracts had suffer, and still suffer a lot for various reasons. The most important of them is associated with the lack of flexibility to amend the agreements in order to adapt them to a rapidly changing environment. There are cases the agreements cannot serve public welfare after a time period, but the obvious changes are not legally possible. Another disadvantage has been that the ratification procedure has been mainly acting as disincentive to create a PPP for a small budget project, because the inevitable long delays and the resulting extra cost that was making PPPs less cost effective. Despite that some successful PPP contracts were achieved such as the Rion Antirrion Bridge, the Athens International Airport and the ATTIKI ODOS, though for the latter the previously mentioned comments are fully applicable.

After the promulgation of L. 3389/05, parliament ratification of PPP contracts for the cases included in this law, is no longer needed. Specific issues that justified the ratification are efficiently manipulated in the law text. The law applies to PPP projects up to 200 mio € and makes clear that only a limited number of mature plans can enjoy the provisions of this law. Inclusion of a PPP project plan to this law is not compulsory, but it is optional. The general legislation about public contracts for concessions, services or public works remains valid and all EU Community directives (2004/17 and 2004/18) are fully applicable as well as the respective Greek laws (L. 3669/2008, L. 3316/2005 and PD 59/2007 and 60/2007). However major project contracts over 200 mio € will still may go through parliament ratification.

Currently, 5 years since the elaboration of the Greek PPP law, the competent administrative body has approved many projects of different types: construction and

maintenance of hospitals, of administrative buildings, of school buildings, of university buildings, of court houses, of prisons, of International Conference Center, of fire stations, installation and operation of security systems in Greek ports.

However, since 2005, and based on available data, only one PPP contract concerning the construction and maintenance of 7 new fire stations has only been signed. Some 70 other projects are in the pipeline waiting for the final go-ahead. These facts prove that the application of this law is very slow, despite its many good provisions. The main issues that hinder the successful application of L. 3389/2006 are in our opinion, the following:

- Lack of specialized personnel and lack of centralized support mechanisms; this was translated into extra time and cost since the authorities were obliged to hire, following a tender procedure, advisors/consultants to prepare the PPP tender documents.
- Lack of standardized procurement documents, though the need for standardization of the contracts and the new award procedure (competitive dialogue) is obvious
- Instable political commitment – incapacity of the public sector to manage its side, though legal certainty is particularly important in attracting interest in long term, in high levels of investment and in long term financial commitments by the contracting authorities
- Lack of an overall plan before decision
- No seek of best value for money resulting from a life cycle evaluation

## 6. Conclusions

After the introduction of L. 3389/05 a large number of potential legal gaps, associated with this type of contracts, have been filled. The specific law makes a lot of provisions that facilitate promotion of PPP schemes, aiming to implement facilities or provide services to the public, and also allocates risks among public and private partners arising from legal issues.

However, the de facto slow application of L. 3389/05, which is mainly attributed to the inability of the public sector to respond to the challenges of our era, shows that the legislation itself is not enough, neither to secure success of PPP initiatives, nor to significantly reduce risks.

The efforts of the Greek state to boost provision of services and new facilities through PPPs, without further burdening public debt in the short run, did not yield the expected outcomes, at least in the first 4-year period following the introduction of L. 3389/05. Furthermore, the large amounts spent for consultant fees to support public authorities made PPP's less attractive. A better overall picture will be possible only after the finalization of the procedures which have already started for the projects included in the Government plans.

Current legislation about PPPs in Greece seems to favor projects under 200 mio €, but the fact that only a very limited number of projects have been realized, proves that the environment for PPPs is still not the right one. Most authorities, despite that lack of funds for investments, prefer the approach of the conventional public debt tender. In this case, risk allocation is irrational and results to higher costs of project implementation and lack of best value for money. What seems to be needed is a Public Administration reform rather than a radical change in PPP legislation combined with extended staffing of these authorities. with specialized personnel

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*AA/055*

# A Risk Assessment and Management Framework to Support Project Delivery

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## Abstract
Risk factors associated with construction projects have a major impact on issues related to cost, time and quality of project delivery. Unexpected events result in either positive or negative outcomes often causing deviations from project plans and making construction projects particularly prone to risk. Despite the extensive research on risk management in the construction industry, there is limited literature dealing specifically with project risk in developing countries. It is against this background that this study investigates the use of risk assessment and management processes in organisations. Data were collected from construction professionals working with construction clients (both private and public), consultants, and contractor organisations within the Ghanaian construction sector. The survey data were used to examine the differences in the levels of agreement between the three stakeholders. The research findings indicated that although project stakeholders are aware of risk factors associated with construction projects, there is a need for the benefits of using risk management processes to be emphasised and communicated. Based on the research findings a risk assessment and management framework was established to support future successful delivery of construction projects in developing countries.

## Keywords
Risk assessment, risk management, developing countries

## 1 Introduction

In the current global competitive economy, managing various forms of risk is of paramount importance to an organisation's survival, Tah et al (2008). Additionally, stakeholders including regulators, legislators, investors, customers and the public are now demanding full accountability and effective controls. Proactive risk assessment and sound risk management is therefore necessary to protect an organisation's competitive position and the successful completion of construction projects.

This situation is undoubtedly more pronounced in developing countries, and may be directly related to the demise of some construction companies in Ghana where numerous construction projects fail to fulfil the expectations of users resulting in project failures. Clients' perceptions of delay in construction projects have revealed that most of the causes of project delay which lead to cost overruns can be avoided, or the impact substantially reduced, if risk assessment and management is

carried out effectively throughout the project life cycle (Agyakwa-Baah, 2009). It is therefore paramount that project managers, particularly in developing countries like Ghana, consider risk assessment and management as an integral part of the construction process.

## 2 Risk Assessment and Management

In risk management, one attempts to identify all possible foreseeable risks, and assess the likelihood of occurrence and impact. Decisions can then be made on how to manage risks by reducing their impact, or by avoiding them completely. Moreover, the risk management process must not only involve identifying potential risks but should include a formal planning activity. Estimates need to be made on the likelihood of occurrence and predicted impact (RAMP, 2002). A monitoring process should also be introduced to ensure that risks are reduced to the desired level (Kerzner, 2006). It is important to note that although risk management aims to ensure that risks are managed in the most effective way, it will not remove all risks from a project (Mills, 2001). It is imperative to ensure that risk management processes are made as simple as possible in order to remain manageable and effective (Dallas, 2005).

## 3 Ghanaian Construction Industry

Over the past 10 years, construction in Ghana has greatly improved, albeit not to expectations. The various sectors such as affordable housing, infrastructure and transport, including road and rail, have received some, but limited, attention. According to the External Aid Financing Performance Report, 2008, external aid, which includes grants and concessional loans flow into Ghana, has averaged some US$770 million between 2001 and 2007, registering its highest inflow of US$1.1billion in 2005. The average revenue flows generally representing some 25% of budget revenue and 6% of GDP.

In an effort to improve the Ghanaian economy and the government's objective in the Ghana Poverty Reduction Strategy (GPRS II) to promote the provision of basic services, much investment has been made in infrastructural development. The construction industry in Ghana, therefore, plays an important role within the economy. However, despite the investment made, construction is still largely inefficient as characterised by lengthy payment delays, cost and time overruns, and poor project implementation. Moreover, many of these issues can be directly attributed to risks not being managed effectively on the projects.

## 4 Aims and Research Methodology

The aims of the research were to investigate the implementation of risk assessment and management practices in medium and large enterprises within the Ghanaian Construction Industry, and to develop a framework that would facilitate effective risk assessment and management practices. The research carried out adopted a quantitative and qualitative approach involving both the administration of questionnaires and interviews with construction professionals within the Ghanaian construction sector.

The research focused on three categories of respondents within the industry. A total of 180 questionnaires were administered to professionals working for

contractors, consultants and clients with a resulting response rate of 57%. Interviews were also arranged with 10 experienced professionals who were randomly selected from a cross section of organisations. The interviews provided useful information on the awareness of risk assessment and management processes.

## 5 Development of Risk Assessment and Management Framework

In considering the practicality of a framework it was important to seek the opinions from respondents as to whether they agreed that the development of a risk assessment and management framework for the Ghanaian construction industry would greatly influence projects outcomes. The majority of the respondents (i.e. 85% of contractors, 91% of consultants and 100% of clients), believed that there was a need for a framework that could be effectively used by Ghanaian construction organisations. This indicated that most respondents were supportive of implementing a procedure that would guide them in carrying out the risk management process.

The framework shown in Fig. 1 was developed based on information from literature and research findings, together with information obtained on other approaches used by construction organisations in the UK (Agyakwa-Baah, 2009). The framework is composed of three major components which are; communication and monitoring, risk assessment and management processes, and risk management tools and techniques.

### 5.1 Communication and Monitoring

The results from the research indicate that team work and communication is critical in the process of risk assessment and management. The management style used will also have an effect on communication, and there is a need for effective monitoring throughout the whole process, especially when risk management measures are put in place.

### 5.2 Risk Assessment and Management Process

In utilising risk management, it is essential to identify all foreseeable risks, assess the likelihood of their occurrence and impact, and then decide on how to manage them, or avoid them completely. It is important to note that each project will require a bespoke risk management approach and a plan that will fit its specific requirements.

### 5.3 Risk Management Tools and Techniques

Throughout the risk management process, appropriate tools and techniques need to be adopted. Some common techniques for risk identification would include: influence diagrams, fault trees, cause and effect diagrams, in addition to checklists. For risk assessment, tools and techniques would include: probability impact, sensitivity analysis, Monte Carlo simulation, and Bayesian analysis. Additionally, algorithms, mean end analysis, Bayesian theory and decision trees, amongst others, are methods of decision analysis, which provide decision making tools for use in uncertain environments. Other tools needed for the process include, prior risk knowledge, decision support systems, qualitative and quantitative measures,

and risk mitigation planning. Several software tools are also available for risk management which can be used as part of the framework implementation.

The information required to carry out the process includes:

- Understanding of scope of work and site environment
- Client's planning supervisor's risk schedule
- Tendering team's risk schedule
- Subcontractors' perception of risk
- Site team's perception of risk
- Other stakeholders' risk both known and perceived
- The tender, with contract programme.

The issues in applying the risk assessment and management practices in each of the phases of Fig. 1 are addressed as follows:

*Phase 1- Planning and Preparation*
Organisation and Training - It is important for training to be organised which will help in the awareness of the overall process. The tools and techniques to be used need to be agreed at this stage.

Risk Management Plan - A risk management plan should be established to set out the type, content and frequency of reports, the roles of risk owners and the definition of the probability and impact criteria, covering time, cost, performance and quality.

Process Plan and Control - The plan for the risk management process needs to be drawn up so that it serves as a guide to control the process.

*Phase 2- Risk Identification*
Make a list all possible Risks - There is a need to make a list of all possible risks, known or perceived. This can be achieved through brainstorming, using prompts or lists, and historical records.

Identify Nature or Area - This refers to the nature of the risk and source of the risk.

Identify Owner of Risk - The owner of the risk can be the contractor, subcontractor, client, or a third party.

*Phase 3- Risk Assessment*
Identify Probability and Impact - It is important to identify the earliest and latest event dates.

Prioritise Risks - From the impact and probability of the risk, establish a rating e.g. 1-5 rating or high, medium and low risks.

Grade Priority – Select those that are high risk that needed immediate attention, disregarding those that are low risk, which can be ignored.

More Detailed Analysis - For risk factors that need more detailed analysis, other tools and methods such as Monte Carlo Simulation and Bayesian analysis may be used.

*Phase 4 - Risk Response/Management*

Assign Action for Priority Levels – establish appropriate actions related to the priority levels of risk.

Assign Levels of Authority – establish levels of accountability and authority to individual staff.

Ensure Risk Allowance in Cost Plan – Appropriate risk allowances must be included with cost plans.

Establish Control Measures/Actions – Identifiable control measures and actions to be established as appropriate.

Communicate measures to Risk Owners – All aspects of risk associated with the project should be communicated to appropriate risk owners.

*Phase 5 - Monitoring and Control*
Assess Risk Status – the status of risk level to occur must be assessed before its impact is experienced.

Assess Control Measures – establish appropriate control measures appropriate to the status of risk occurrence.

Elapsing of Event Time – constant monitoring of risk throughout its period of occurrence until the event time has elapsed.

New Risk Identification - New risks identified would have to go through the whole process. If the control measures adopted for any of the risk factors is not effective, these will need re-assessment.

## 6 Implementing Risk Management Measures

A critical evaluation of risk factors in the research led to the development of possible risk management measures that can be applied to Fig. 2. in order to manage indentified risk. The risk factors were placed under groupings: Stage 1: All stages, Stage 2: Planning & Design, Stage 3: Construction.

For example in Stage 1: All stages, risk factors include: change of government, change in government policy, poor communication amongst the project team, lack of commitment, local laws, and quality and performance control.

Corresponding risk management measures include: obtain insurance for political risks, adopt effective quality control procedures, review risk management processes with all project team members, review project plans with all stakeholders, and adopt a non-adversarial procurement strategy and form of contract.

Risk factors and corresponding risk management measures were also established for stage 2 and stage 3.

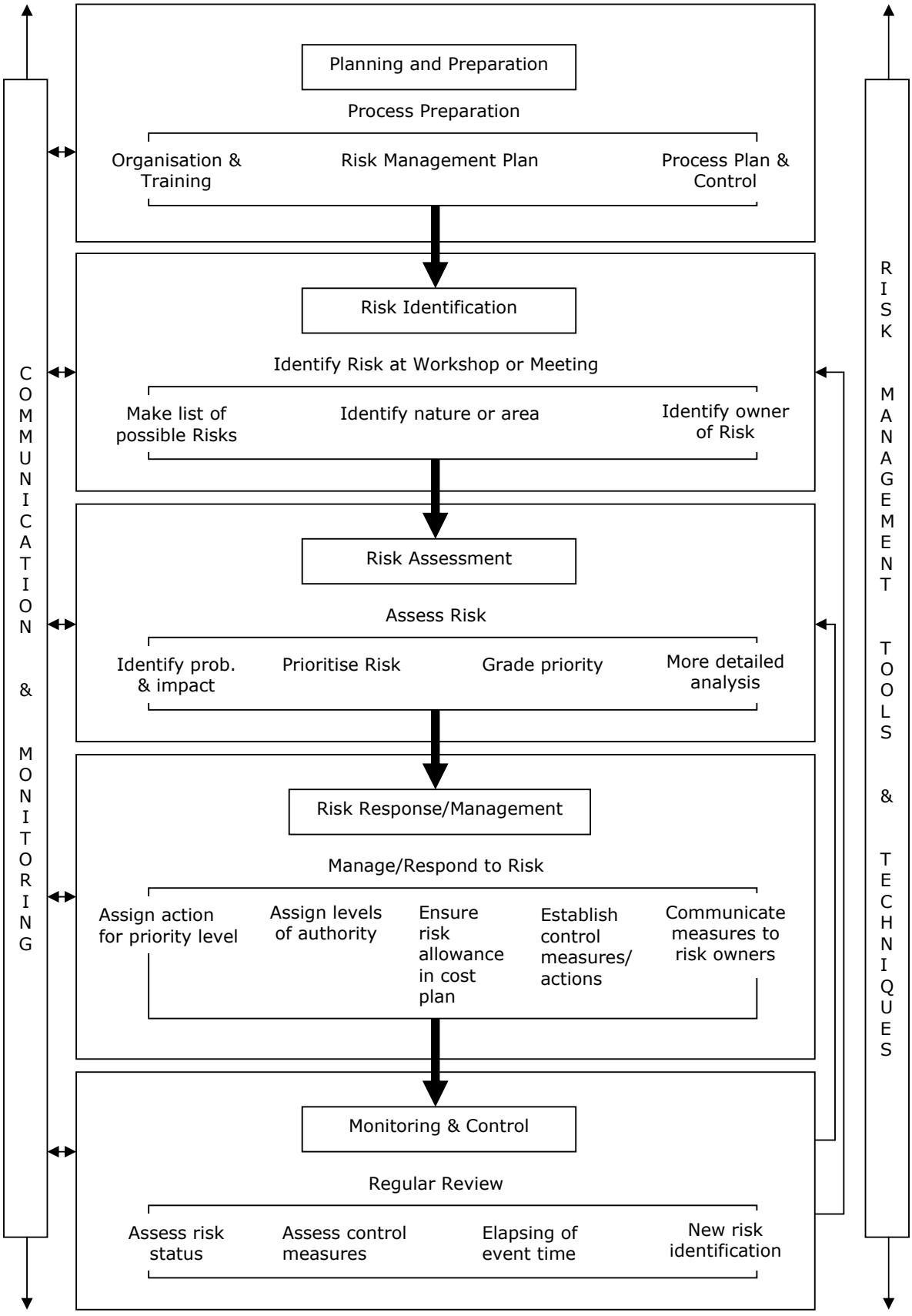


**Fig. 1**: Risk Assessment and Management Framework

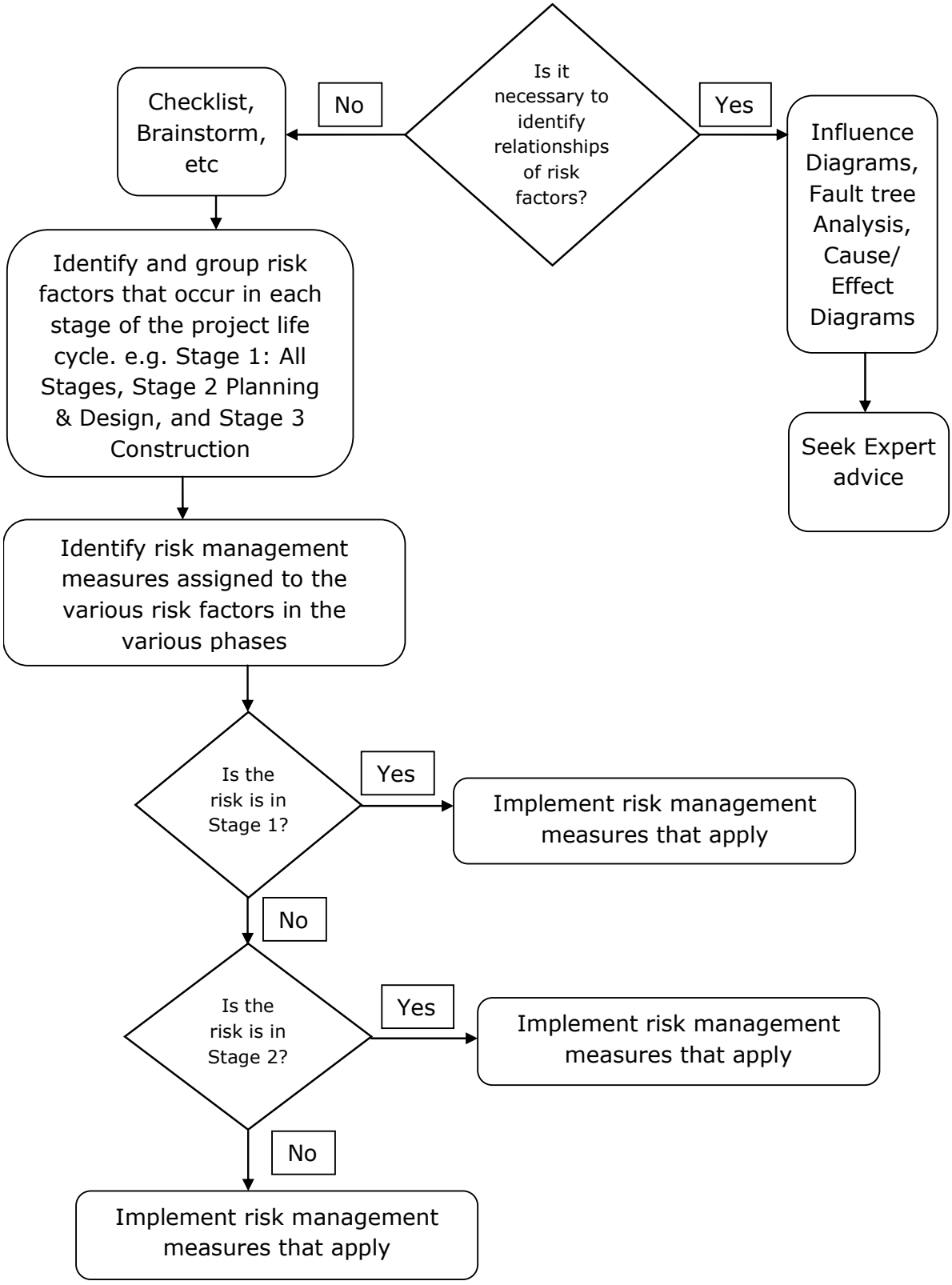


**Fig. 2**: Risk Assessment and Management Framework (Manage Identified Risks)

## 7 Conclusion

The study into risk assessment and management in the Ghanaian construction industry has revealed that there is a need for construction organisations as well as project stakeholders to be made aware of the benefits of using risk management processes. The research findings show that the majority of respondents believed that there is a need for the development of a risk assessment and management framework that can be used efficiently and effectively. Construction organisations in Ghana need to organise and deliver training programmes on risk management in order to equip staff with the tools and techniques they will need in managing projects. The use of such tools within a risk assessment and management framework will be an essential requirement to avoid cost and time overruns, and support future project delivery.

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*AA086*

# Critical Success Factors for Risk Assessment and Management Processes Implementation: Perceptions of Construction Professionals in Ghana

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## Abstract
Despite the extensive research on risk management in the construction industry, there is limited literature dealing specifically with the identification of critical success factors necessary for the deployment of risk assessment and management processes in developing countries. It is against this background that this study attempts to elicit the perception of construction professionals on CSFs appertaining to risk assessment and management processes within the Ghanaian construction industry. Data was collected from 34 contractors, 46 consultants, and 23 clients (private and public) within the Ghanaian construction industry. Response data was subjected to descriptive statistics and subsequently analysis of variance (ANOVA) and other non-parametric tests were used to examine the differences in the identification of the critical success factors. The research findings indicated that among the critical success factors, 'Management style' and 'team work and communications' were ranked as the most important whereas 'goals and objectives of the organisations' and 'customer requirements' were considered to be the least important. There was a disparity of the ranking of the 10 critical success factors among the groups; however the differences were not statistically significant. The study also established a number of managerial implications in that the identified critical success factors could be used as a 'road map' for the successful implementation of risk assessment and management processes in developing countries.

## Keywords
Construction industry, Critical success factors, risk management, developing countries

## 1. Introduction

The Construction industry in Ghana has been growing steadily over the years. The Government's objective in the Ghana Poverty Reduction Strategy (GPRS II) to promote urban infrastructure development and the provision of basic services including increased access to safe, decent and affordable shelter has given the industry a further boost. Ghana seeks to be the gateway to West Africa and the champion of African excellence. The 2008 Budget Statement of Ghana projected the Construction industry to grow by 11.0 percent, exceeding the 10.0 percent target for the year. This statement attributes the growth to the increased road construction and other infrastructural development throughout the country. The Construction industry in Ghana has been growing steadily over the years. According

to the World Bank (2003) report, the annual value of public procurement for goods, works and consultant services represents about 10% of Ghana's Gross Domestic Product. Despite the noted contribution of the Ghanaian construction industry to economic growth and development, it is still fraught with frequent cost overruns and delays on a lot of projects. The above observation calls for the further exploration into the possible implementation issues of risk assessment and management techniques on construction projects executed in Ghana. For example, how many construction organisations in Ghana currently implement risk assessment and management techniques? If there are, what are the critical success factors to the deployment of RAMP? Can the level of RAMP deployment be assessed? Thus, based on the analysis of past research, the main objectives of this paper are as follows:

(1) To identify the critical success factors of RAMP in the Ghanian construction sector; and (2) To examine whether differences exist in the perceptions of the critical success factors by the construction professionals working with the 3 groups of respondents (clients, contractors and consultants).

## 2. Literature Review on Critical Success Factors

Rochart (1979 cited in Chen 1999) was first to define the concept of critical success factors. These were defined as "the limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organization". Oakland (1995 cited in Salaheldin, 2009) defined CSFs as the critical areas which organizations must accomplish to achieve its mission by examination and categorization of their impacts. The importance of csfs has also been highlighted by Johnson and Scholes (1999) through acknowledging that one of the major shortcomings of strategy implementation in organisations is a failure to translate statements of strategic purpose. Within the concept of benchmarking, Deros et al., (2006) defined CSFs as a range of enablers which, when put into practice will enhance the chance for successful benchmarking implementation and adoption in an organization. Drawing heaving on Deros et al., (2006) definition of CSFs, within the context of this study, are defined as drivers or enablers for successful risk assessment and management practices implementation. Several studies have examined the antecedents to risk management practices (e.g. Mok et al.,1997; Akintoye and MacLeod, 1997; Frimpong et al., 2003; Abor, 2005; Ayirebi Dansoh, 2005; Hassanein and Affify, 2007; Osburn, 2008; Luu et al., 2008). Other studies such as Toor and Ogunlana (2009) have identified critical success factors for large construction projects. The following section briefly describes some of these studies and the critical success factors as adopted within this study.

Mok et al., (1997) observed that the successful implementation of risk management process (RMP) depended on whether the critical success factors could be overcome. The management style adopted in any organization will therefore go a long way to affect the way risks are managed. Aje et al., (2009) identified contractor's management capability as one of the factors impacting on time and cost performance of building projects.

Lack of awareness of risk management processes has been identified as leading to poor resource management (Frimpong et al., 2003). According to Frimpong et al., (2003), project management tools and techniques play an important role in the effective management of a project. Dada and Jagboro (2007) examined the impact of risk on project cost overrun in the Nigerian construction industry and identified

improper assessment of risk factors as a contributory factor to ineffective project delivery. Manelele and Muya (2008) also found lack of technical advice as one of the project initiation risks affecting community based projects in Zambia. Hassanein and Affify (2007) evaluated the risks relevant to construction contracts among Egyptian international and local contractors and found limited project management experience among the local contractors as one of the barriers to the identification of risks. Some of the earlier studies such as Akintoye and MacLeod (1997) also identified lack of familiarity with the techniques as one of the reasons provided by contractors for not using techniques of risk analysis and management.

Co-operative culture can be defined as an environment where team members are able to work or act together or jointly for a common purpose or benefit. Osburn (2008) assert that cooperate culture has the potential to make the organization more than the sum of its parts. By inference, an organisation where co-operate culture was weak was bound to be ineffective. Lack of communication amongst team members is in itself a risk factor as observed by Tchankova (2002), that changes in people's values, human behaviour and state of social structure are another source of risk. According to Carter (1986), the parties within the construction industry represent different professions and their multidisciplinary skills limit the scope of co-operation between them. Projects rely on clients, consultants, contractors amongst other stakeholders. Lester (2007) acknowledged that relationships to the project by stakeholders can vary from being very supportive to antagonistic but added that this needs to be managed effectively so that it does not have any effect on the project. It is essential that for each project, communication and team work is encouraged.

The "customer requirement" as a critical success factor can be argued to be closely aligned with the "goals and objectives of the organisation". Using the definition as provided by Powell (1995), customer requirements or 'customer focus' is the determination of customers (both inside and outside the organisation) requirements, and then meeting those requirements no matter what it takes. The need for understanding customer requirements was also highlighted by Nguyen et al. (2004). "Consideration of external and internal environment" can be viewed as part of the strategic planning which involves auditing of the external environment. The importance of strategic management has also been highlighted by several studies (Tummala and Burchett, 1999; Assibey Mensah, 2008; Ayirebi Dansoh, 2005; Luu et al., 2008). For example, Ayirebi Dansoh (2005) observed that the operating environment for construction firms in Ghana is constantly changing in the face of a volatile economic environment, shifting political climate and a highly competitive market. Similar studies such as (Ahmed et al., 2007; Hlaing et al., 2008) have also identified the linkages between the economy and procurement methods.

## 3. Research Methodology

To identify the critical success factors of risk assessment and management practices implementation within the Ghanaian construction sector, the following specific methodology of this study based on literature review, a pilot study and a question survey was employed to ensure a robust methodological design (Edwards and Holt, 2010).

## 3.1 Sample

This study issued 180 questionnaires to randomly selected professionals within the Greater Accra region of Ghana. The list of all registered construction related firms in Ghana was obtained from the relevant ministries and professional bodies (Tulli et al., 2007). A total of 103 useable questionnaires were returned, 34 (33 percent) were from contractors, 46 (45 percent) were from consultants and 23 (22 percent) from clients. This comprised a 54 percent response rate and was therefore deemed adequate for the purpose of data analysis. Fitzgerald (2000 cited in Odyinka et al., 2008) state that this is way above the norm of 20-30 percent response rate in most postal questionnaire of the construction industry.

## 3.2 Measurement Instrument

The data collection instrument was a self-administered structured questionnaire. The questionnaire was pre-tested by sending to randomly selected 20 professionals within the Ghana construction industry via email survey in March/April 2009. Based on the feedback, the questionnaire was modified. As observed by Forza (2002), the choice of professionals for piloting was to test whether the questionnaire accomplished the study objectives. Gill and Johnson (1991) also observe that piloting is also necessary as it is very difficult to predict how respondents will interpret and react to questions. The questionnaire was divided into four parts, as follows: demographics, evaluation of risk survey, awareness of risk assessment and management processes, and antecedents (critical success factors and barriers). The first part (demographics) sought information pertaining to organisation size, type of sector, years of service in construction industry and profession background. The questionnaire used in this study was designed to identify and measure the critical success factors and comprised ten items namely: (CSF1) management style; (CSF2) awareness of risk management processes (CSF3) co-operative culture; (CSF4) positive human dynamics; (CSF5) customer requirements; (CSF6) goals and strategic objectives of the organisation; (CSF7) impact of environment; (CSF8) usage of tools; (CSF9) team work and communication; and (CSF10) availability of specialist risk management. These factors are drawn from the extensive literature review as discussed in the preceding sections.

## 3.3 Statistical Methods

The primary focus of the study presented in this paper was to determine whether differences existed in the perception of construction professionals on CSFs appertaining to risk assessment and management practices. *Statistical Package for Social Sciences* (SPSS) computer program version 17.0.0 was used to analyse the data generated by the research questions. Analysis of Variance (ANOVA), and separate independent t-test were used for the analysis. Therefore, the main hypothesis proposed is:

**Null hypothesis: $H_0$:** There is insignificant differences in the perception among construction professionals working for the clients, consultants and contractors with regards to the critical success factors for risk assessment and management processes.

**Alternative hypothesis: $H_1$:** There are significant differences in the perception among the construction professionals working for clients, consultants and

contractors with regards to the critical success factors for risk assessment and management processes.

## 4. Survey Findings and Discussion

Table 1 provides background of research respondents.

| Position | Frequency | % | Cumulative % |
|---|---|---|---|
| Quantity Surveyor | 32 | 31.07 | 31.07 |
| Engineer | 33 | 32.03 | 63.10 |
| Project Manager | 22 | 21.36 | 84.46 |
| Architects | 11 | 10.68 | 95.14 |
| Site Managers | 5 | 4.86 | 100.0 |

**Table 1.0:** Positions held by respondents

Table 1 shows that more than half of the respondents were quantity surveyors and engineers. The majority (56 percent) of the respondents have more than five years experience in the construction industry. A total of twenty five percent of the respondents work for organisations having more than 300 employees and only 17% had less than 25 employees. The rest (58%) had more than 25 and less than 300 employees. This confirms that organisations were drawn from medium and large organisations are per classification of the Ghanaian Statistics Service (GSC). The respondents were asked to rate these critical success factors on a four-point scale from "strongly disagree" = 1 to "strongly agree" = 4. Thus using the criticality cut off point of 2.40, represented agreement levels. The reliability and internal consistency of the survey instrument comprising the 10 critical success factors items found in Table 2 was examined using the cronbach's alphas coefficient. The Cronbach's Alpha value was 0.840 (*F*-statistic = 5.379, Sig. = 0.000) alpha greater than 0.7 thus indicating a high reliability of scales (Nunnally, 1978).

### 4.1 Overall ranking of critical success factors

Table 2.0 shows overall ratings of CSFs with respect to the sample as well as group wise. For the contractors, the means ranged between 3.15 (csf3 = co-operate culture) and 3.52 (csf9 = team work and communication); for clients between 3.08 (customer requirement) and 3.44 (csf9 = team work and communication); and finally for consultants, between 3.00 (csf3 = co-operate culture) and 3.50 (csf1 = management style). Based on the data presented in Table 2, it is clear that all the critical success factors were deemed to be important as they scored above the 2.40 cut off point. However, examination of Table 2 indicates that there was a disparity in the ranking of the factors by the construction professions working the three different types of organisations. The top three critical success factors according to the professions working for contractors were as follows: "csf9 =team work and communication" (mean = 3.52); "csf10 = availablity of specialist risk management consultants" (mean = 3.39); and "csf8 = effective use of methods and tools" (mean = 3.36). The clients also ranked "csf9 =team work and communication" (mean = 3.44) highly, followed by "csf1 = management style" (mean = 3.41); and "csf2 =awareness of risk management processes" (mean = 3.34). On the other hand, the consultants viewed "csf1 = management style" (mean = 3.50) as critical followed by "csf9 =team work and communication" (mean = 3.37); and "csf2 =awareness of risk management processes" (mean = 3.37).

| R | CSFs | Overall | ANOVA | | Contractors (N=33) | | Clients (N=23) | | Consultants (N = 46) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | MS[1] | *F*-value | Sig | MS[1] | $R^2$ | MS[1] | $R^2$ | MS[1] | $R^2$ |
| **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** |
| 2 | CSF1 | 3.41 | 1.105 | .335 | 3.30 | 4 | 3.41 | 2 | 3.50 | 1 |
| 3 | CSF2 | 3.34 | .099 | .906 | 3.30 | 5 | 3.34 | 3 | 3.37 | 3 |
| 9 | CSF3 | 3.11 | 1.551 | .217 | 3.15 | 10 | 3.11 | 9 | 3.00 | 10 |
| 6 | CSF4 | 3.23 | .722 | .488 | 3.24 | 7 | 3.23 | 6 | 3.15 | 6 |
| 10 | CSF5 | 3.08 | .299 | .742 | 3.15 | 9 | 3.08 | 10 | 3.04 | 7 |
| 7 | CSF6 | 3.22 | .656 | .521 | 3.27 | 6 | 3.22 | 7 | 3.24 | 5 |
| 8 | CSF7 | 3.17 | 2.137 | .123 | 3.24 | 7 | 3.17 | 8 | 3.02 | 9 |
| 4 | CSF8 | 3.30 | .301 | .741 | 3.36 | 3 | 3.30 | 4 | 3.26 | 4 |
| 1 | CSF9 | 3.44 | .604 | .548 | 3.52 | 1 | 3.44 | 1 | 3.37 | 2 |
| 5 | CSF10 | 3.24 | 2.976 | .056 | 3.39 | 2 | 3.24 | 5 | 3.04 | 8 |

**Notes**: [1]The mean score (MS) based on participants levels of agreement on the agreement level of a scale of 4 = strongly agree, 3 = agree, 2 = disagree, and 1 = strongly disagree ; [2]R = Ranking

**Table 2**: Overall sample and group-wise rating of CSFs.

Overall the research findings indicate that the csf of "team work and communication" as important. This finding is in line with several researchers (Tchankova, 2002; Lester, 2007). In order to confirm and ascertain whether there were any significant differences in the rankings of the critical success factors by the three groups, using a similar approach as adopted by Yang et al., (2008). Kendall's coefficient of concordance (*W*) was conducted and the results showed that the spearman rank correlation coefficients (rho) of different pairs of respondents, i.e. rho was 0.673 between the respondents from contractors and consultant organisations. These statistical results indicate a general consensus on the ranking of the critical success factors among the different group of respondents.

## 4.2 Differences in ranking of critical success factors

To investigate whether construction professions working for the three different types of organisation had significant differences in the perceptions of the critical success factors, ANOVA was performed with the significance level set at 5 percent. The results are shown in Table 2. Although the results indicates no statistical differences of opinion in the perception of the different types of organisations for the csfs to risk assessment and management processes, however it is evident that there was a disparity in the ranking of the critical success factors. This suggests that construction professionals within the Ghanaian construction industry, irrespective of the sector (clients, consultants or contractors) that they worked for generally have similar opinions regarding the critical success factors influencing the deployment of RAMP. As such, the null hypothesis of no significant difference in the perception of different types of organisations to the critical success factors to RAMP is upheld.

## 5. Limitations, Conclusions and Future Research

This paper presented part of the MSc dissertation study which sought to identify the critical success factors of risk assessment and management practices (RAMP) deployment among the MLE's within the Ghanaian construction sector. This involved a questionnaire survey of clients (or owners), contractors and consultants involved with construction projects. Key findings from the survey include the

observation that the most important factors for implementing risk assessment and management practices within Ghanaian construction organisations were; team work and communication; management style; and awareness of risk management processes; and the level of risk assessment implementation in Ghana was medium. One of the main contributions of this study is identifying an ordered and grouped set of CSFs for risk assessment and management practices for construction projects in Ghana. Another significant contribution of this paper is that it sheds light on the understanding of critical success factors necessary for the implementation of risk assessment and management practices (RAMP) within the Ghanaian construction sector, an area previously under-researched. It also expands the effort of studying and evaluating critical success factors across the developing economies and particularly within the African context.

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*AA080*

# Management of Communication Risks: Evidence from international projects case study

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## Abstract
The realization of project requires collaboration between many different participants. The majority of interactions happen on the project management team level. The general believe is that teams/groups can achieve more efficiency if they use effective instruments of risk management in their communication process. The aim of this study is to investigate how the level of communication risks varies between different project group development stages and how project manager can help project group to reach the maximum effectiveness of communication. The study analyzes different communication barriers that project group meets while working at project. The investigation was performed by using qualitative analysis method in four different projects of an engineering and consulting company involved with mining industries in South Africa. Interpersonal relationships were measured by FIRO model and communication risks were evaluated by a typical risk analysis method. Results of investigations show that communication risks are directly affected by the stage of group development and different factors of group development tend to synchronize with each other. The total amount of risks tends to decrease as group moves from one stage to another on the FIRO model. For improving communication process in project groups the dynamic nature of FIRO model should be considered. The risks will not be settled down unless the group stands in "Openness" stage and the group development stage is vulnerable to any changes; the environmental effects should be carefully followed for preventive action.

## Keywords:
Project risk management, Communication, FIRO model, Group development

## 1. Introduction

Risk management is considered as the identification, assessment, and prioritization of risks followed by coordinated and economical application of resources to minimize, monitor, and control the probability and/or impact of unfortunate events or to maximize the realization of opportunities (Hubbard (2009)). Managing risks on projects is important factor affecting the successful reaching of project goals. Nowadays risk management has become "an integral part of project management" (Olsson (2007)).

Working groups have different challenges during their project work. The group members should pass different stages to become an effective group or a team. Although each group may face different difficulties during project lifecycle, there are some challenges that are related to the group development stage and getting familiar with them helps to prevent/overcome these difficulties. That is why it is

important to investigate the effects of risks in communication that frequently occurs between team members in international projects.

The aim of this study is to investigate how the level of communication risks varies between different project group development stages and how project manager can help project group to reach the maximum effectiveness of communication. The investigation is focused only on communication processes that occur within the project group and does not cover communication with other stakeholders.

One can find a lot of discussions underlining to the importance of communication management in international projects, but researches in this area are limited. This paper is the novel attempt to unite existing group development theory with risk management tools and to investigate whether the relationship exist between them, more specifically to investigate in what way they are connected in the area of project communications. That is why the result of this study can be considered as a relevant contribution to communication risk management science.

## 2. Literature review

Resent studies in the area of project management indicate that geographical zone and cultural differences affect communications and team relations on projects. Lee-Kelley and Sankey (2008) in their study consider a number of issues that team members often encountered while working on projects. For example, lack of communication can lead to confusion that can add more cost and more time, misunderstandings are expensive in terms of time and resources and they also create bad feeling within a team. We have summarized most important communication barriers that can be met in project work:

Unclear message (Jensen (2001)); contradicting message (Stoner (1995)); complicated language (Robbins (2002)); absence of feedback (Schermerhorn, Hunt, & Osborn (2002)); Robbins (2002)); language characteristics (Schermerhorn (1999)); time pressure (Jensen (2001)); failure to recognize nonverbal signals (Schermerhorn, Management (1999)); Inability to communicate (Jensen (2001)); cultural differences (Schermerhorn, Management (1999)); organizational culture (Stoner (1995)); status Effect (Schermerhorn (1999)); filtering (Robbins (2002)); withholding information (Jensen (2001)); partial information (Jensen (2001)); hidden agenda (Jensen (2001)); indirect communication (Jensen (2001)); perception and stereotyping (Schermerhorn (1999)); Lack of trust / incredibility (Stoner (1995)); emotions (Robbins (2002)); defensiveness (Robbins (2002)); poor choice of channel (Schermerhorn (1999)); information overload (Robbins (2002)).

To study the relationship of the group members and different challenges which exist in each stage, we use FIRO model (Fundamental Interpersonal Relation Orientation), introduced by William C. Schutz in 1958 as a theory of interpersonal behavior. This model describes a team's development in the following three phases:

1. Inclusion. The team is formed and the members get to know each other during the Inclusion phase. The project manager maps out the objectives of the project, which have to be achieved by the team.
2. Control. The project manager identifies each team members' values during this phase. This phase satisfies the members' social need or individual attention and their sense of contributing to the overall project.

3. Openness. By this phase the team is working well and strong group identity has developed. An atmosphere of openness has developed within the team. In the last phase the group becomes highly efficient. All teams are not progress to the Openness phase. When changes in personnel occur in the team, it is common for it to take one or more steps backwards in its development.

## 3. Research method

Research method is based on qualitative case study analysis. To ensure the reliability of the paper, the most reliable resources were considered for literature review. To ensure the validity of the paper only the tested methods were applied. The risk analysis matrix for example was constructed in a similar way that the one used in the research for South African Air force before (Jensen (2001)). Also the cases were selected within four projects of a company to unify organizational culture and policy. Sometimes a specific person involved in more than one project was investigated for different projects to emphasize on the role of the individuals within a group.

After thorough literature review we have created a list of common risk communication related factors described above and formulated a number of survey questions for face-to-face interviews of project managers and project team members. Three different phrases were placed at the top of the page indicating the three different stages of FIRO to let the interviewee choose their current state. Using this data enabled us to find out the perspective of the interviewees about their stage of group development. It should be considered that this data was not the basis to judge the project group development stage but it enable us to find out whether the project members are aware of their stage of group development. To identify and evaluate the scale of the communication risks, the perception of project members in this approach was measured (Chicken (1996)) and to collect their opinion regarding this approach, Dephi method was applied (Bilal (2001)). The respondents were asked to evaluate different communication barriers they encountered working on projects and also to evaluate the level of likelihood and the level of impact of the identified barriers in their current situation to make the risk analysis possible. This process was supposed to be three times for three existing stages of group development based on FIRO model. The result analysis was aligned with risk matrix (Heldman( 2005)).

Totally twenty eight estimation were collected from a group of fourteen people. The interviewees were from different nations and different races according to the nature of the country.

## 4. Data collecting

The main process of data collection was performed during May to August 2009 in South Africa in four different project of an engineering and consulting company involved with mining industries. As the paper is going to study the communication related to the interpersonal relationship developed in the project groups, we have assumed that the whole organization is working with four project groups; three groups consist of the members of running projects and the forth project group represents of higher levels of the permanent organization who set up the projects and are involved working with the project managers.

Case-1(Permanent Organization): In the higher levels of the permanent organization, there are usually managers who have being working with each other for a long term. As the project goes to new phases according to the project life cycle, new project managers would be employed. The respondents' estimation regarding the group development degree was so different but over 70% of them were aware of where they are standing

Case-2: Comparing to the other projects of the company, this project has a small scale. The project group is consisting of the available human resources employed by the company and if the project would be extended for further works, new people would be employed according to the requirements. Despite these people are experiencing work in this group for the first time, they know each other from the past. There are 10 people involved in this project of which some are not working full time on that. The result of questionnaire indicates that the estimation of the respondent about their group development stage is different from each other but over 60% of the respondents were aware of their group development stage.

Case-3: This case is Engineering Procurement Construction Management project. There were fifteen people at the time working in the project that has been started 6 months ago. Relations in this group used to be problematic as it is located in another country. Despite CEO interfered to improve the situation, the project climate did not seem to be stable; the project team faces so many changes that the group development is not successful. The result of questionnaire indicates that only 28% of the respondents were aware of their group development scale.

Case-4: This is an Engineering Procurement Construction Management Project that has been running about 15 months. As the project life cycle changed, new people were employed and it brought changes for the project team. There are 25 people working in this project from this company and new people are being employed. Those experiencing a longer period of work in this project believe that they are in phase 3 of FIRO but new comers evaluate it as phase 2. The result of questionnaire indicates that only 40% were aware of their group development stage.

## 5. Results

According to the related theory by applying *Median* as a measure of central tendency the best value among the expert cases for probability and impact are found, and by applying risk matrix (Appendix 1) the values for risk assessment would be achieved. The identified risks are classified in four classes of High, Significant, Moderate and Low based on the severity. Appendix 2 shows the transfer of each single risk in different stages of FIRO circle for each case.

Case-1: Despite the result of interview indicates that this group is standing in Openness, according to the FIRO model, this stage implies high level of cooperation and goal sharing; consequently, the likelihood of the barriers that might affect the group goal or cooperation should be minimum to enable us conclude standing in Openness. So according to the FIRO model this group is standing in Control stage. In this situation we should consider that the level of risk is being shaped by two factors of likelihood and impact; exploring the risk matrix makes it clear that unlikely and rare Likelihoods –that are the expected likelihood values in Openness- do not return the result of risk assessment as High (unless it is unlikely but the impact would be catastrophic). In other words, while 36% of all the specified risks are specified as high risks and the remaining 64% as the significant risks in FIRO

first stage, this percentages change into 27% high risks and 73% significant risks in the second stage and also 18% high risks, 36% significant risks, 36% moderate risk and 5% low risks in the third stage (Appendix 2). Comparing the theory with the results achieved in Openness emphasizes on the dynamic process of FIRO and the importance of a precise group development measurement in finding the results. In other words the high risks appeared in Openness dedicates the fact that the result of high risk in this stage is due to a return to the previous stage of group development and as the result the impact affecting the medium likelihood of the barrier composed the high risk.

Case-2: The result of interview indicates that the members of this group have different opinion about the stage that they are standing in. Although the group members know each other well and some of them have experienced working in a group with each other, it seems that they are not working as a team. They are not facing plenty of problems with each other but many of them still think that they are standing in the second stage of FIRO. The reason for this misjudgment is due to changes occurred on the type of work they are doing. According to the FIRO model this group is standing in Control. In this case we found that while 41% of all the specified risks are specified as high risks and the remaining 59% as the significant risks in FIRO first stage, this percentages change into 18% high risks, 68% significant risks, 9% moderate risks and 5% low risks in the second stage and in the third stage, they would be 5% high risks, 45% significant risks, 27% moderate risk and 23% low risks (Appendix 2). The rate of changes shows that moving from Inclusion to Control stage, the high risks are the most influenced group by the changes and moving from Control to Openness stage the significant risks are the most influenced. All the changes are in order to descend the severity of risks. Each of the single risks had a descendent rate in their severity or remained unchanged by moving from first stage of FIRO to the second stage and the third stage. Despite the apparent results seems satisfactory, there is an unfavorable implication about risk evaluation of Openness. It can be identified that there are quite many items that the likelihood has been evaluated as Moderate or even Likely. It clarifies the dynamic process of FIRO; so it can be concluded that the group would be shifted to previous stages by evaluating this likelihood for the barrier.

Case-3: The result of interview indicates that most of the group members do not have a clear understanding of the current stage that they are standing in. Working in distance makes it difficult to have close relationships and frequent changes on arrangement and also some unclear procedures running in this group makes the situation harder. According to FIRO model this group is standing in Inclusion.
Studying the rate of change of severity of these risks in different stages of FIRO shows that while 44% of all the specified risks are specified as high risks and the remaining 55% as the significant risks in FIRO first stage, this percentages change into 14% high risks and 82% significant risks and 5% moderate risks in the second stage while there would be no residual high risks in the third stage but 36% significant risks, 27% moderate risk and 27% low risks in the third stage (Appendix 2). The rate of changes shows that moving from Inclusion to Control stage, the high risks are the most influenced group the by the changes and moving from Control to Openness stage the significant risks are the most influenced. All the changes are in order to descend the severity of the risks. Each of the single risks had a descendent rate in their severity or remained unchanged by moving from first stage of FIRO to the second stage and third stage. In this case, Large risks reside in Openness are not due to the likely/moderate likelihood but they are caused by high level of impact evaluated for them. However, the moderate likelihoods for

different single risks make doubt about the stability of different stages of FIRO during risk evaluation.

Case-4: Although the result of the questionnaire shows that most of this group members believe that they are standing in Openness and despite the steady and calm climate of the project, this is an overestimation. By the start of the new phase of activities, new members were employed in the group. Now the group is standing in the second stage of FIRO: Inclusion. Results indicate that while 32% of all the specified risks are specified as high risks and the remaining 68% as the significant risks in FIRO first stage, this percentages change into 14% high risks, 73% significant risks and 14% moderate risks in the second stage and in the third stage there would be no high risks but only 50% significant risks, 23% moderate risk and 27% low risks (Appendix 2). The rate of changes shows that when moving from Inclusion to Control stage high risks are the most influenced and when moving from Control to Openness stage significant risks are the most influenced. All changes are in order to descend the severity of risks. Each of single risks had a descendent rate in their severity or remained unchanged by moving from first stage of FIRO to the second stage and the third stage. The same as the previous cases, there are some items of barrier that the likelihood has been evaluated as Moderate. It makes the dynamic process of FIRO more clear and it can be concluded that the group would be shifted to previous stages by evaluating this likelihood for the barrier. In this case also the time pressure barrier that have been identified as likely to happen in Openness is a matter of environment that regardless of relationship running in the group is related to managerial aspect and sometimes external environment of the project.

## 6. Conclusion

Although the result of cases is different from each other, they are following a similar trend:

- Each of risk items has a descendent rate in the severity or remains unchanged by developing from Inclusion to Control and Openness in FIRO.
- The density of high risks decreases when moving from Inclusion to Control and Openness in FIRO.
- The density of significant risks increases when moving from Inclusion to Control in FIRO, but it sharply decreases when moving to Openness.
- The density of moderate risks and low risks increases when moving from Inclusion to Control and Openness.

This implies that residual risks of communication are directly affected by the scale of interpersonal relationship among the group members. To decrease the residual risks to the minimum amount, project manager should try to lead the group into the next stage of the FIRO model and try to be aware of situational symptoms of stepping back into previous stage. It should be considered that the group is frequently in back and forward movements but the project manager can manage to shift the group in a specific stage of group development based on the applicable risk management tools and leadership skills. More over there are frequent changes in group development stages and it should be remarked that sometimes group members do not have a clear understanding of their group environment, their relation and the group stage. The changes within the stage of the group can be predicted by analyzing the internal and environmental situations.

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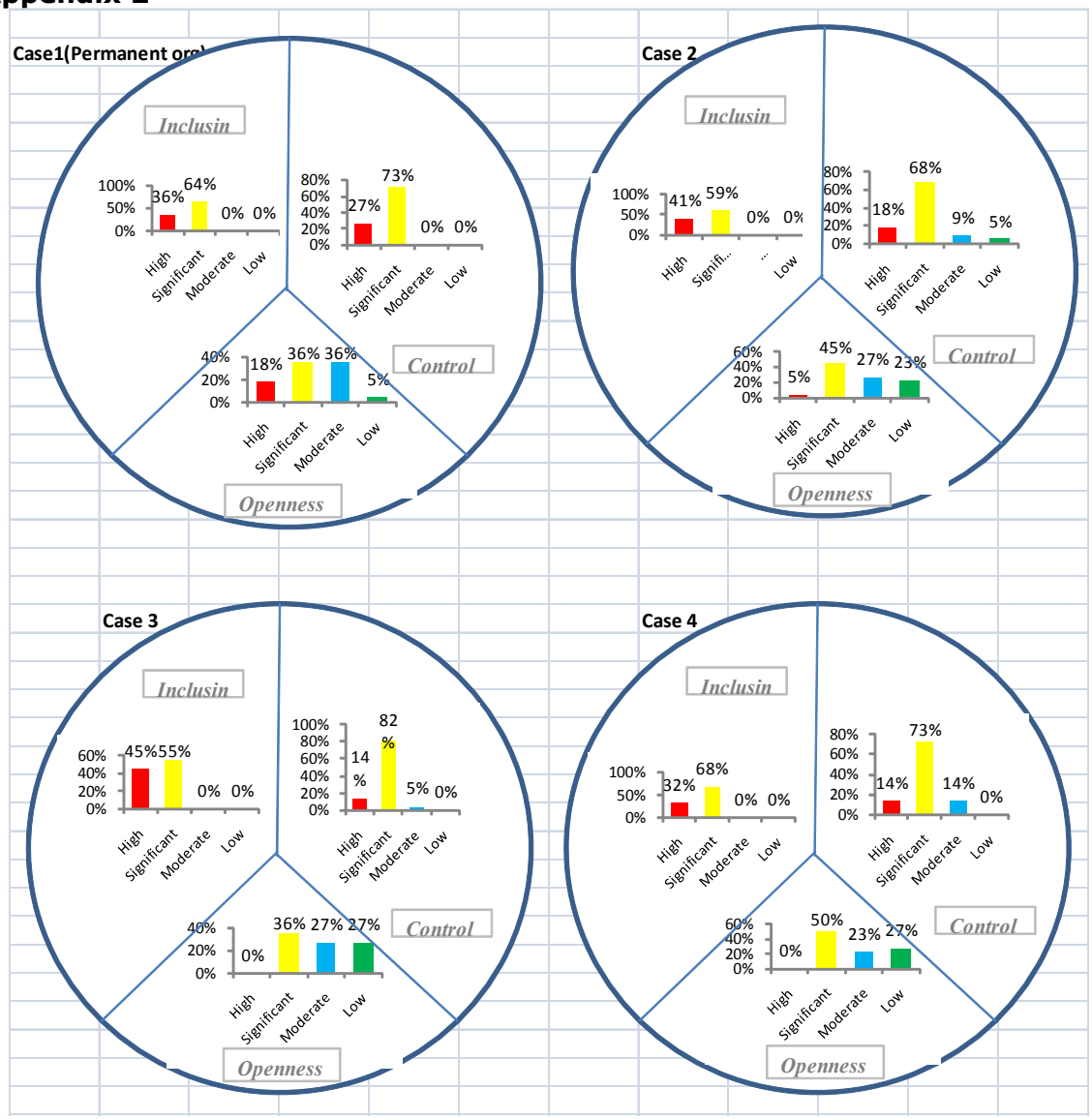
## Appendix 1

| Consequences / Likelihood | 1 (Incignificant) | 2 (Minor) | 3 (Moderate) | 4 (Major) | 5 (Catastrophic) |
|---|---|---|---|---|---|
| A (Almost certain) | S | S | H | H | H |
| B (Likely) | M | S | S | H | H |
| C (Moderate) | L | M | S | H | H |
| D (Unlikely) | L | L | M | S | H |
| E (Rare) | L | L | M | S | S |

**Table 1**: Risk matrix to assess the level of risk (Jensen (2001))

H: High risks that require detail research and planning by senior managers
S: Significant risks that require attention of senior managers
M: Moderate risks that must be specified as the responsibility of management

## Appendix 2



*W010*

# Evaluation of the Standardised form of contract at Sultanate of Oman

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## Abstract
The use of standardised forms of contracts has been generally considered practical and economical in the construction industry. Originally produced in the 1980s, the standardised form of construction contract for government works is the only standard contract document available and recognised for public works in the Sultanate of Oman. In Oman, government contracts for the construction of public works are required by statuary law to be fixed-price contracts awarded through competitive bidding. The standardised form of contract has never really been reviewed and updated. Unfortunately, there is limited research in the Omani construction industry particularly in the contractual management field. Based on this, a PhD research has been set up intending to evaluate the use of the standardised form of construction contract in Oman and to formulate recommendations of necessary improvement to incorporate the contemporary and future needs and trends in the Omani construction industry. This paper discusses the background and rationale of conducting the research followed by the research methodology applied in this study. The earlier stages findings are also presented followed by discussion. The paper is concluded by summarising the progress and findings so far as well as the further stages of this research guided by the findings.

## Keywords
Clarity, Construction Law, Standardised form of Contract at Sultanate of Oman.

## 1. Introduction

The construction industry has generally been considered playing a powerful role in sustaining economic growth and typically considered an important industry for most countries. In many countries, it contributes to domestic economies as both a large employer and as a sector of considerable economic value (Thompson, et al. 1998). Construction industry is normally a major source of jobs, making a large contribution to the GDP and is a major purchaser of other sectors.

In many projects, the growth of construction industry with its inherent increased complexity has resulted in higher number of claims. Claims are common in construction projects and can happen as a result of several reason, that can contribute to delaying projects or increasing there cost. For this reason, the well drafted construction contracts should include some kind of clauses for addressing disputes and claims at the germane stage in a project. This includes for instance, clauses containing carried provisions and instructions for parties to resolve disputes

as they arise, during the course of the project (Jannadia et al. 2000). Additionally Broome and Perry(1995) extended the discussion by asserting that the clauses within a contract should fit together to form a logical whole, be procedurally correct and relevant to modern construction practice in distinguishing the factor affecting the clarity of the standard forms of contract. A good construction contract should include well drafted drawings and specifications that inform the contractors what he must do to earn the promise compensation and provide a method of determining whether the objective has been reached (Ibrahim and Madon, 2006).

At the Sultanate of Oman, the standardised form of construction contract (OSFC) is the only standard contract document available for public works. The form of contract was statued by the Ministry of Finance and National Economy of the Sultanate of Oman in 1980s and has been used in the construction of all types of public projects leading to the large industry projects. In line with the common ways of working in the 1980's for instance, the government contracts for the construction of public works are required to be fixed-price contracts awarded through competitive bidding. Over the years, the OSFC has never really been reviewed and updated to keep up with the development and trend in the global and local Omani construction industry.

Limited research in the field of standardised form of contract in the context of Omani construction industry has necessitated further study on the matter. Therefore this research intends to collect evidences of practices in OSFC and provide directions for future study in the field. The main aim of the research is to study the standard form of Omani contract, and to recommended frame work that can be used to improve the OSFC and contracting practice in Oman.This study provides a framework for comparing the contracting practices in the UK and in Oman. It starts by reviewing previous studies on OFSC and two of the standard form of contract, i.e. FIDIC standard of contract and NEC3 form of contract practices and explores the main delivery methods, inform of comparison with different aspects of contracting systems. It examines construction contracting types, processes and procedures and interaction between the client and other parties. This study was based on a literature review and the result shows the similarities and differences between the NEC3, FIDIC and OSFC within each practice and between both practices; the distribution of responsibilities and risks both in pre-construction and during the construction stages; and allocation of responsibility in both practices. The literature has show different aspects for each of standard form of contract.

## 2. Standardised Form of Contract

### 2.1 Standardised Form of Contract Construction Industry.

The construction industry generally uses many types of contracts. Each one allows responsibilities and risks to be allocated in various ways and integrate different payment mechanism. Moreover, standardised form of contracts such as NEC are progressively flexible in determining, for example , which party takes responsibility for design, what performance incentives are adopted and how risks are to be allocated (Stovin *et al*. 2004).

Contract is defined as an agreement between the parties in exchanging promises giving them rights and duties bound by the law (Owen, 1998). In order to create a legally binding contract, it is sufficient for the parties to express their agreement

and intention. However, in order to avoid potential disputes, the contract terms should be set out in writing in a document, subsequently signed by the parties, which can be used as a legal-evidence (O'Reilly, 1999). A construction contract is then made between two parties, the 'Employer' and the 'Contractor'. Their roles are defined clearly in the contract. However, there is normally a need for daily supervision of the construction that the two parties may agree for a third party to carry out such duties. The third party can be designated as 'the Engineer' under the contract; or may be designated 'the Project Manager' or 'Employer's Representative' with different roles suitable for the project (Twort and Rees, 1995).

In creating a contract, in many cases, there is a necessity for contractual arrangements to be entered into in one of the many standard forms of contracts available (Capon, 1990). Standard forms of contracts are conditions of contracts that have been prepared jointly by professional bodies and organisations to distribute the risk fairly and equally to the parties (Abrahamson, 1985). The use of standard forms of contract intends to ensure that all parties are familiar with the terms as a result of common usage that reduces the likelihood of disputes arising over the interpretation of the clauses. The parties are then aware of their rights and obligations under the terms of the contracts that are well documented.

### 2.2 Standardised Form of contract at Sultanate of Oman

Construction contracts in Oman are usually set out from FIDIC forms of contracts. The changes made by FIDIC to transform the ICE form to an international form of standard contract can be considered insubstantial (Bunni, 1999). Oman's legal system is based on civil code principles and in particular, the Egyptian Civil Code. This has been citied the first legal issue with Oman Construction contracts (Mansour and Al Sharji. 2008) as this contrasted by the general practice of directly translating FIDIC into the Arabic language in some Arab countries in the contracts and related documents, including in Oman (Arrowsmith et al. 2000).

In public sector, the OSFC drafted in 1980s is the only standardised form of contract available. This OSFC consists of two parts. Part one is entitled 'the principal document of the contract' and is composed of eight articles dealing with matters similar to some of those generally stated in standard agreement and/or bid forms of construction contracts. Part two is called 'general conditions' and is composed of 61 clauses expressing terms and conditions similar to some of those usually found in standard general conditions of those contracts (Ministry of National Economy,2005). However OSFC has never really been reviewed and updated. Thus, taking into account the vast development in the global local (Omani) construction industry, there is a need to review/evaluate the OSFC and recommending potential improvement to the OSFC to enable it accommodating or even embracing current days needs characteristics of the Omani construction industry.

## 2.3 Methods of Evaluating Standardised Form of Contract

There are many aspects to be considered in evaluating general conditions of construction contracts, Abdulaziz *et al.* (2001) defined many aspects to be considered to ensure the "smoother" completion of the construction process. The general condition should anticipate the potential trouble spots of the relationship between the contracting parties. The other aspect to be considered is the language

which should be clear to the parties. The 'workability' of the rules prescribed in the general conditions is related to this aspect. Responsibilities and fairness are other important aspects: the general conditions should be fair to the contracting parties whilst the best principle for allocating responsibility is that controllable risks should lie with the party who is in control, In addition, the general conditions should elevate the achievement of the more palpable dimensions of project success in terms of cost, time, quality and safety. As a starting point, the OSFC has been compared against other standardised form of contract (FIDIC and NEC) in this research. This stage has been defined to capture updates that have been implemented in another standardised form of contracts that reflect the current situation and trends in the global construction industry.

## 3. Research Methodology

There is a strong suggestion within the research community that research, both quantitative and qualitative, is best thought of as complementary and should therefore be mixed in research of many kinds (Amaratunga et.al. 2001). Thus, the combining of the research methods is intended to be complementary, i.e. adding different dimensions to the research. In collecting data, the use of in depth interview combined with a postal questionnaire are considered appropriate to provide breadth and depth for the research. Moor (2000) discussed the technical term for combining research methods in this way to provide a number of different views on an issue is triangulation. It is useful to concept and one that it well worth considering when designing projects as it adds consider-able value to the research result. The link between the quantitative and qualitative methods enables the transfer of idea from each other and provides richer details. It enables the idea to be developed as well as initiating new lines of thinking and providing fresh insights.

Following an in depth literature review and archival study of construction law cases in Oman and comparative analysis between OSFC and other standardised form of contracts, the research intends to conduct semi structured interview and questionnaire to facilitate data collection. As stated by Naoum (1998), this form of interview uses' open' and 'close-ended' questioning but the questions are not asked in a specific order and no schedule is used. Semi-structured questionnaire and interview has been considered as the most appropriate technique for this research. The independents targeted are Questionnaire survey designed to evaluate various aspects of the standardised form clauses in the Sultanate of Oman. Thus questionnaire survey will designed to identify best practice in Omani construction sector in implementing the standardise contract clauses. On return of the completed questionnaires, data analyses will be performed. After refinement of the data, various stages of data analyses will be conducted. The analysis of the survey results will be conducted using descriptive statistic tool, subsequent to this, follow up will be by semi structured interviews will be conducted to further discusses as well as the validating the finding.

## 4. Comparison Study Between OSFC, NEC3, and FIDIC

This part of this paper presents the findings of the comparison study between the OSFC and two other standard form of contracts ex NEC3 and FIDIC form of contracts. The OSFC standard forms are intended to be applicable to a wide variety of types of work including building, civil engineering, mechanical and electrical engineering and for major and minor works in the Sultanate of Oman. All government-awarded construction and civil engineering contracts use a standard

form of contract: the 'Standard Documents for Building and Civil Engineering Works' (Fourth Edition, September 1999). The forms in fact are applicable more to domestic civil engineering projects than building contracts. Ideally, substantial amendment would be necessary to deal adequately with building contracts, where the other standard forms may be more appropriate. Among various differences, two major differences have been identified, namely the dispute management and subcontracting.

In term of dispute management the OSFC contains terms that provide for disputes not capable of resolution determination by the project's engineer to be referred to arbitration. The adoption of the standard form of contract in building projects between private parties is widespread throughout Oman thus requiring any disputes arising in relation thereto to be determined by way of arbitration also. The arbitration process, and the interpretation of the agreement to arbitrate itself, is governed by Sultani Decree 03/07, promulgating the Law of Arbitration in Civil and Commercial Disputes (the Arbitration Law). Whereas in FIDIC the clause for arbitration is one part of a comprehensive dispute resolution process in which at several stages decisions will be made as to entitlement and/or quantum, including a Dispute Resolution Board whose goal is to prevent the parties from engaging in an arbitration.

NEC3 alternatively provides for a dispute to be referred to an adjudicator under option W1 (W2 for the UK). Whatever reservations there may be about some aspects of adjudication, there is now no doubt that decisions made by adjudicators are generally either accepted by the parties or are used by them as the basis for an agreement to settle the dispute finally. A party that is dissatisfied has the right to take the resulting dispute to the tribunal (court or arbitrator as designated in the contract data). That tribunal decides the dispute referred to it. It does not of course act as an appellate tribunal but as a tribunal of first (and possibly last) instance with the obligation to reach its own decision. However acceptance of an adjudication decision may turn on the competence and experience of the adjudicator, as the guidance notes explain. NEC3 provides for an adjudicator to be named by the employer in the contract data. If an employer or its legal advisers are concerned that a dispute might arise about a "tricky" legal point then a lawyer (or someone with legal qualifications) whose ability is not in doubt should be selected. It is impossible to guarantee that a legal point will be decided 'correctly'—one has only to look at the decisions of appellate courts in countries where the judges are familiar with construction contracts Lloyd (2008).

In subcontracting term the FIDIC Conditions of Contract for Construction (Red Book) do not permit the Contractor to subcontract the whole of the works. These conditions of contract hold the Contractor responsible for the acts or defaults of any of his domestic subcontractors as if they were the acts and defaults of the Contractor himself. However the NEC3 Engineering and Construction Contract (ECC) has been designed on the assumption that work may be subcontracted. There is no provision for the nomination of subcontractors within the NEC contracts. Provision for selected subcontractors may, however, be included in the Works Information (scope of work). The principle of the ECC is that the Contractor is fully responsible for every aspect of managing the work he has contracted for. Nominating subcontractors conflicts with this principle and causes many practical problems. On the other hand, the nomination of sub-contractors arises under clause 59 of OSFC conditions of contract whereby it refers to them being all the persons to

whom, by virtue of the provisions of the contract, the contractors is required sub-contract, and shall in the execution of such work or the supply of such goods, materials, plant or services, be deemed to sub-subcontractor to the contractor, and to refer to as nominated sub-contractor. The nomination process is prone to so many problems as the contractor has the right to object to a 'nominated sub-contractor', or to that who refuse to enter into a sub-contract which is back to back with the main contract and which identifies the contractor in respect of the nominated sub-contractor's breaches. It is emphasised on no privacy of contract between the employer and subcontractor. In summary of this term, Unacceptable forms of subcontracts are those which contain provisions for payment procedures based on a pay-when-paid, or pay-if-paid system; a right of set-off in favour of the contractor not provided for in the law; authoritarian rights given to the prime contractor, or his agent, with no recourse to independent adjudication in the event of a dispute arising (CIDP Practice note, 2007). It can be concluded from this discussion that OSFC has failed to incorporate alternative ways of procurement such as construction management.

## 4. Conclusion and Further Research

The study conducted in this PhD research was instigated by construction contract and contractual process in construction industry at the Sultanate of Oman. The research intends to investigate the potential problems in using the dated standard form of construction contract and recommend solutions. This research paper outlined the proposed study, which illustrated the research justification, significance, contribution drawn from previous literature from the developed and developing countries. The report also presented an overview of the intended research methodology.

At this point of writing, the research is in progress of performing a comparative analysis between OSFC and other standard form of contracts i.e. NEC 3 and FIDIC. The initial findings reported and discussed in this paper demonstrated that there are 2 major differences between OSFC and the other two (updated) forms of contract, namely the dispute management and the sub-contractor management. The differences reflect the more contemporary needs of construction industry as accommodated by NEC 3 and FIDIC which have been updated regularly.

Further research involve finishing the archival updated study on construction law cases in Oman to identify the most common and contemporary contractual issues in its construction industry. Combining the findings from construction law cases study and general trend of construction industry in the recent time and in the future, questionnaire will be distributed as well as follow up interviews to help the researcher in formulating recommendations of necessary improvement to the OSFC in order to incorporate the contemporary and future needs and trends in the Omani construction industry. The recommendations from this research will be forwarded to the decision makers in the Sultanate of Oman to inform them in improving Omani construction industry.

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*AA037*

# Framework for Managing Complexity of Interconnections in Projects

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## Abstract
Interconnections and boundaries between the various project parties have been identified as an area which requires careful consideration. Complexity is caused by interconnections and this could lead to a reduction in performance if the resulting interface is not purposefully and efficiently managed. Understanding the characteristics of complexity of interconnections, and how these affect organising projects and the management style will enable the development and implementation of innovative project actions and tools that will support the management of complexity through the respective processes. The authors present results from a study of UK construction organisations to shed more light on the influences of complexity generated by the interconnections. The results from the study have significant implications for the way project teams are put together and managed, and enabled the introduction of a framework for managing complexity of interconnections in projects.

## Keywords
Complexity, Project Management, Organisation, Management Style

## 1. Introduction

Construction projects often involve a large number of activities comprising several entities and interconnections. The nature of interconnections in a project can generate complexity with defined characteristics. The various entities involved in delivering the project are normally streamlined to minimise any potential constraints that could arise from workflow. However, current practices in the management of socio-organisational aspects of a project do not allow for such streamlining (Busby and Hughes, 2004; Burns, 2005). The limitation occurs because the conditions that cause interactions, from the organisational side, involve methods that are unsuitable for the projects (Egan, 2005; Green, 2006). Also project practitioners continue to adopt a transactional rather than transformational approach (Andersen, 2003). Within this paper the authors investigate the conditions that give rise to complexity of interconnections in the management of projects and propose a framework to help mitigate the effects of such complexity in projects by tackling the conditions that give rise to them. Interviews were employed to investigate the implementation of existing practices, understanding of complexity in projects, and innovative actions proposed to address the complexity of interconnections in the areas investigated by managing its characteristics. From the results it was established that complexity of interconnections is not managed and the development of a framework is proposed. The framework will enable

project management practitioners to manage the effects of complexity of interconnections and the conditions that create them through the sub-processes investigated.

## 2. Review

### 2.1 Complexity

The application of complexity theory to the management of complex adaptive systems (CAS), which seek to understand the behaviour of individual elements, can enable the systematic considerations of the conditions that give rise to such complexity (Stacey et al., 2002). In construction interfaces cause complexity (Baccarini, 1996; Williams, 2002), which is associated with the interconnection structures that link various objects (Lucas, 2000a; Burns, 2005). Also the need to deal with complexity at the lowest organisational level, the interactions between the systems and the formulation of tenets of interactions, has been emphasised (Burns, 2005). Understanding the characteristics of these interconnections especially from a socio-organisation standpoint can contribute to a more efficient project organisation and its management. In particular, it should enable project managers to respond with the necessary actions and improve the setting up of projects, as well as other project management processes. Lucas (2000b) has suggested that complexity arising from interconnections reflects distinct characteristics. The 16 directly relevant characteristics have been mapped onto project conditions and described in Antoniadis et al. (2006).

Construction projects are typically characterised by complexity and non-linearity (Bertelsen, 2004); under time and/or cost pressure and requiring both creativity and cooperation. Analysis of complexity in construction projects has been conducted mainly from the technical perspective (Lillieskold and Eklstedt, 2003). However, recently the subject of complexity has been linked to other non-technical project activities such as – organisational and socio-behavioural (Geraldi, 2008; Girmscheid and Brockmann, 2008). Much of the socio-organisation complexity can be associated with the organising and the management style adopted, and it is the focus of this investigation.

### 2.2 Organising projects and Management style

Organising projects – selecting team members and structuring the project team, and the management style adopted are two major socio-organisational aspects in projects which generate interconnections. Therefore, in order to establish the current status of the three areas a brief review is carried out.

#### 2.1.1 Selecting team members

The importance of the process of selecting team members has been highlighted by a number of authors (Katz and Lazer, 2002; Belbin, 2004) and there are a number of techniques available and key activities that provide the means. However, although knowledge and training have been provided the sub-process is not implemented and remains subjective, partially implemented and biased (Ogunlana, et al., 2000, Hinds, et al., 2000; Green, 2002 and 2006). Therefore the sub-process lends it self for investigation from the complexity perspective and in

particular examining if any actions are taken by PM practitioners to manage its effects.

### 2.1.2. Structuring project teams

Extensive literature exists on structuring projects and the types of organisational structures and all the authors consider and discuss the importance of interconnections between the project teams. Due to the importance of the interconnections suggestions have been made which consider notions ranging from complexity and chaos theory to behaviour and biology. However, as revealed in literature, theory is not applied and the transactional approach with hierarchical linearity are imposed (Andersen, 2003; Bertelsen, 2004). Glass ceilings within structures (Green, 2006), unofficial structures (Panas, 2006), short-termism and cost demands have a detrimental effect on structuring of projects as discovered by Winter and Smith (2006). In general PMs do not consider how to structure their team or the idiosyncrasies of projects (Moore, 2002; Busby and Hughes, 2004). Therefore, this sub-process also lends it self for investigation from the complexity perspective and in particular examining if any actions are taken by PM practitioners to manage its effects.

### 2.1.3. Management style

Whilst considering complexity in project management, one cannot disregard the management style which will enable the management of its effects in projects. The topic is covered extensively in project management literature (Turner and Muller, 2005) and seven basic styles, with some overlaps, are suggested as applicable to projects:

- Laissez Faire, Bureaucratic, Democratic, Autocratic; and
- Task / Production, People / Relationships, Corporate.

However, with the rapid socio-organisational, economic and technological changes and the evanescent nature of projects there is a need for a new paradigm that will enable the management of virtual project environments and the reduction in complexity introduced by group interactions (Edum-Fotwe and McCaffer, 2004).

Thomas and Mengel (2008) in an extensive review of project management education material, highlight that very little is currently covered regarding the management style to be followed when dealing with complex adaptive systems such as teams. In particular they state that there is concern that PMs are not educated on transformational leadership and that there is a need to equip PMs so that they are able to sense the prevailing conditions and lead / act accordingly. Therefore, this area also lends it self for investigation from the complexity perspective and in particular examining if PM practitioners consider the style to be adopted in order to manage its effects.

## 6. Research Method

The literature review provided strong indications regarding the appropriate implementation of the two sub-processes and the management style adopted in construction projects. This coupled with the established view that construction projects are immersed in complexity of interconnections led to the formulation of the following study questions (SQ) as part of a wider research into complexity of interconnections in construction:

*SQ 1*: *Complexity characteristics are considered when selecting project team members.*
*SQ 2: Complexity characteristics are considered when structuring project teams.*
*SQ 3: Complexity characteristics are taken into account when considering the management style to be adopted on a project.*

The breadth and depth of the issues and the topics under investigation as well as the requirement for a broader understanding of the issues demanded the use of open-questions through closed interview sessions. The interviews explored current understanding of complexity, its characteristics and techniques used to manage its effects. Questionnaires were prepared and piloted with practitioners from three organisations and corrections were made. The stratified sampling technique was implemented in order to consider both sides of the project with the two main strata comprising of three major construction client organisations and three major construction companies. Board Directors from the six organisations were contacted and asked to select randomly PM practitioners with more than 10 years experience who would participate in the research. Interviews with 31 PM practitioners from Site Manager to Project Director level were set up. The study questions were operationalised by establishing a response greater than 75 points (from a scale of 0 to 100) of the average weighted effectiveness of the actions taken towards managing the effect of each complexity characteristic. Following from the interviews the findings were validated by conducting saturation interviews with organisations and PM practitioners that did not participate in interviews.

## 4. Results

Implementation was over a period of ten months and presentations were given to respective Board Directors on the aims and objectives of the research.

### 4.1 Interviews

From the 31 interviews conducted the majority of interviewees indicated that the construction environment is friendlier, complex and dynamic, that the sub-processes remain subjective and their organisations do not define nor give any tools or techniques to identify complexity (Antoniadis et al, 2008). Figures 1, 2 and 3 provide an overall indication of the average weighted effectiveness of the actions taken to manage the effect of each complexity characteristic when selecting team members, structuring the project team and by the management style adopted. All proposed actions for all the characteristics were reviewed with the interviewees and any additional actions were included in the listings and considered in the overall weighting.

### 4.2 Validation

The findings were validated by carrying saturation interviews. These were conducted with PM practitioners, from Director to PM level, but from different Client and Construction organisations. All interviewees confirmed that findings represent reality and agreed with the need for a framework to manage the effects of complexity of interconnections through the topics investigated. Interviewees indicated that the framework, by using complexity characteristics and the generic actions identified, can be generalised and used not only by construction PMs but also by general managers.

## 7. Analysis

In terms of SQs 1,2 and 3, interviewees (see Figures 1, 2 and 3) indicated that very little is done and that no consideration is given to using techniques to manage complexity. Results on the average weighted effectiveness of the current level of actions taken for each complexity characteristic indicate that none has reached the 75 points level of acceptance. Thus, complexity of interconnections is not considered and all three study questions are rejected.

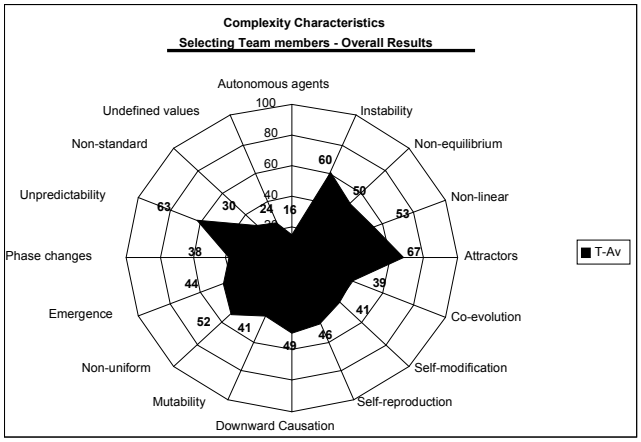


**Fig.1** Overall results for current level of actions taken for managing the effect of complexity characteristics when Selecting Team members

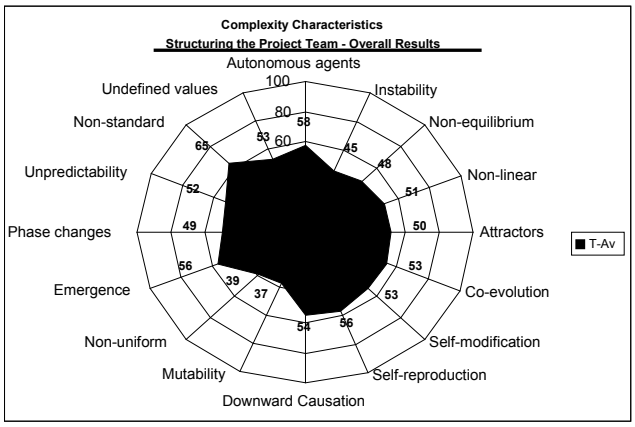


**Fig. 2** Overall results for current level of actions taken for managing the effect of complexity characteristics when Structuring the Project Teams

## 8. Proposal for Managing Complexity of Interconnections

Complexity in construction requires a more structured approach. The establishment of a simple plan of action and the availability of a framework will enable practitioners to manage its effects.

The following points are proposed as a plan of action:
1) Define types of complexity;
2) Identify / understand the complexities to be dealt with;

3) Establish the means to manage complexity. The 'tools'/means that will be used to identify actions that will mitigate complexity;
4) Monitor, that is, following up on actions implemented; and
5) Review and Improve; frequent review of actions taken, results obtained, and any further actions required for improving the outcome.

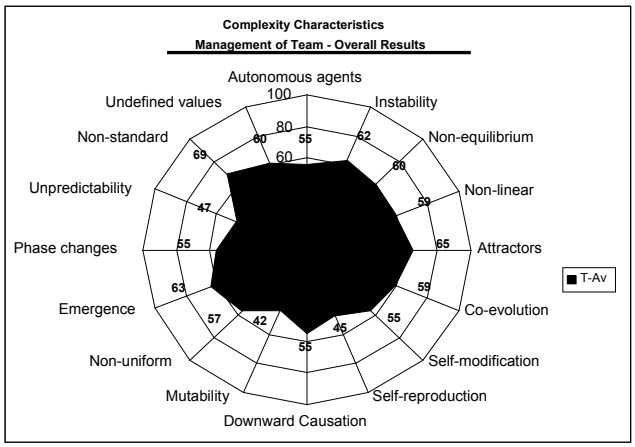


**Fig. 3** Overall results for current level of actions taken for managing the effect of complexity characteristics by the Management style adopted

With regard to complexity of interconnections and in terms of the means to be used (step 3), the decision matrix process was used to evaluate the three options considered and select the best suitable solution. A simple framework was developed for the project management processes investigated which, by using the characteristics of complexity establishes action(s) to be taken. The framework allows PMs to ascertain the level of managing its effects at a particular point in time, provides guidance for follow-up action(s) and allows for sequential actions to be taken to support the monitor, review and improve steps. Additionally it is flexible, it can be cascaded to the various project team levels and be implemented multiple times. It also allows for different types of projects and project management styles. The simple and holistic approach offers practitioners an innovative and straight forward handling of the effects of complexity of interconnections on projects through each project management process.

## 7. Conclusions

The investigation into the sub-processes of selecting team members, structuring project teams as well as the management style adopted and the consideration of complexity characteristics by practitioners, established that very little is done to manage its effects. Results indicate that management of complexity remains within a number of mechanistic tools which have been created by the construction industry. Having linked the characteristics of complexity of interconnections to construction, it is of interest to all parties to implement actions which will enable the management of its effects through the project management sub-processes.

In a friendlier and more dynamic environment, where both clients and contractors cooperate from a much earlier stage, organising and managing projects is feasible and achievable. Also in a more complex environment the implementation of appropriate behavioural processes and the understanding and management of

complexity is feasible through a framework of actions that enables the management of its effects through its characteristics.

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*AA058*

# Project Managers and Designers: required or enabling cognitive skills and personality characteristics

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## Abstract
This study is discussing the personality characteristics, cognitive abilities and body of knowledge that synthesize the profile of successful project managers and designers. The paper determines the principal characteristics and skills which enable engineers in the construction industry to excel either as project managers or as designers. Our hypothesis suggests that personality characteristics and cognitive abilities could potentially function as prerequisites or enablers in a career path. Behavioural characteristics and skills are identified through a series of focus groups' questionnaire surveys. Statistical analysis of the answers highlight personality characteristics and cognitive abilities. The results are then compared to findings from literature. Finally, appropriate psychometric tests are proposed in order to quantify these characteristics and skills. This methodology could standardize the selection procedures and implement similar approaches in improving and managing human resources in Greek construction industry.

## Keywords:
Project managers, designers, personality characteristics, cognitive abilities, psychometric tests

## 1. Introduction

The effectiveness and productivity of organisations have been always dependent heavily on the quality of their workforce, or their human capital (Wolf and Jenkins (2006), (Dainty *et al*. (2003)). This study focuses on two essential groups of engineers: project managers and designers. The term project manager (PM) is used in the general sense of applying to the person, who has responsibility for managing the whole or some major part of a total project (Pilcher (1994)). Typical responsibilities of a project manager are coordinating and integrating of subsystem tasks, assisting in determining technical and manpower requirements, schedules

and budgets, and measuring and analyzing project performance regarding technical progress, schedules and budgets (Jha and Iyer (2006)), (Royer (1974)).

On the other hand "Design" methods of today often emphasise a rationality based on the designer's cognitive powers (Stolterman (1991)). The very word "Design" is in everyday use and yet given quite specific and different meanings by particular groups of people (Lawson (2005)). Design ability is summarised as comprising resolving ill-defined problems, adopting solution-focussed cognitive strategies, employing abductive or appositional thinking and using non-verbal modelling media (Cross (1990). Engineering design is a thoughtful process that depends on the systematic, intelligent generation of design concepts and the specifications that make it possible to realize these concepts (Dym and Little (2003)), (Dym (1994)). The paper presents the questionnaire survey and its results. Based on the personality characteristics and cognitive skills identified through the survey, the proper psychometric tests are defined and analyzed. Finally, the conclusions and future work are presented.

## 2. Questionnaire Survey

Questionnaires were presented to engineers, attending master programs in the Civil Engineering Department of the Aristotle University of Thessaloniki. The questionnaire included two simple, open research questions, quoted as follows:

- "Which are the cognitive skills and personality characteristics of construction project managers"
- "Which are the cognitive skills and personality characteristics of designers"

The goal of the questionnaire survey was firstly to identify the personality characteristics, the cognitive abilities and required knowledge. The survey collected 53 answers from engineers of various disciplines. The first stage included decipherment of the data appearing in the answers. Information was recorded and data was screened multiple times. Same elements are brought together, and elements with similar meaning are grouped. Finally, descriptive statistics are estimated and the dominant elements are identified.

## 3. Questionnaire Survey Results

The answers of participants focus on three main - significant aspects: Cognitive Skills, Personality Characteristics, and Knowledge. The following tables identifies required knowledge:

| PROJECT MANAGER KNOWLEDGE | PERCENTAGE |
|---|---|
| KNOWLEDGE OF PROJECT DETAILS, DESIGN AND PHASES | 12,4% |
| TECHNICAL KNOWLEDGE, ECONOMICS, ACCOUNTING | 22,5% |
| KNOWLEDGE OF CIVIL ENGINEERING | 18,0% |
| KNOWLEDGE OF LAW, REGULATIONS | 5,6% |
| KNOWLEDGE OF MECHANICAL EQUIPMENT | 1,1% |
| KNOWLEDGE OF PROJECT MANAGEMENT SOFTWARE | 5,6% |
| KNOWLEDGE OF PROJECT MANAGEMENT | 10,1% |
| CONTROL ON RESOURCES AND WORKFLOW | 4,5% |
| CONSTANTLY UPDATING TECHNICAL KNOWLEDGE | 3,4% |
| EXPERIENCE | 16,9% |

**Table 1**: Project Manager's Knowledge

| DESIGNER'S KNOWLEDGE | PERCENTAGE |
|---|---|
| TECHNICAL KNOWLEDGE, REGULATIONS, LEGISLATION, CONSTRUCTION PROCEDURES | 33,3% |
| KNOWLEDGE OF ARCHITECTURE | 1,9% |
| KNOWLEDGE OF LAND SURVEY | 1,9% |
| KNOWLEDGE OF SOFTWARE | 7,4% |
| KNOWLEDGE OF ECONOMICS | 2,8% |
| KNOWLEDGE OF SCHEDULING | 2,8% |
| KNOWLEDGE OF MATERIALS | 1,9% |
| CIVIL ENGINEERING DIPLOMA | 6,5% |
| HEALTH AND SAFETY | 0,9% |
| EDUCATION | 3,7% |
| KNOWLEDGE OF PROJECT DETAILS AND DESIGN | 23,2% |
| CONSTANTLY UPDATING TECHNICAL KNOWLEDGE | 1,9% |
| EXPERIENCE | 12,0% |

**Table 2**: Designer's Knowledge

The analysis that took place was aiming at estimating the frequency of appearance of each factor. The results of the statistical analysis are presented in the two following tables. The items that received the greatest percentages are highlighted in the following tables:

| PROJECT MANAGER'S SKILLS AND CHARACTERISTICS | PERCENTAGES |
|---|---|
| INTEGRATED PERSONALITY | 0% |
| CAREFUL, CAUTIOUS, DILIGENCE | 2% |
| FORECAST, FORESIGHT, ANTICIPATION, PROVISION, PREVENTION, PREVENTION OF RISKS | 4% |
| RESPECTED | 1% |
| PRACTICAL | 1% |
| HUMAN RESOURCE MANAGEMENT, DIPLOMACY, MAINTAIN BALANCE, CRISIS MANAGEMENT, CONFLICT | 9% |
| UNDERSTANDING OF THE WHOLE PICTURE, PERCEPTION OF DEVIATIONS, SCALE PERCEPTION | 2% |
| INSPIRATION - CREATIVITY | 1% |
| LEADERSHIP CAPABILITIES, MOTIVATION CAPABILITY COORDINATION, COLLABORATION, PERSUASION | 13% |
| COMMUNICATION, SPEECH CAPABILITY | 13% |
| INTEGRITY - ETHICS, JUSTICE | 2% |
| METHODICAL | 2% |
| FLEXIBILITY, CONSIDERATION OF ALTERNATIVE SCENARIOS | 3% |
| CONFIDENCE | 0% |
| COMMITTED, DECISIVE, EFFECTIVE | 4% |
| PROMPTNESS ON DECISION MAKING, READINESS, CAPABILITY OF SOLUTION MAKING | 3% |
| COST MANAGEMENT CAPABILITY | 2% |
| SELF-CONTROL, POLITE, UNDERSTANDING, COMPREHENSIVE | 2% |
| RELIABILITY, RESPONSIBILITY, CONSISTENCY | 5% |
| CAPABLE OF PSYCHOLOGICAL EVALUATIONS | 1% |
| SCHEDULING, TIME PERCEPTION, PROGRAMMING CAPABILITIES | 2% |
| STRATEGIC CAPABILITY | 2% |
| SOCIAL AWARENESS - CONSCIOUSNESS, FRIENDLINESS | 4% |
| ORGANIZATIONAL | 11% |
| COMBINATORIAL LOGIC | 1% |
| PATIENT, PERSISTENT | 1% |
| INVENTIVE | 3% |
| SELF RESTRAINED | 1% |
| ADAPTIVE | 2% |
| RIGHT JUDGMENT, CRITICAL THINKING | 1% |
| PERCEPTIVE | 1% |
| HARD WORKING | 0% |
| DYNAMIC | 1% |

**Table 3**: Statistical Results for Project Managers' Skills and Characteristics

The descriptive statistics' results in the "Project Managers'" case are presented in the following decreasing order of significance:

- Leadership Capabilities 13%
- Communication 13%
- Organizational 11%
- Human Resource Management 9%
- Reliability, Responsibility, Consistency 5%
- Social Awareness – Consciousness, Friendliness 4%
- Committed, Decisive, Effective 4%

| DESIGNER'S SKILLS AND CHARACTERISTICS | PERCENTAGE |
|---|---|
| FORECAST, FORESIGHT, ANTICIPATION | 4% |
| INTEGRATED PERSONALITY | 1% |
| FANTASY | 2% |
| CREATIVITY | 2% |
| COMMUNICATION, CAPABILITY OF SPEECH AND EXPRESSION | 9% |
| CONFLICT MANAGEMENT | 1% |
| REALISTIC | 1% |
| COLLABORATIVE, TEAM SPIRIT | 11% |
| CAPABILITY OF COMBINING VARIOUS VIEWS, COMBINATORIAL THINKING | 4% |
| EFFECTIVE, CAPABILITY OF SOLUTIONS' FINDING | 11% |
| CLARITY OF SOLUTIONS, DRAWINGS, ESTHETICS FUNCTIONAL PERCEPTION OF SPACE | 4% |
| INSTRUCTIVE | 1% |
| SPEED OF RESPONSE | 2% |
| ANALYSIS - SCHEDULING, SIMULATION, FORESIGHT, IDENTIFICATION OF SENSITIVE POINTS, PLANNING | 5% |
| CONSISTENCY, RESPONSIBILITY, ABIDE TO RULES | 9% |
| ACCURACY | 2% |
| CLEVER, SHARP | 1% |
| TYPICAL, METHODICAL, CONSTANT CONTROL | 5% |
| INVENTIVENESS, ORIGINALITY, RESOURCEFUL, INNOVATIVE THINKING, OPEN MINDED | 5% |
| PROPER ACQUAINTANCES, SOCIAL, PUBLIC RELATIONSHIP, PROJECT CONSEQUENCES | 7% |
| ORGANIZATIONAL | 2% |
| CRITICAL JUDGMENT | 2% |
| DECISIVE | 2% |
| PATIENT, POLITENESS, UNDERSTANDING | 3% |
| SIMPLE THINKING | 2% |
| DOMINATING | 1% |
| INTEGRATED PERCEPTION OF PROJECT – WORK SCALE | 3% |
| JUSTIFIED OPINION | 2% |
| TRUSTWORTHY | 1% |
| HARDWORKING | 1% |

**Table 4**: Statistical Results for Designer's Characteristics and Skills

On the other hand in the case of the planner the frequency of appearance of the answers in decreasing order of significance are the following:

- Effective, Capability Of Finding Solutions 11%
- Collaborative, Team Spirit 11%
- Communicative, Capability Of Speech And Expression 9%
- Consistency, Responsibility, Abide To Rules 9%
- Proper Acquaintance, Social, Public Relationship, Project Consequences 7%
- Typical, Methodical, Constant Control 5%
- Inventiveness, Originality, Resourceful, Innovative Thinking, Open Minded 5%
- Forecast, Foresight, Anticipation 4%

A comparison of the descriptive statistics' top results (receiving 4% and above) for the two different disciplines indicates the following:

- Project managers place at the top of the list "Leadership Capabilities" which is a characteristic that does not appear as a priority in the designer's list

- "Communication" is considered by both parties very significant and receives high percentages, with the project managers emphasizing it more than designers
- Consistency and Reliability are also important for both groups and receive high scores, but designers place them higher in their list
- Social aspects of the engineer's life and work are identified as significant by both parties, with the designers being more socially aware
- Effectiveness is at the top of the designer's list and receives a noticeable but not significant score in the project managers' approach
- It can be suggested that human resource management capabilities, organizational, collaborative and team spirit have common elements and they are similarly identified as significant by both disciplines

Literature has extensively covered the theme of project managers' skills and characteristics. Gaddis (1959) cited in Jha and Iyer (2006), emphasizes that project manager needs solid basic experience in the relevant field and should be a leader able to carry out planning and follow-up activities, in addition Stuckenbruck (1976), cited in Jha and Iyer (2006) mentions that a proficient manager must be: multidisciplinary oriented, global problem oriented, an effective problem solver and decision maker, a good manager and administrator, possessing good analytical abilities, creative in dealing with information and problems, an effective communicator, able to motivate his team members to achieve fixed goals, flexible, and able to adapt to change, of the right temperament, and should be able to keep his calm. Finally Katz and Kahn (1978) cited in Jha and Iyer (2006) summarize the skills of a project manager in three main categories namely: technical skills, human skills and conceptual skills.

A glance at the abovementioned tables clearly presents that questionnaire survey and literature highlight almost the same characteristics and skills concerning project managers. In the case of designers, literature has little to offer on their characteristics and skills. Most reviews highlight the skills often associated with good designers, namely, the ability to:

- tolerate ambiguity that shows up in viewing design as inquiry or as an iterative loop of divergent-convergent thinking
- maintain sight of the big picture by including systems thinking and systems design
- handle uncertainty
- make decisions
- think as part of a team in a social process
- think and communicate in the several languages of design (Dym *et al.* (2005)).
- Thinking about system dynamics
- Reasoning about uncertainty
- Making estimates
- Conducting experiment
- Design Thinking in a Team Environment (Dym *et al.* (2003))
- The Languages of Engineering Design (Bucciarelli (2002))

## 4. Proposed Psychometric Tests for Evaluating Skills and Characteristics

The selection of psychometric tests has been based on the identified characteristics and skills of project managers and designers. Firstly, a personality test would be

implemented. The paper proposes that the "Personality Inventory-Revised NEO PI-R" should be used. The NEO PI-R provides a systematic assessment of emotional, interpersonal, experiential, attitudinal, and motivational styles, a detailed personality description that can be a valuable resource for a variety of professionals (NEO-PI-R (2010)).

The abovementioned test can be used in combination with the "BarOn Emotional Quotient Inventory™ (EQ-i™)". There is a strong correlation between emotional intelligence and job performance. The EQ-i is a scientifically developed and validated measure of emotional intelligence, which reflects an individual's ability to effectively deal with daily environmental changes. It assesses 15 dimensions of emotional intelligence: Emotional Self-Awareness, Self-Actualization, Interpersonal Relationships, Flexibility, Impulse Control, Assertiveness, Independence, Social Responsibility, Reality Testing, Optimism, Self-Regard, Empathy, Problem Solving, Stress Tolerance, and Happiness. It can be used as part of recruiting process to aid in identifying potentially successful employees, also helpful in identifying those emotional and social skills that are important to develop in employee training programs, team building, and in enhancing managerial competencies at work (BarOn EQ-I (2010)).

The next phase includes application of cognitive tests, in order to assess intelligence. It is recommended to use the "Wechsler Adult Intelligence Scale". This examination was developed to provide most advanced measure of cognitive ability (Wechsler Adult Intelligence Scale (2010)).

The final stage includes the examination of "Executive Functioning". The use of "Delis-Kaplan Executive Function System" is the proposed tool. This test is designed to provide a comprehensive assessment of higher-level thinking and cognitive flexibility – key components of executive functioning. It assesses vital executive functions such as flexibility of thinking, inhibition, problem solving, planning, impulse control, concept formation, abstract thinking, and creativity in both verbal and spatial modalities (Delis-Kaplan Executive Function System (2010)). Appropriate tests for verbal abilities should also be considered as part of this approach such as "Word Fluency Task" (Kosmidis *et al*. (2004)).

## 5. Conclusions

It is observed that personality characteristics and cognitive skills from the two groups appear to have simultaneously significant similarities and striking differences. It is in these differences that the future work will be focused on. Project Managers place at the top of their list "Leadership Capabilities" which is something that is expected to appear in the case of managers. On the other hand, the top of the designer's list is occupied by "Effectiveness – Capability of Finding Solutions".

Both focus groups identify "Technical Knowledge" as the most significant, with slight differences in the content of term. Furthermore, the second place is occupied by "knowledge of Project Details and Design".

The proposed psychometric tests are based on the characteristics and skills identified by the questionnaire survey and literature. The application of these tests can facilitate evaluation of characteristics and skills and thus provide a substantiated decision making tool for hiring or promoting people in the

construction industry. Typically, a company first uses psychological profiling to help hire or promote key people. Many companies establish a policy to have the psychologist see all final candidates for a position above a specific salary level or grade (Aretoulis et al. (2009)). This approach should be accompanied by close examination of the curriculum vitae of the participants, a thorough structured interview and available references.

## 6. Future Work

More extended statistical analysis can take place on the data acquired by the survey. The participating groups of engineers have chosen postgraduate academic programs that lead to project managers' and designers' master degree. Correspondence analysis conducted separately for each group could potentially reveal new data on their beliefs and perception concerning their career path and choices.

The first stage of this study aimed at identifying the cognitive skills and personality characteristics of these specific groups namely the project managers and the designers. Since the characteristics and skills are identified then it is possible to define the appropriate psychometric tests. The latter would be used to assess the characteristics and skills.

During the future activities of this research study, proper groups of engineers will be defined. More specifically engineers that excel as designers and engineers that have made a career as successful project managers will be the appropriate candidates. The aim of the research would be to measure if there are statistical significant differences on the factors identified from the survey. The outcome of the research can prove that there exist specific cognitive skills and personality characteristics that lead engineers to excel or make a successful career as designers or project managers. Apart from the unique and interesting results the definition and identification of these factors can provide measurable criteria for selecting the best people for hiring or promoting people in the construction industry. It could also be used for training programs in order to create more competent designers or project managers.

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*AA077*

# Modelling as a soft skill for the assembly and usage of a Project Compendium via sensemaking concepts and its software application

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## Abstract
This paper takes a systems view in order to explore and illustrate the relationships between the factors and actors that have an influence upon the course of action as the project plan is realized. An understanding of the issues relating to a project's risks, requirements and resources is the basis for a successful implementation of a plan to meet the time, cost and quality criteria. So, the ability to use qualitative models would be a potential component in revising the competency baseline now that complexity has a greater influence on projects (e.g. performing project health checking). From the recent set of case studies and interviews, it is viewed that Project Compendium components can be used to manage project knowledge effectively. They help to ensure transparency, availability and accessibility of information that is a potential contribution to project success, assuming they have an adequate level of quality within the context.

## Keywords
Project Compendium, complexity, modelling, knowledge management, soft skills

## 1. Introduction

There are many texts available on the topics related to human behaviour inside organisations (e.g. McShane and vonGlinow, 2008). Some of the models related to organisational behaviour have been used inside some of the recent research associated with the soft skills needed in the context of project management (e.g. Pant and Baroudi, 2008). Taking the view that promoting a successful project needs a combination of both hard and soft skills depending upon its context, then the curriculum for teaching project management needs to be revised.

As organisations become more mature in the application of project management, the criteria for judging success include those that are concerned with the impact of the project on its environment. The fit between the project and the organisation and its consequences for the performance of the organisation are reported as important issues. Hence, there has long been an interest in establishing a set of factors to be monitored in order to promote success and/or avoid failure (e.g. Cleland and King, 1983). A lack or excess in any such factor leads to risk. Furthermore, relationships between factors lead to other consequences: an excess of user involvement, for example, places pressure on the communication channels as well as the schedule.

This paper is intended to show how a particular systems approach to modelling can be used in the 'shifting sands' of project working. For example:

- a significant shift in a client's preferences may be regarded as a requirements change

- reframing a requirement can make it forcibly relevant to a new set of stakeholders
- a significant event can cause stakeholders to switch roles and this is likely to change their requirements.

In each subsequent situation, there will be resource and risk implications (Armstrong and Saunders, 2004). The Association for Project Management (2006) has identified modelling and testing as one of the techniques to 'assist in the successful delivery of project objectives' (p51). The central issue of this paper is concerned with the use of models in projects from a theoretical and practical perspective. Modelling is a way of thinking about things and ideas in the 'real world'. In effect, a model is a way of expressing a particular view of an identifiable system of some kind. So, models are:

- a way of understanding the problems involved
- an aid to communication among those involved, especially when a part of some deliverable is being investigated
- a component of the methods used in a given activity, such as the financial modelling done to test the feasibility of a proposal.

A good model is an abstraction, which allows those involved to concentrate on the essentials of a complex problem by keeping out the non-essential details. Changing the model you have about a situation is equivalent to changing the way you think about it, which may have an influence upon your current practice. For example, decision making is a technique that has to be used effectively when you apply the process of modularisation (breaking up a large problem into a number of smaller, more manageable ones).

## 2. Model examples related to change

Over the years there have been many models defined, constructed, used etc. But, this section introduces a small number of examples to promote a practical association to the systemic perspective that can be used in the management of projects. Of course, all the various forms of qualitative and quantitative models can contribute to the decision making processes used in project management. The concept of changes that cause unwanted or unplanned difficulties is not new; 'side-effects' have been studied since ancient times. The difference between solving and resolving has deep roots in our thinking. When it comes to change and any 'realities' we might identify, we see that change has direction: either conventionalising or differentiating. This means that change takes us either towards (conventionalising to a monoistic position) or away (differentiating to a pluralistic position) from an existing symbolisation, which was discussed by McWhinney (1992) who also defined six basic modes of change:

1. Imperative - change achieved by either a charismatic or authoritarian leadership;
2. Analytic - change achieved by imposing policies such as theory applied through data;
3. Influential - change achieved by acceptance of new values from the imposition of 'truth' by either an authority or a population;
4. Inventive - change achieved through the materialisation of a new and creative idea;
5. Participative - change achieved by the development of a consensus of value within the relevant group and based upon empirical explorations;

6. Emergent - change achieved through the creating and accepting of the new by an idea leader or crystallisation from within the group.

These modes of change help to refine the tools and methods needed to achieve change, but they require involvement with two, or more, realities. The basic view or reality will provide those things which we take as given, especially the structure. We use a second reality to produce the concentration and effort that regulates and co-ordinates movement towards a desired outcome.

## 2.1 Formal Systems Model

In reviewing the 63 publications that had focused on critical success factors (CSFs), Fortune and White (2006) found that some of the definitions of each factor were not clear; thus, raising the potential for ambiguity. This is not surprising, given the variety in the various authors' backgrounds and in the case studies and surveys that were used in the papers that were reviewed. The Formal Systems Model (FSM) is a framing device to deliver the benefits of using CSFs whilst, at the same time, taking into account their inter-relationships and dynamics. The FSM comprises a decision-making subsystem, a performance monitoring subsystem and a set of subsystems and elements which carry out the appropriate tasks to achieve the desired outcome. When used during the planning and implementation phases, the FSM can guide the project manager in addressing the human and organisational aspects. A business case, for example, should contain a prioritised list of critical success factors to reflect the context in which the proposed project will take place. For each critical success factor, it may be possible to identify a qualitative or quantitative measure that can be monitored during the project. Any variation beyond a given threshold for a particular critical success factor can be interpreted as placing the project at risk. In practice, appreciating different viewpoints is likely to be the most important, influential or sensitive factor in trying to achieve project success. So, the ability to understand and appreciate different viewpoints is a competency that may be associated with the soft skills for project management.

## 2.2 Influence and multiple cause diagrams

Figure 1 contains an influence diagram showing some of the relationships between CSFs from a project perspective (Armstrong, 2007). This would is something that could be done in the preparation of the business case for a new project. The diagram does not show all the potential influences, since it is important not to overload a single diagram with too much information. For example, all the stakeholders have a potential influence on communication and feedback.

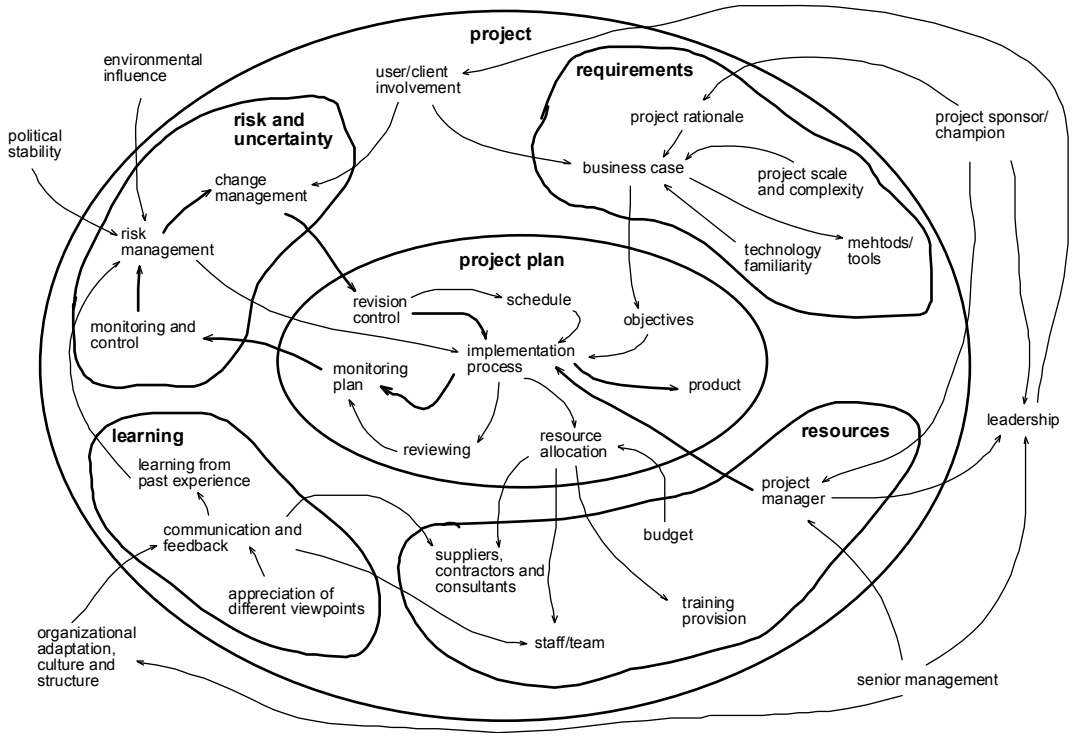


**Fig 1**: Influence diagram of some of the factors and actors concerned with a project's success

The project plan has been placed at the centre of Figure 1 to represent its central role in project working. The four other sub-systems (requirements, resources, risk and uncertainty, and learning) were created to illustrate the potential for grouping factors and actors in the context of a project. In general, influence diagramming in a way of interpreting the complexity of a project. A number of authors, such as Austin, Newton, Steele and Wasket (2002), have investigated aspects of project complexity in order to get improvements in efficiency and effectiveness.

A multiple cause diagram can be used to identify and tackle the causes of a complex problem in a systemic way. This type of diagram is used to explore why a given event happened or why a certain class of events tends to occur. In practice, multiple cause diagrams are often derived from influence diagrams. This has been a part of the Open University's long-standing courses on systems thinking (e.g. Ship, 2008). The normal starting point for constructing multiple cause diagrams is with the state or event to be explained. When a lack of support form senior management is detected, for example, that state is the focal point of the diagram. Then, you can work outwards and backwards through the chains of causal connections to identify the relevant sequences and/or loops. Alternatively, you might begin by assuming that a particular project had failed. Then, consider changes in state for the CSFs, such as the following:

- Lack of user involvement
- Lack of resources
- Unrealistic expectations
- Incomplete requirements.

Figure 2 contains an example of the states and/or events that might lead to a strong sense of dissatisfaction with a new software application. In practice, the context for software projects does vary. So, there is a probability that different

multiple cause diagrams will result from the analysis of each situation when user dissatisfaction becomes significant.

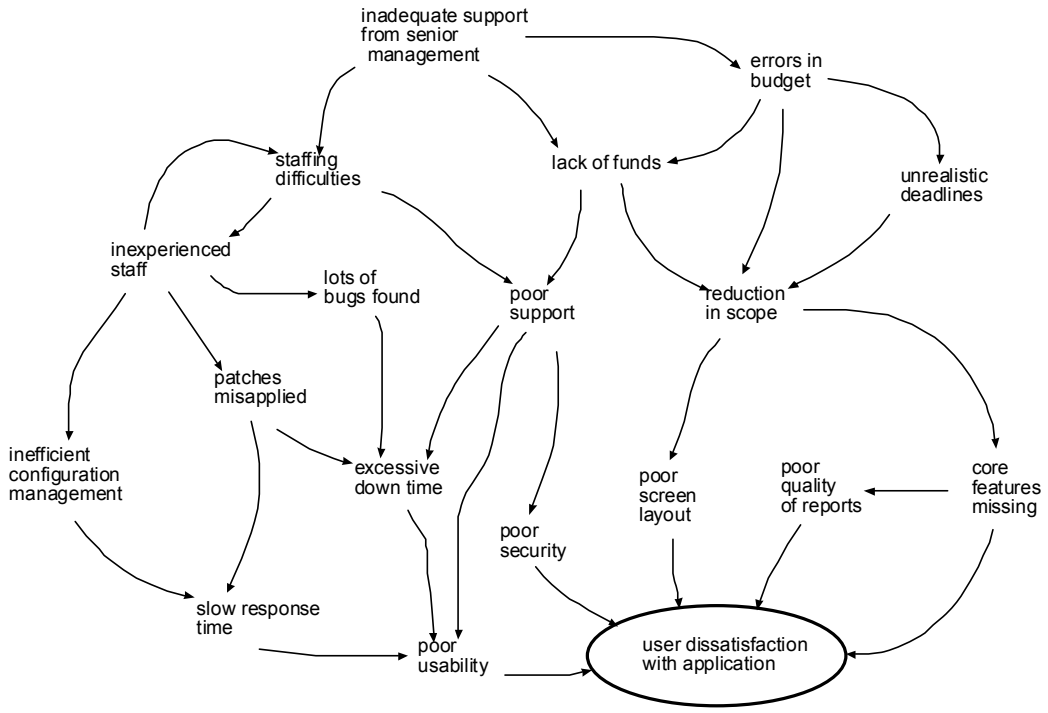


**Fig 2**: Multiple cause diagram investigating user dissatisfaction

It should be noted that multiple cause diagrams are not intended to predict behaviour, but they may be used to construct a list of factors to bear in mind when investigating comparable circumstances in the future. Hence, a number of multiple cause diagrams might be constructed as part of a risk analysis for a project. Their contents would contribute to the quantitative elements in the planned responses to the risks. In practice, some further annotation may be required when there is insufficient evidence to denote a causal connection. For example, an arrow might be associated with other phrases like: 'contributes to', 'is followed by' or 'enables'.

## 3. Project Compendium

The notion of a Project Compendium is a set of templates, methods and tools that tie people, the stakeholders and the project team, and their ideas together. When assembled, a Project Compendium allows people to work in different ways: in meetings, in documents, working alone and/or in different locations. The underlying goal is to improve the way project teams go about their work via the facilitation of knowledge sharing and a collaborative way of working. The introduction of a hypertext-based tool allows the project manager to address the problems associated with communication and knowledge management, which is a natural link to decision making in practice.

Compendium is a software tool that has a flexible visual interface for managing the connections between information and ideas. It was developed at the Open University in the 1990s and is located in the Compendium Institute (http://compendium.open.ac.uk/institute). The application allows teams to analyze, design, communicate, manage and collaborate using a compendium of tools and

artifacts. It has a strong association with the sensemaking needed for knowledge management that has been implemented via dialogue mapping and its extension for conversational modelling (Conklin, 2005). After all the research and practice, the discipline of mapping intellectual landscapes is now called 'Knowledge Cartography' (Okada, Buckingham Shum and Sherborne, 2008). Maps of concepts, discussions and arguments make the connections between tangible and disputable ideas now that the software is seen as a set of visual tools for reading and writing in a networked age.

As a fairly simple introduction to the maps that can be created inside the Compendium application, Figures 3 and 4 illustrate a number of ideas in response to two questions that may be asked during the initiation of a project.

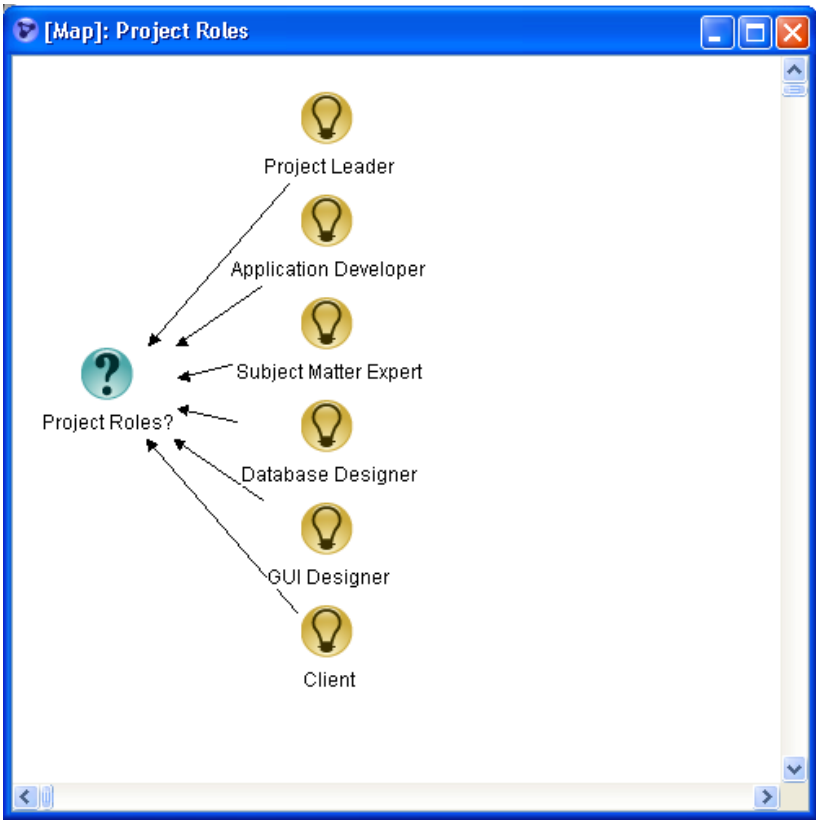


**Fig 3**: A question about project roles

The next set of nodes might be for arguments for and against each idea that may be followed by a decision node. Each node may also be linked to another one containing notes or even an accessible reference (e.g. business case document). Maps may also be created as templates for other contexts (e.g. project phases).

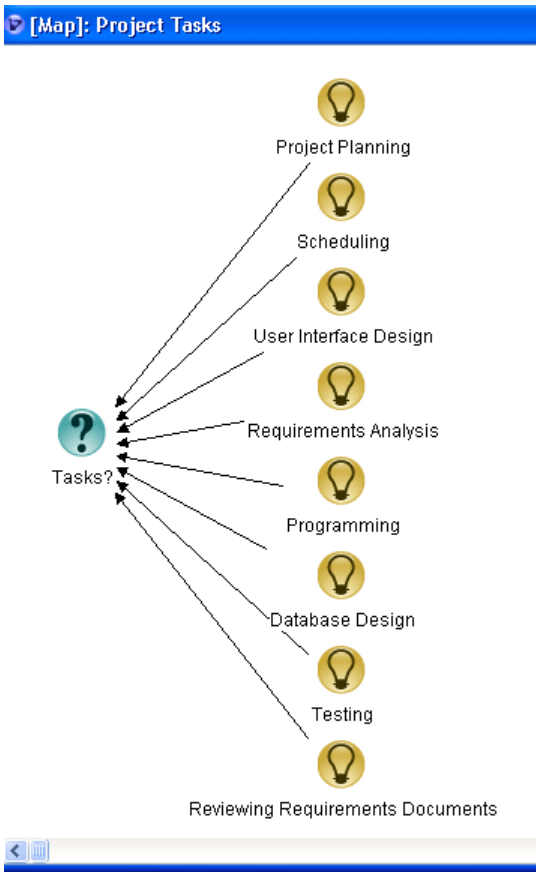


**Fig 4**: A question about the tasks in a project

## 4. Conclusion and some openings for further work

This paper has identified a couple of modelling tools that could be put into a project's 'kit bag'. In practice, a number of decisions should be taken about who might use the techniques and when they might be used. The main aim of the research that is going to be started is to investigate the assembly and usage of a Project Compendium. In each case, the focus will have to be upon all of the phases of a project. The Compendium application can be used to address concerns related to knowledge management for a project team, so that it offers the possibility of improved efficiency and reduced uncertainty when dealing with projects that have various levels of complexity. For example, it can also be used to construct and perform project health checks. The respondents to a number of interviews since 2004 viewed that the concept's application may contribute to project success. These discussions took place when the author gave a presentation about the software at the IPMA World Congress in 2004 and 2007. An MSc student, Meiers (2010), conducted a related survey. The respondents viewed that components can be used to effectively manage project knowledge which should ultimately contribute to project success. Achievement of business objectives was voted by more people as being highly relevant to project success compared to budget, schedule, scope and customer satisfaction.

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*AA097*

# Construction Superintendents need Leadership

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## Abstract
This paper presents a method of profiling the leadership skills of construction field superintendents and relating these skills to the success of their project. The leadership competencies of 43 superintendents were assessed utilizing a self-evaluation "Field Construction Superintendent Questionnaire" (FCSQ) complemented by a "Project Manager Questionnaire" (PMQ) that provided an independent performance evaluation from the superintendent's project manager.

Analysis of the data collected from the FCSQ and the PMQ shows significant correlation between the leadership competency levels and the job performance levels of the Field Construction Superintendents. The data collected allowed to asses the importance and need of leadership as well as management skills for superintendents. Not surprisingly, the effectiveness of management skills dominates the job performance of a construction superintendent but it is the degree of applied leadership skills that make the difference between average and exceptional performance (Great Superintendents). Participants were ranked based on their leadership scores. Interviews conducted with the participants' company executives found a 90 percent accuracy rate in the ranking when compared to performance and profits generated by the participants.

## Keywords
Leadership, Management, Profiling of Skills, Construction Superintendents

## 1. Introduction

To achieve better than average success in the construction industry, Field Construction Superintendents need to possess effective management and leadership competencies. According to Post (1998), improved leadership competency is clearly needed at this level as studies indicate that barely 70 percent of building owners were fully satisfied with the performance of their construction project.

Construction companies face an increasing need to formalize not only their safe-work environment efforts, but also to rapidly and continuously improve their field

productivity. Until recently, ongoing field productivity improvement efforts have been focused on the operational side of the business, where 85 to 95 percent of the dollars are spent (Abberger, McComb, & Spragins (1997)). Substantial research funds are spent on the development of new building materials, software, automated management processes, and concepts designed to improve the construction industry's ability to estimate, plan, schedule, and manage operations. Comparatively, leadership at the construction site has received little attention thus scant research exists on leadership competencies and development of construction project managers and engineers. However, it is becoming increasingly apparent that all participants in this industry must spotlight the leadership and management development of their superintendents and foremen with an emphasis on creating more robust, effective competencies.

For the purpose of this study, the Field Construction Superintendents were defined as the overseer of the daily activities at a construction site and called superintendents (Adams, (2007)).

Superintendents enter the field for numerous reasons and with widely diverse abilities and skills. In addition, the shrinking labor pool is driving the construction industry to hire workers from less traditional labor pools, including women and minorities, creating the need for additional employee training - not only in technical skills, gender and diversity sensitivity - but also in leadership and management skills. This training is, all too often, only rudimentary or non-existing (Abberger, McComb, & Spragins (1997)). Leadership studies at universities have rarely focused on the leadership role of construction site managers. They have not been assessed as the leaders of their site teams, nor have they been assessed on their wide range of managerial styles which are adopted on the job site and are crucial to successful projects.

Over the past five decades, the interest in understanding the essence of leadership has continuously grown and taken many directions. Recently, the leadership in construction has attracted attention, recognizing a definitive need and dearth of data. Research conducted by Adams (2007) examined the role that the presence or absence of leadership skills plays in the job performance of field construction superintendents. Also examined were the influences that drive the development of their leadership competencies. Obviously, his research is based on the assumption that leadership behaviours can be taught and learned and that they are not endowed only to exceptional individuals at birth.

There are many types of superintendents. Their job titles and responsibilities vary significantly from one company to another; they even differ within the same company by project size. Confusion concerning the role of the superintendent is common as there are no uniform rules or definitions which apply to all construction firms, construction projects, or supervisory positions.

The objective of the research was to test the hypothesis that the leadership competency level of a superintendent significantly influences his/her job performance. The selected approach was to first understand the role that leadership plays in the job performance of superintendents, second to identify potential causal influences that affect a Total Average Leadership Score (TALS), and finally relate everything to project results and financial success.

## 2. Research Objective and Methodology

The research process was preconditioned on the development of a questionnaire that would effectively profile a superintendent's management and leadership competencies and determine how leadership affects his or her job performance. The objective was to obtain sufficient data that would allow ranking the leadership levels of superintendents and identify a possible relationship between leadership levels and job performance levels. An extensive literature review identified all the concepts, ideas, theories, instruments, tools, and practices that could possibly be related to leadership in the construction industry. Too many promising constructs were included in an initial draft of the questionnaire resulting in an expansive, lengthy and time-consuming survey document. This first iteration was quickly deemed impractical for the construction industry due to its length; it demanded a quick grasp of many complex concepts, and would require too much time to answer. Furthermore, to safeguard against self-bias, inaccurate, inflated, and closed-minded responses, it was decided to develop two questionnaires, one aimed at the superintendent and one at the supervisor of the superintendent (i.e. the project manager). It was the combined use of the Field Construction Superintendent Questionnaire (FCSQ), and the Project Manager Questionnaire (PMQ) that assured sufficiently accurate and valid leadership data on the performance of the individual serving as superintendent as well as on the overall project success and customer satisfaction.

Each of the two questionnaires shred a list of sixteen leadership competencies (as defined by Zenger & Folkman (2002) - see Table 1) and seven job performance questions (developed by the authors - see Table 2). The FCSQ also contained twelve job experience and educational questions reproduced from by Skipper & Bell (2006) , as well as six questions on the amount of time the superintendent spends in leadership and management roles cased on Kotter (1990) (see Table 3).

The participants were asked to rank the competencies on a horizontal Likert scale from 1 to 10. At the two ends of the Likert scale the questionnaire presented a clear description of the behavior representing the indicated performance for the specific characteristic (poor at one end and superior at the other).

For instance, selecting 1 on the Likert scale for leadership competency #5 (see Table 1) "Practicing self-development" was described as: "Seems unconcerned about any kind of self-development. Is content with current skills and abilities. Fears that others might perceive their development of new skills as a sign of incompetence or weakness." At the high end of the Linkert scale (10), competency #5 was described as: "Makes constructive efforts to change and improve based on feedback from others. Seeks feedback from others to improve and develop themselves. Constantly looks for development opportunities. They are excited to learn."

| Leadership Competencies |
|---|
| 1. Displayer of high integrity and honesty |
| 2. Technical and professional expert |
| 3. Problem solver and issue analyzer |
| 4. Innovator |
| 5. Self-developer |
| 6. Focused on results |

| |
|---|
| 7. Establisher of stretch goals |
| 8. Leader responsible for outcomes/ initiatives |
| 9. Powerful and prolific communicator |
| 10. Inspiration and motivator for others to be high performers |
| 11. Relationship builder |
| 12. Developer of others |
| 13. Collaborator and team worker |
| 14. Developer of strategic perspectives |
| 15. Champion of change |
| 16. Connector of internal groups with outside world |

**Table 1**: Leadership Competencies

| **Job Performance Factors** |
|---|
| 1. Quality |
| 2. Safety |
| 3. On Time |
| 4. On Budget |
| 5. Retention |
| 6. Interpersonal Skills |
| 7. Technical Skills |

**Table 2**: Job Performance Factors

| **Leadership** | **Management** |
|---|---|
| 1. Aligning people | 1. Controlling and problem solving |
| 2. Establishing direction | 2. Planning and budgeting |
| 3. Motivating and inspiring | 3. Organizing and staffing |

**Table 3**: Leadership and management roles

The Project Manager Questionnaire (PMQ) contained the same leadership competencies and job performance questions as the FCSQ with three additional impact questions:

1. In the overall results of the construction project, how well are the services you received from the field superintendent meeting your expectations?
2. In the overall results of the construction project, how likely are you to recommend this field superintendent to others?
3. In the overall results of the construction project, would you want to work with this field superintendent again on another project?

The subjects of this study were superintendents and project managers from established and successful construction companies that conduct business across the American Southwest (Arizona and Nevada area). Comprehensive data was obtained regarding 43 superintendents from four construction companies who agreed to participate in the study. The number of employees and the annual construction revenue of the participating companies vary significantly. Each data point in this study consisted of the combined input from both the superintendent and his/her project manager. The scores for both responses for each of the participants were combined and averaged for every question common to both questionnaires.

The data were then analyzed as follows:

1. Data from the 16 leadership competency questions were totaled, combined, averaged, and then converted into percentages. The resulting percentage scores from the 16 leadership competency questions were labeled as "Leadership Competency Level" (LCL).
2. Data from the seven job performance factors were totaled, combined, averaged, and then converted into percentages. The resulting percentage scores from the seven job performance factors were labeled as "Job Performance Level" (JPL).
3. Data from the three impact questions, unique to the PMQ, were totaled and converted into percentages. The resulting impact questions were labeled "Impact Level" (IL).
4. The raw scores from the combined and averaged 16 leadership competency questions, the combined and averaged seven job performance questions, and the three impact questions were totaled and then divided by the total possible points of 260. These scores were then converted into percentages. The resulting scores were labeled "Total Averaged Leadership Score" (TALS).
5. The data were grouped according by companies and by "Great Superintendents" (GS). The Great Superintendents possessed TALS of 90 percent or higher; only eight out of the 43 qualified.

The findings were validated by comparing the superintendent's leadership ranking in the study to the participating companies' executive own internal and independent ranking of the individual.

## 3. Data, Findings, and Interpretation

The findings of this study are based on the results of the FCSQ-PMQ and unequivocally support the hypothesis that the leadership competency level (LCL) of a superintendent significantly influences his/her job performance level (JPL). Plots of the data of all the participating 43 superintendents (see Figure 1) reveal an R-squared value of 0.6875 suggesting that the trend line is significant. The hypothesis is supported by the fact that the two variables, LCL and JPL, yield a Pearson correlation value of 0.829 and a p-value of 0.000, which is less than alpha level of 0.05.

The data appears to indicate that the age and job experience of the superintendents is correlated with TALS, but more data is needed to confirm this conclusion. The data also indicate that the FCSQ is either ineffective in assessing the time each superintendent spends in leadership or management roles or that the superintendent lacks the understanding to differentiate between leadership and management.

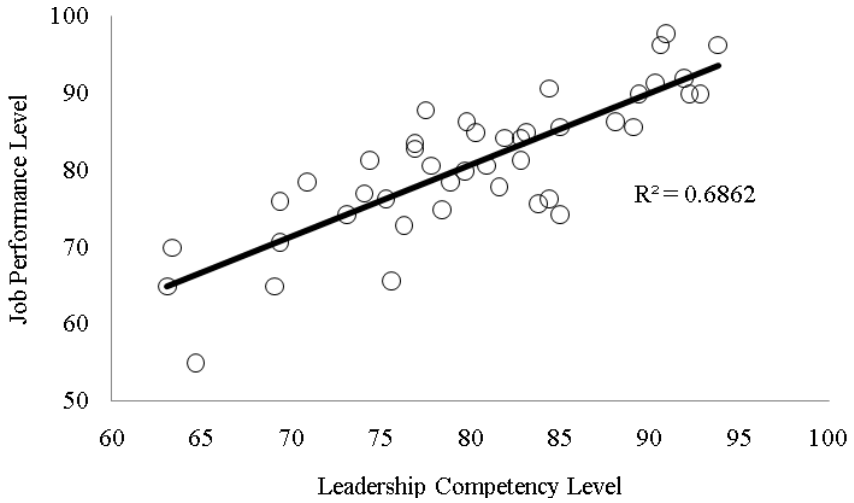


**Table 3**: Leadership Competency Level vs. Job Performance Level

The data show that every "Great Superintendent" as well as every participating company identified "Develops Strategic Perspective" as one of their top three leadership weaknesses. This competency was defined as: (1.) knows how work relates to the organization's business strategy (line-of-sight connection), (2.) translates the organization's vision and objectives into challenging and meaningful goals for others, and (3.) takes the long view, can be trusted to balance short-term and long-term needs of the organization. This weakness clearly indicates that all the superintendents act more like managers than leaders.

Three of the four fully participating companies list on-time projects as another one of their top weakness. However, the data on the eight "Great Superintendents" (GS) only show "retention" as a relative weakness, although even this job performance factor of theirs is significantly higher than the average. Retention was defined as keeping personnel from departing the organization and as such a low retention may be good or bad. If the GS is moving people up the career ladder to a better fit in the company, or if they are getting rid of ineffective people, the low retention rates may be serving the company well. On the other hand, if the GS is unable to retain his followers for other reasons, a low retention rate may be detrimental.

The data strongly concur with earlier findings by other researchers, indicating that most superintendents learn their leadership through job experience and that top performers have mentors. It confirms the importance of mentorship in leadership development along with the fact that most construction superintendents have acquired their leadership skills through job experience and by observing their leaders. The differences between leadership and management are highlighted by the data. It is very apparent that a balanced blend of leadership and management skills are a key characteristic of every one of the eight "Great Superintendents." The research also indicates that the amount of time that the superintendent spends in a leadership role is less than the amount of time project managers or the company executives spend in leadership roles.

Furthermore, the data support the unsurprising fact that superintendents' increased-educational levels do not directly relate to superior leadership, which

leads to the conclusion that there is a critical need for leadership training in the construction industry.

The responses also reveal that college courses in construction related subjects are presently inaccessible to the average superintendent, who works an average of 53 hours per week. The average superintendent's long work hours and lack of free time may explain why the average number of college courses taken in the past five years is nearly zero. The rigor of university construction management courses may also be intimidating to the already over-extended superintendent, since most superintendents have started college but few have ascertained university degrees. Perhaps the higher education classes are not being taught at the level necessary for the average superintendent to comfortably and effectively learn, given the indirect finding that their communication skills are significantly underdeveloped. There appears to be a need to build-up their communication-skill level prior to recruiting them to enroll in university construction courses and programs. Since education generally improves the quality of life in other industries, perhaps an analysis of how the university and the construction industry could collaborate in creating innovative, leadership-building programs for the majority of superintendents that have so far not recognized the need or found the opportunities to develop and improve their leadership skills.

## 4. Conclusions

The collected data support the hypothesis that the Leadership Competency Level of the superintendent has a major influence on his/her Job Performance Level. They clearly indicate whether the study participants possess management or leadership tendencies, and the degree to which they possess leadership competencies. The individual leadership-competency levels can be related to Job Performance Levels, thereby surfacing a clear relationship between them. The eight "Great Superintendents" (GS) very significantly outperform the average on all leadership elements.

The FCSQ-PMQ also provides detailed data regarding specific areas of leadership and job performance in which superintendents have some deficiencies. The FCSQ-PMQ can be utilized by the construction industry's executives in comparing their superintendents' Total Average Leadership Score (TALS), LCL and JPL scores with the scores of the "Great Superintendents" or a benchmark group. The resulting gap analysis can then be used to design individual mentorship plans for each superintendent to improve his/her leadership, which should, within a relatively short time, impact the companies' bottom line.

Certain characteristics of leadership enhance the chances for success in working with diverse project teams. An open style of management increases trust. A good sense of humor can diffuse potential misunderstandings. A sincere interest by the superintendent in his staff as individuals goes a long way toward creating good morale. A good communication style is exceedingly important.

Awareness of social and cultural factors are widely considered today as critical to effective construction project performance and pivotal in achieving successful construction projects outcomes. Many field teams have members whose first language is not that of the dominant group. An understanding of the differences in world view between groups is essential in promoting understanding among team members. The same event can be interpreted differently by various individuals

depending on their origin and what they have been conditioned to believe. Understanding and avoiding stereotypes prevent self-fulfilling prophesies.

Interviews conducted with three of the participants' company executives, covering almost 90% of the participating superintendents, found that, for those companies, the FCSQ-PMQ has a 90 percent accuracy rate in ranking the superintendents compared to their internal ranking based on performance and to the profits generated by the projects they managed. These interviews also found that the construction industry executives appreciate comparative studies of this kind that provide data regarding their company's workforce in relation to other companies.

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*[Professional Presentation]*

# Application of IPMA/PMA Standard Documentation on a Construction Project Located at Romania – Modulation of PM-Office Standard Documents According to the ISO 9001:2008 on the basis of IPMA

Baltas M.

## Abstract

The present abstract refers to the presentation and analysis of the methodology and standard documentation, through which the efficient management, control and coordination of the construction project, located at Copaceni – Romania, were made possible.

Project ID

The individual characteristics of the project and the contract relations that define the progress of the project are:

- Description of the project: The owner of the project has at his possession a site at Romania of total area 38.772,40$m^{2.}$ On the site are planned to be built 3 individual industrial and corporate buildings (production building, office building, storage building). An underground fire safety water tank and a pump station are also to be constructed. The total constructed area of the 3 buildings and the water tank together is 8600$m^2$. It is worth mentioning that the designs and blueprints of the buildings had already been carried out by engineers at Romania before the establishment of the Project Manager at the project.
- Location of the project: Copaceni , Ilfov Prefecture Romania
- Project Budget : 3.620.000,00€
- Corporation owning the project: "B"
- Project Owner and representative of the owning Corporation: "Mr. A."
- Construction Contractors:
    1. Structure and load bearing elements works
    2. Electromechanical works
- Project Management Team:
    1. Project Manager : Baltas Manolis
    2. Assistant Project Manager : Poulios Makis
    3. Project team member: Kaminaris Tasos
    4. Project team member: Baltas Sokratis
        - ❖ Engineering Experts
            1. Civil Engineering : Manolatos Grigoris
            2. Electro-Mechanical Engineering: Tripidakis Jonh
            3. Electro-Mechanical Engineering: Kaminaris Andreas

## "Nature & Problems" of the Project

- ❖ The nature of the project (scientific, engineering, management and financial issues)
- ❖ The specific problems that emerge because of the location af the project (scientific standards, construction methods, project culture)

- The complexity of the individual company organization of each participant in the project organization (owner, contractors, pm office)
- The clarification of methods concerning project management via contract terms

The above described, four key project factors DICTATED the application of a "special standardized documentation" during the project start, project control and project coordination:

- in order to all of these three phases to be successful.
- In order to orientate the contractors to follow the P.M. norms
- in order to construct the project
  - in time
  - in budget
  - and in quality standards
- in order to deliver a constructed building to the Project Owner that meets his needs and demands

The above stated standard documents were created on the basis of the IPMA/PMA methods. Obligatory, but minor from our point of view, changes were made in order to meet all the "special principles" of the project and the professional reality.

## Results

- The methods used for monitoring and formatting the project
- The "loyal" following of all the P.M. methods that were agreed
- The rigid stance of the Project Manager, during the project start phase, according to the use of this standard documentation by the contractors

Have all lead to the:

- Distinct, efficient, and pleasant project management resulting a significant save of resources.
- Significant improvement of the construction works schedule by the contractor in quality terms
- Excellent and smooth progress and implementation of the construction contract in terms of quality, time and budget
- Authorization of the P.M. by the project owner to act as if he was the project owner according to certain decisions concerning the project. This authorization came as a result of the mutual trust and appreciation relationship that was founded because of the transparency throughout all the project phases.

Finally and not less important, the use of this standard documents since the start of the project till today, has improved the existent monitoring, control and coordination system that our company has already established. As a result these standard documents are part of the COMPANY's documentation that we abide, following the ISO 9001:2008 norms.

*AA012*

# An MCDA Approach for Project Selection in Public Sector

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## Abstract
Effective and efficient selection of projects is a crucial issue for every organization and should be aligned with its vision and strategies. The decision making process is highly complex, especially for public organisations, as it encompasses various, often conflicting criteria. Moreover they have to consider a much larger picture than private organisations and many scholars argue that public investment decisions fall into the category of constrained optimisation problems. The present study develops and proposes an approach for the prioritization of public projects, based on the Analytic Network Process (ANP), which is further validated through a real case example concerning the project selection process of a Greek municipality. The results indicate that social and political criteria dominate the decision making process, while the ANP documents the results in such way that they can be communicated to various stakeholders, ensuring public trust and establishing a system of transparency in public administration.

## Keywords
Project Selection, Multicriteria Decision Analysis, ANP, Public Sector

## 1. Introduction

Project selection is a long lasting problem in business. Since finite resources exist at each period of time, the senior management of each organisation should decide which projects to undertake out of a set of potential alternatives. Effective project selection may lead to the prosperity or decline of an organisation, thus the problem has attained the focus of both practitioners and academics. In order to come up with a decision, the senior management of an organisation *should analyze and evaluate the economical and technical feasibility of* each *project, evaluate alternatives, secure financing etc.* (Fitsilis et al., 2008).

The problem is even more interesting and difficult to be solved for a public organization. In this cases, apart from the typical set of criteria such as technical (e.g. maturity of implementation), economic (e.g. investment cost) or those related to sustainability (e.g. environmental impact) the decision makers have also to take into account political criteria (e.g. mission and strategic policies) or social ones (e.g. contribution to employment). Thus the problem is further aggravated due to

the various tangible and intangible characteristics that need to be taken into account. The complexity of the decision environment and the strategic importance for the organisation leads to the need for a multicriteria decision analysis approach (Kirytopoulos and Voulgaridou, 2008). Although the number of MCDM methods is already big and still increases, there is no specific, generally accepted, method for every selection problem as each problem is unique (Kirytopoulos et al., 2008). In this paper the Analytic Network Process (ANP) method is selected for the analysis of decision criteria and alternatives. The scope of this paper is twofold. First the paper emphasises on revealing the criteria that have to be taken into account in public project selection. Second the paper offers a comprehensive approach on how ANP can be used to aid decision making in the aforementioned problem.

The rest of this paper is organised as follows. The second section offers a brief literature review on public project selection criteria. The third section is divided in two sub-sections where the analytic network process and its implementation on the public projects' selection are elaborated. The paper concludes with the last section where basic findings are discussed, minor limitations of the approach proposed are underlined and further research ideas are offered.

## 2. Literature Review

Effective and efficient selection of projects is a crucial issue for the viability of every project-based, private or public organization. Management decisions concerning the prioritization of projects proposals and the determination of the appropriate investment plan are guided by both intrinsic and extrinsic criteria (Mohanty, 1992). The intrinsic criteria concern the resources requirements and availability, the experience of the organization in managing similar projects, the management's perspectives and the time horizon of the projects. The extrinsic criteria concern the risk/return ratio, the target-market needs, the governmental policies and regulations, the socio-economic climate and the legal and technological implications. The selection criteria can be further specified depending on the organization or the project type.

As far as public organizations are concerned, the project selection process becomes even more complex. The great number of stakeholders, whose interests may be conflicting, introduces major difficulties into the decision-making phase. Zanakis (1995) argued that political factors related to a project play much more leading role than technical or other more rational considerations. According to Chapman (2006), public project investments involve great capital engagement, uncertainty and long lasting impacts. Furthermore, it is difficult to assess the value of a project, as it is affected by dynamic changes of the surrounding socio-economic environment (Medaglia et al., 2008).

When comes to public project selection criteria, apart from targeting at the maximization of net financial benefits or returns to stakeholders, decision makers should also prioritize and select projects through social equity, economic and political criteria (Medaglia et al., 2008). Puthamont and Charoengam (2007) indicated 32 factors that influence public project selection during the conceptual, design and the final approval stage of the selection process. The identified factors are related to the organization strategy, the project's rationale, feasibility, investment analysis, maturity, benefits/impacts and socio-economic and political environment. In Spain, R&D public projects (Santamaria et al., 2010) are appraised through the compliance of project's goals with governmental strategies, the

innovativeness and technological development of a project, quality, applicability of project results etc. In addition, the project selection may be guided by the project's region and the project's size.

# 3. Proposed Approach

## 3.1 The Analytic Network Process

The Analytic Network Process is a generalisation of the Analytic Hierarchy Process (AHP) developed by Thomas Saaty (1996). ANP incorporates feedback and interdependent relationships among decision criteria and alternatives and provides a general framework to deal with decisions without making assumptions about the independence of higher level elements from lower level elements or the independence of the elements within a level as in AHP. In fact, the ANP uses a network of elements without need to specify levels (Saaty, 2005). Technically, the model consists of clusters and elements. As in the AHP, the dominance or relative importance of influence is the central concept and judgments are provided from the fundamental scale of the AHP (Saaty, 2005) by answering the question: Given a criterion X, which of the two elements Y,Z is more dominant with respect to that criterion? In order for the influences among the elements to be meaningful at the final stage of the method (synthesis), a specific element, each time, is used to perform the pairwise comparisons. This element is called control criterion. In short, the ANP approach handles interdependence among elements by obtaining the composite weights through the development of a 'supermatrix'.

## 3.2 The Proposed ANP model for public project evaluation

The proposed model applies the ANP to the problem of evaluating, prioritizing and selecting public projects. The model has been validated through a real case implementation concerning the prioritization of three different public projects for a Greek municipality, within the frame of the development of its annual programs/actions plan. The referred municipality is located in a depressed area near Athens and 10 years ago had suffered from a big earthquake, which caused serious damages in most public infrastructures. The projects, which were examined in order to validate the proposed model, have been selected with the contribution of the technical director of the municipality who was asked to propose the three most important projects that should be implemented during the next year, according to his opinion. In this matter the following projects were examined:

1. Repairs on earthquake-stricken roads and buildings (short name: EARTHQ), referring to specific infrastructures damaged by the earthquake, which have not been repaired yet. Estimated budget 7 million euros, external funding 0.3 million euros, high maturity of implementation.
2. Bioclimatic reconstruction of the central square of the municipality (short name: BIOCL), including a total reconstruction of the square on a basis of bioclimatic design using cool barrier technologies and relevant planting. Estimated budget 0.5 million euros, external funding 0.25 million euros, low maturity of implementation.
3. Development of a web portal for the municipality (short name: PORT), offering e-government services to the citizens. Estimated budget 0.3 million euros, external funding 0.225 million euros, low maturity of implementation, high urgency (open call for proposals).

The purpose of applying the proposed model was to prioritise these projects on the basis of a set of specific criteria, with the use of the Analytic Network Process. The ANP processes were made by using Super Decisions Software created by Saaty (2004) to alleviate the mathematical burden. The framework of the method is illustrated through seven steps:

**Step 1- Model construction**: To develop the public project evaluation ANP model, fist, the authors performed an extended literature review concerning the evaluation criteria in the public sector and then interviewed the public project managers about the critical factors that need to be taken into consideration in order to choose among the different candidate projects. These factors were initially compiled as a long catalogue with overlapping data and redundancies. Afterwards, they were reviewed and categorised into clusters. These final clusters and criteria were communicated to the public project managers, hereafter referred as decision makers, who, after some minor corrections, verified the final model. From a technical point of view, the structure of the ANP model is described by its clusters and elements and the connection between them. These connections indicate the flow of influence among the elements. The resulting model is illustrated in Figure 1 and consists of six clusters:

1. The *1ECONOMIC* cluster controls the economic viability of the decision and consists of two elements: the Investment Fundability (representing the chance of allocating sources for funding the project, including the possibility of receiving external funding, e.g. through Operational Programmes of the Greek National Strategic Reference Framework and the Investment Financial Analysis (evaluating financial indexes like ROI, IRR, etc).

2. The *2POLICY/POLITICAL* cluster consists of the main elements that determine policy-related criteria such as the compliance of the project to the Organisation's Mission and the Strategic Policies, the Urgency of the project (taking into account not only the real urgency for covering a specific need, but also possible deadlines concerning opportunities for ensuring external funding for the project) and the projected Public Perception of each project.

3. The *3SOCIAL* cluster is related with the impact of each project to the citizens and the society, consisting of two elements, the first one concerning the possible benefits for the society and the second one concerning the contribution of the project to local employment.

4. The *4SUSTAINABLE DEVELOPMENT* cluster encompasses all those elements concerning the environment and the regional development. These elements include: the Environmental Impact of the project (in the local region, as well as in national level) and the general projected contribution of the project to Local Development.

5. The *5TECHNICAL* cluster controls the technical characteristics of each project that influence the final decision and consists of the project's Maturity of Implementation (concerning the status/availability of prerequisite factors for implementing the project like relevant studies, resolved legal issues, reassurance of equity capital, land expropriation needs etc), the Availability and Technical Ability of the Human Resources of the Organisation for monitoring the project and possible Regulatory Needs (in the terms of requirements for completing any regulatory/legal actions as prerequisite for implementing the project).

6. Finally, the *6ALTERNATIVES* cluster comprises all candidate projects as described previously on this subsection.

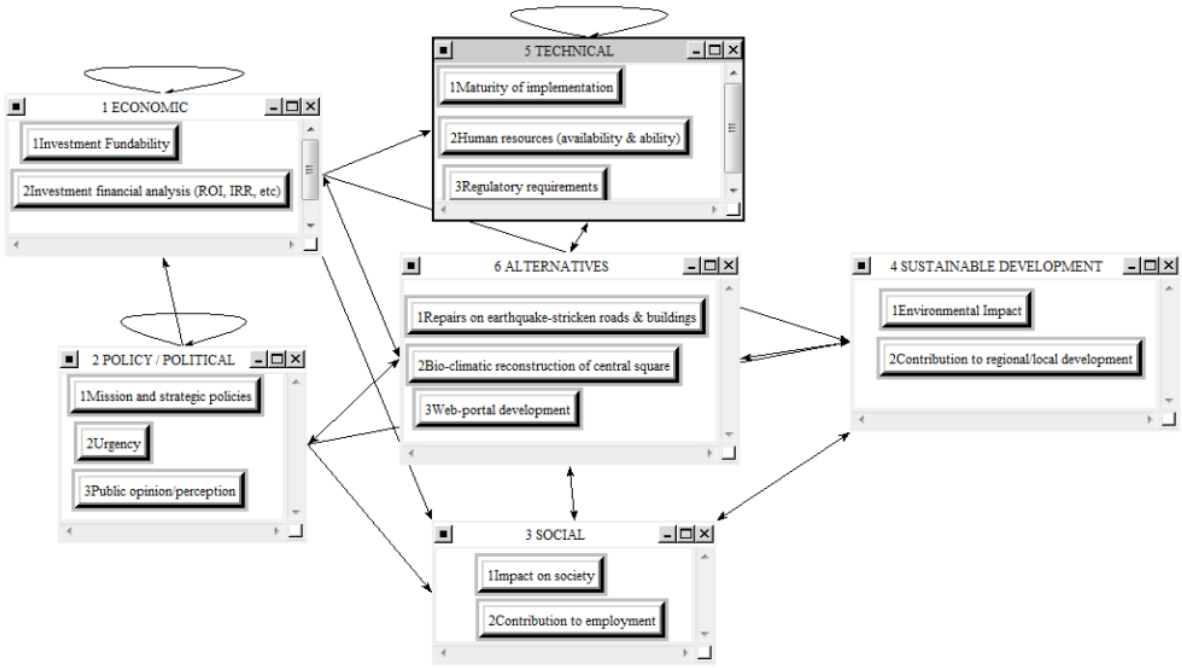


**Fig 1:** The Public Project Evaluation ANP Model

The connections among the clusters and elements are depicted in Figure 1 with arrows. The definition of these connections can only be defined by the decision makers, the public project managers in the present case, who are expert in terms of knowing how the elements interact in the real environment. For example, the arrow from the cluster *2POLICY/POLITICAL* to the cluster *4SUSTAINABLE DEVELOPMENT*, captures the notion of outer dependence of ANP and is interpreted as follows: some of the elements in cluster *4SUSTAINABLE DEVELOPMENT* influence some of the elements in cluster *2POLICY/POLITICAL* (Specifically, the Public opinion/perception is influenced by Environmental Impact and Contribution to Regional/Local Development). Finally, the concept of inner dependence of ANP (some elements of a cluster influence other elements of the same cluster is depicted with a feedback loop. Refer, for example to the loop above the *5TECHNICAL* cluster, which represents the fact that Maturity of implementation is influenced by both Human Resources (ability & availability) and Regulatory requirements. The volume and the diversity of the criteria identified during this step, reveal the complexity of the decision problem in the public project evaluation environment.

**Step 2- Clusters' pairwise comparisons and Clusters Priority Matrix**: After the model was constructed, an additional meeting between the authors and the public project managers took place, during which the managers were asked to respond to a series of pair wise comparisons with respect to a control criterion. The elements in a cluster are compared by applying Saaty's 1–9 scale (Saaty, 2005) according to their influence on an element in another cluster to which they are connected or on elements in their own cluster, as described above. "Super Decisions" software is able to calculate the inconsistency ratio for each comparison matrix, so the most consistent value for the entries can be determined. The inconsistency measure is useful for identifying possible errors in judgments as well

as actual inconsistencies in the judgments themselves. For example, if A is more important than B and B is more important than C, C cannot be more important than A. In general, the inconsistency ratio should be less than 0.2. Afterwards, the Clusters Priority Matrix is constructed. Its columns consist of the weighted priorities derived during the pair wise comparisons.

**Step 3- Elements' pair wise comparisons**: in order to compare the elements of the clusters, the same procedure described in the former step was followed.

**Step 4- Formation of the SuperMatrix**: The priorities of the elements are arranged both vertically and horizontally according to clusters. This matrix is known as SuperMatrix. Each vector taken from a paired comparison matrix is part of the column of the SuperMatrix representing the impact, with respect to the control criterion of the elements of that cluster on a single element of the same or another cluster, listed at the top.

**Step 5- Formation of the Weighted SuperMatrix**: The weighted priorities at the Clusters Priority Matrix are used to weight all the elements in the block of column priorities of the SuperMatrix corresponding to the impact of the elements of that cluster on another cluster. This process is repeated for all the clusters resulting in the Weighted SuperMatrix.

**Step 6- Formation of Limiting Matrix**: The Limiting Matrix and the system's solution derives from multiplying the Weighted SuperMatrix (step 5) by itself, which accounts for variable interaction, until the system's row values converge to the same value for each column of the matrix. This 'power method' process yields the limiting matrix, which provides the relative importance weights for every element in the model (Niemira and Saaty, 2004). The final results, weights of criteria and prioritization (normalized values) of public projects under evaluation as derived from the limit matrix are graphically depicted in Figures 2 and 3, respectively.

**Step 7- Sensitivity analysis on the final outcome**: Sensitivity analysis is concerned with 'what-if' kind of questions to determine if the final answer is stable to changes in the inputs, either judgements or priorities. Of special interest is to see if these changes alter the order of the alternatives. The sensitivity analysis performed with respect to Impact on society, which is the dominant criterion (refer to figure 2), showed that irrespective of its value, the rank of the projects is preserved. Performing similar sensitivity tests for other criteria led to the conclusion that the outcome is very stable and does not change the overall rank.

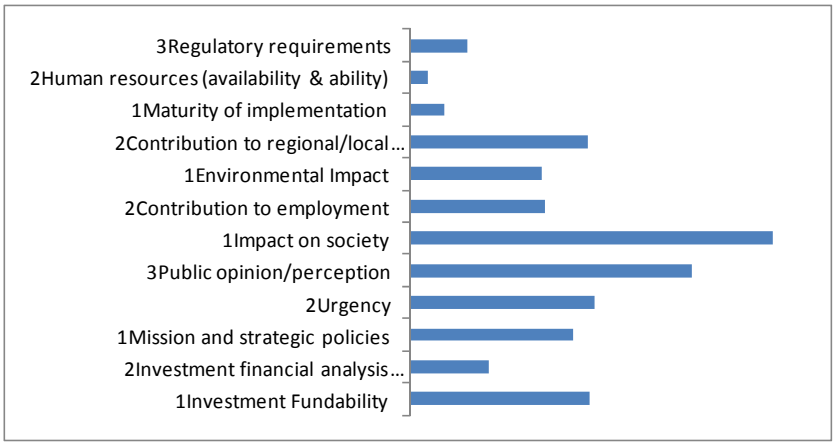


**Fig 2:** Final weights of the decision criteria

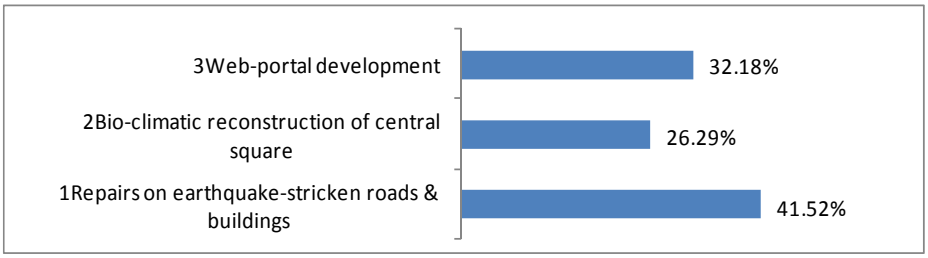


**Fig 3:** Prioritization of projects

## 4. Conclusions

The evaluation and selection of public projects is a difficult endeavour as it takes into account many conflicting criteria, both tangible and intangible. The present study proposed an MCDA approach based on the ANP that is capable of capturing this complex decision environment. The ANP method, as part of this approach, enables the decision maker to visualize the impact of various criteria in the final outcome and documents the evaluation results in such way that they can be communicated to various stakeholders, ensuring public trust and establishing a system of transparency in public administration. Although the case study presented in this paper concerned a limited number of projects, ANP is capable of handling many more alternative but with the cost of complexity.

For the case study presented here, the results indicate that the project with the highest priority is the Repairs on earthquake-stricken roads and buildings followed by the Web-portal Development and the Bio-climatic reconstruction of central square (refer to figure 3). Moreover, the most dominant criteria that influenced the decision were found to be the social (e.g. Impact on Society) and the political criteria (e.g. Public opinion/perception, Urgeny) followed by economic criteria (e.g. Investment Fundability). The results indicate that, under the current conditions and according to the public projects managers' value system, social and political criteria are favoured over economic criteria, which explains the fact that a project with major socio-political impact dominates over more economic compensative projects.

The ANP approach proposed by this paper bears also a few limitations. The most important is considered to be the fact that the outcome of the model depends on the inputs provided by the public managers. Moreover, the formation of the pairwise comparison matrices is a time-consuming and complex task. Finally, inconsistency may also occur, leading to doubtful or wrong results.

This study raises several important issues that could spark further research. The most important is the evaluation of the model and its implementation at additional case studies in related public organisations. Such an endeavour might be beneficial and result in developing a complete system that could support the decision makers and reveal the significance of certain alternatives, criteria and elements.

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*AA007*

# Measuring Performance and Implementing Improvements (Case study)

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## Abstract
The period between 1999-2002 a first-hand applied research was based in one of the biggest corporations in England (UK) in the Project Management field. The target was to create the suitable tools, techniques and methodologies in a practical measurable environment where departments of the company which affect the effectivity and viability of a project to be analyzed so that their effectiveness can be measured and ways and mechanisms of improvement can be found.

It was decided that the start would be made from a project of a budget of € 270 million whose cause was the research and construction of a nuclear laboratory in Shellafield UK.

The department initially chosen to be examined and ways of measuning effectiveness to be found, but also methodology of optimizing the services offered, was the **Information Technology** department since it offered its services to more than 400 engineers.

The paper will cover the concept design, the methodology and tools used as well as the results of the improvements acted out in the period of two semesters when the research was held.

## Keywords
Project Management, Performance Measurement, Improvement implementation, Process mapping, Results charting, Workshops, Service optimisation

## 1. Introduction

Global corporations consume much energy as well as money in order to be able to make their manpower and also the services provided from one department to the other productive.

The research (R&D) was based in one of the largest corporations in England (UK) in the Project Management field, **AMEC,** in the department of **AMEC Nuclear.** The plan was to create the suitable tools, techniques and methodologies that will measure actual performance and then implement change via specific actions for each area.

It was decided that the start would be made from a project of a budget of € 270 million whose cause was the research and construction of a nuclear laboratory (B41 Building). The project was under a series of projects (total budget € 10 billion) whose cause was the first ever closing down of a nuclear reactor in Shellafield UK.

The department initially chosen to be examined and ways of measuring performance & effectiveness was the **Information Technology** department since it offered its services to more than 400 planning engineers.

This paper will cover the concept design, the methodology and tools used as well as the results of the improvements acted out in the period of two semesters when the research was held (May 2000 – December 2000).

## 2. Tools & Management Techniques

The main objectives for this project were: **''To capture, analyse, report and make improvements to the IT service for the Alliance projects''.**

The first step was to analyse and process map all of IT's activities and man power (Chart 1).

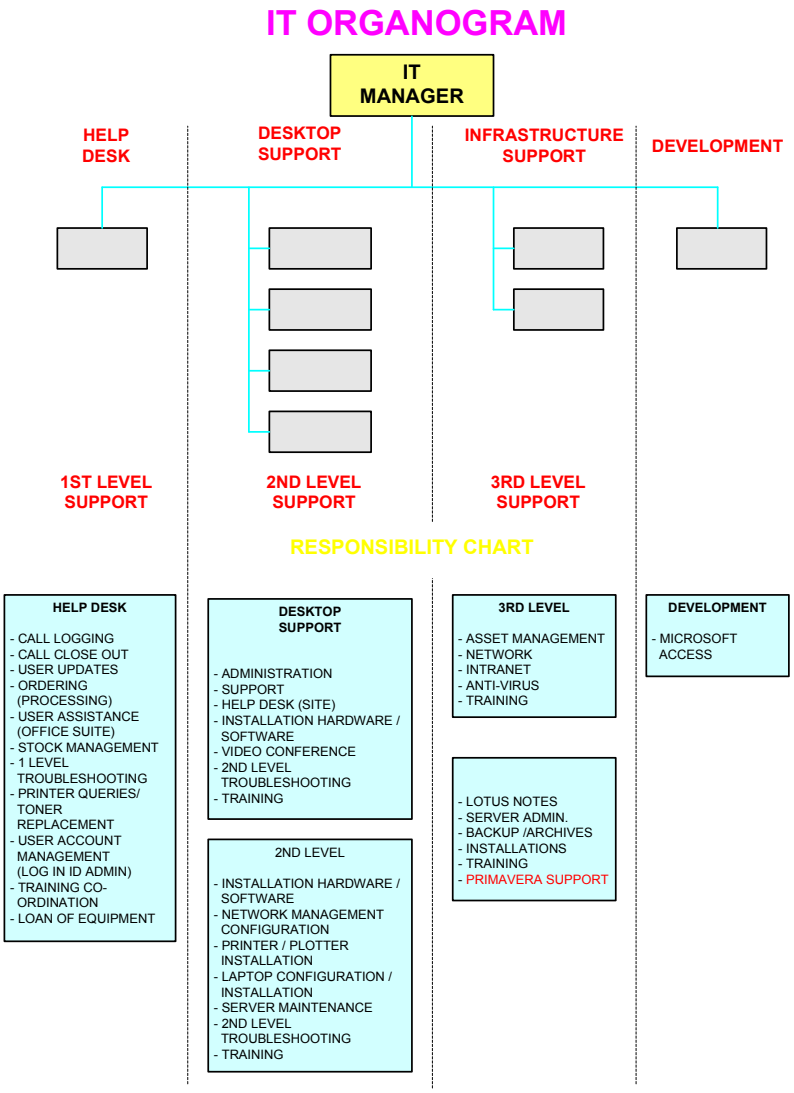



**Chart 1:** IT Organogram

The second step was to develop a Business Process Map (Chart 2) that would assist on understanding the process followed and therefore would make easier for the IT people and the engineers participating to ''buy-in'' to the process.

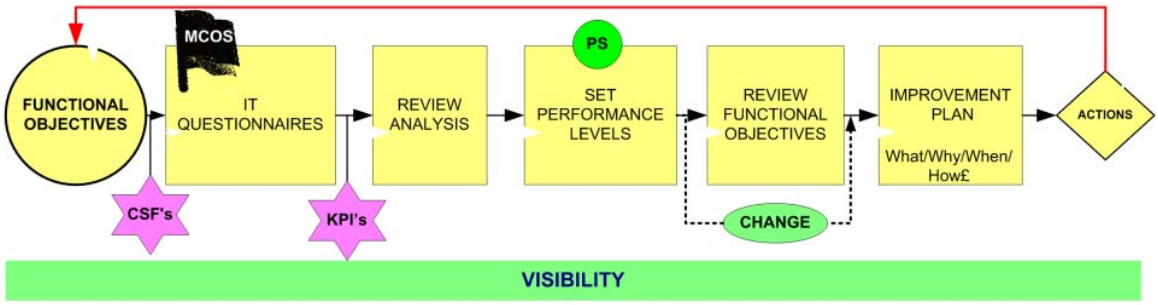



**Chart 2:** IT Business Process Map

The process map started by setting the principal objectives which also were by definition the Minimum Conditions Of Satisfaction (MCOS). Next, the management team set the Critical Success Factors (CSF's) for this Project.
These can be summarized as follows:

- Provide effective and efficient support to the Project Team (Home office, Site and Mobile).
- Equipment and applications must be reliable, robust and maintainable, with the flexibility for expansion/enhancement (Network, individual PC's and equipment, applications, training, help desk, response data etc.)
- Applications must be user friendly, with simple operating instructions.
- Trained personnel, with demonstrable competency.
- Provide networked applications and communication, including mobile users and corporate offices.
- IT budget approval and control (spend profile).

The best way to move forward and set the desired standards was through the creation of a questioner that represents all aspects of IT, physical performance of people, software, hardware and problem solving.

The questionnaire (Table 5 Question 1-13) was structured in such manner that covered all aspects of the working environment and future changes.

The scoring methodology followed can be summarised in table 1:

| **Scoring:** | **Definitions:** |
|---|---|
| A. 0-20% Total Failure | Cannot perform my role effectively |
| B. 21-40% Failure | Impacts my ability to perform my role |
| C. 41-50% Less than adequate | Functions but needs improvement |
| **D. 51-70% Meet requirements** | **Satisfactory** |
| **E. 71-100% Exceeds requirements** | **More than Satisfactory** |

**Table 1:** Scoring methodology

It was then necessary to set the Key Performance Indicators (KPI's) as a percentage of acceptable performance (Performance Levels) and was decided to have a uniform target of **70%** performance target level.

(Where Actual Score =D+E/2). (1)

**(D=Score between 51-70% & E=Score between 71-100% (Table.1))**

Before issuing the actual (hard copies) & virtual questioner (via a dedicated intranet site) a top Managerial letter was issued so that every one in the organization to know that the particular project was well supported by the management team. The letter wrote: ''As part of our commitment to improve our Business Performance, a process of collecting, analysing and improving the IT service has been developed. This is realised through the "IT Performance Evaluation Survey".

This process, measures the performance of the IT service against agreed Critical Success Factors, which are regularly revised, to fit our goals of a high performance organisation.

The process is repeated every six months, with the objective of capturing & improving areas of the IT service that will result on a better quality visually enhanced service'' . A period of 2 weeks was allowed for all questioners to be collected and analysed.

Next, a number of workshops took place in order to review all the functional objectives and a ways of best presenting results to be developed. This was achieved by using presentational Radar Charts (Chart 3) that indicated the target score (red dotted line) across the actual score achieved (blue shaded area).

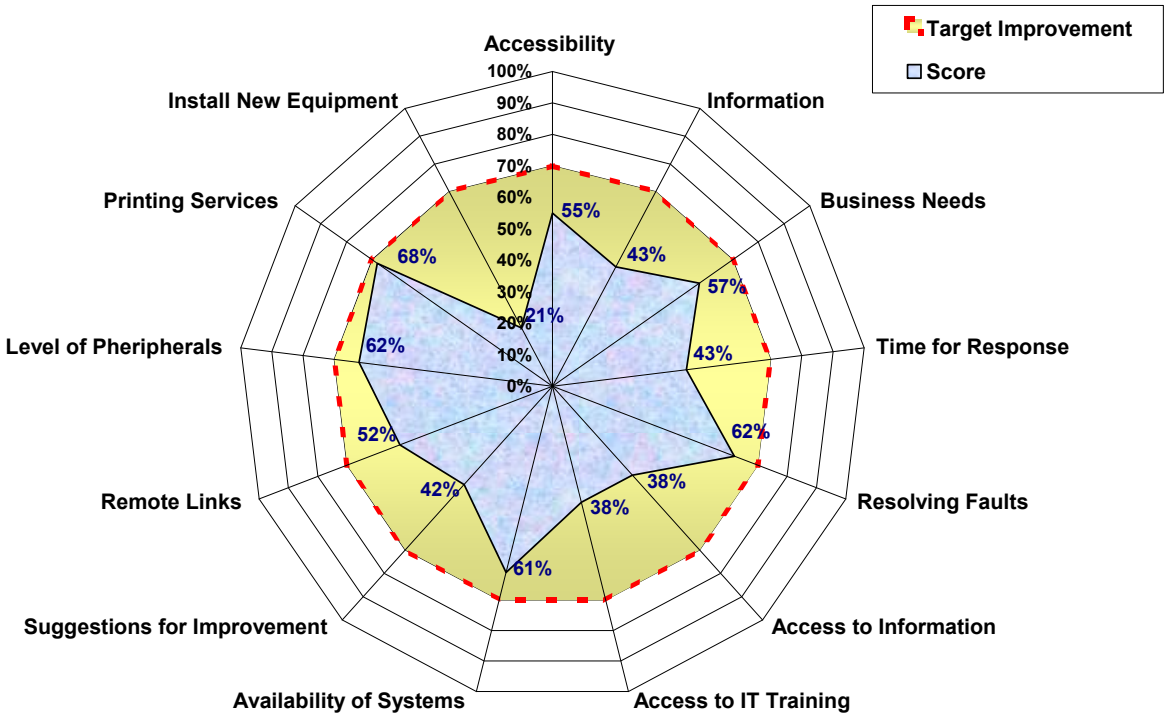



**Chart 3**. Overall Results of IT Performance Survey (All Projects) May 2000

Then an individual ''Result and Subsequent Improvement Plan sheet'' (Table 2) for each question was developed in order to better analyse the What/Why/When and How much.

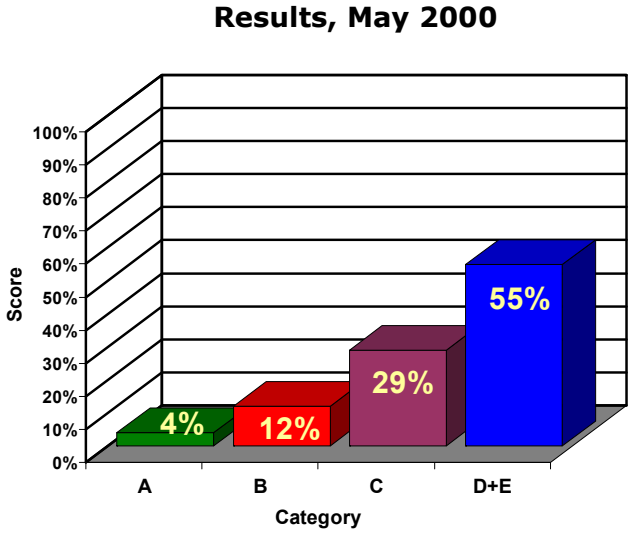
<table>
<tr><td colspan="2">Question 1: What is the accessibility of IT staff when you need them?</td></tr>
<tr><td> 
</td><td>Scoring: The score is the percentage of response who deemed the service to be satisfactory or better (i.e. D+E)<br><br>A: Cannot perform my role effectively<br>B: Impacts my ability to perform my role<br>C: Functions but needs improvement<br>D: Satisfactory<br>E: More than Satisfactory</td></tr>
<tr><td>Improvements /Action</td><td>Help desk/Mobile phone</td></tr>
<tr><td>Action</td><td>• Man help desk/Introduce mobile phone help number<br>• Review resources across IT function<br>• Formalise hours of office coverage</td></tr>
<tr><td>Proposed date for completion</td><td>24/07/00</td></tr>
<tr><td>Progress to-date</td><td>• Staff numbers have been increased to ensure that the Helpdesk is now permanently manned.<br>• Mobile phones are being procured for Both Swinton and Sellafield use. Their usage and contact details will be issued shortly.<br>• Resources have been reviewed across the IT function, leading to an extra member of staff for Sellafield support in addition to the extra helpdesk staff. Risley (BTC) already has a dedicated full time support engineer.<br>• The IT helpdesk will be manned from 7:30 am until 5:00pm Mon-Thurs. Earlier finish may occur on Friday pending office occupation level.<br>• In any instance, if the Helpdesk cannot be contacted, the Mobile phones will be manned within Helpdesk hours and beyond.<br>• Cover outside of office hours will only be available by prior arrangement.</td></tr>
<tr><td>December 2000 target</td><td>70%</td></tr>
</table>

**Table 2.** ''Result and Subsequent improvement plan''

A generic improvement plan was issued (Table 3) with all questions, scores and improvement plans so that the whole process was visible to all staff across all projects.

**TABLE 3. IT QUESTIONNAIRE EVALUATION AND IMPROVEMENT PLAN (ALL PROJECTS) – MAY 2000**

| No | Question | Score % | Improvement (Target 70+) | Action | Proposed date for completion |
|---|---|---|---|---|---|
| 1 | What is the accessibility of IT staff when you need them | D+E=55%<br>A:4 B:12 C:29 | Help desk/Mobile phone | Man help desk/Introduce mobile phone help number<br>Review resources across IT function<br>Formalise hours of office coverage | 24/07/00 |
| 2 | What is the level of information you get for any systems changes and upgrades | D+E=43%<br>A:15 B:11 C:31 | Notify via Intranet/Email<br>Increase level of information available | Advice changes via e-mail/Intranet<br>Build requirement into IT process map | Ongoing |
| 3 | How willing is the IT department personnel to address your business needs (e.g. new software, software licenses, etc.) | D+E=57%<br>A:6 B:13 C:24 | Clarify to users the process for obtaining new software | Publish IMS IT section<br>Advice/Link for location of forms | Ongoing |
| 4 | What is the average time required for response to approved requests for new equipment (software & hardware) | 43% (within 1 or 2 weeks)<br>WITHIN<br>3weeks 11% / 4weeks 23% / More: 23% | New starters: Improve forward planning<br>Others: Improve streamline of ordering | Consultation with HR Department for new starters<br>Provide information on status of orders<br>Review with Dave Kelly process cycle times | Ongoing |
| 5 | Average time required for resolving reported faults | 62% (within 1 or 2 days)<br>WITHIN<br>3days 18% / 4days 8% / More 12% | Additional IT resources to be provided for faster fault resolution | Recruit additional support engineer | 10/07/00 |
| 6 | What rating would you give to the ease of access to information ( e.g. location of Documents, time-sheets, holiday-planner, etc.) for the systems | D+E=38%<br>A:15 B:21 C:26 | Plan and implement new project directory structure | Develop and publicise on Intranet/e-mail | 18/09/00 |
| 7 | How would you rate the access to appropriate IT training | D+E=38%<br>A:18 B:23 C:21 | Provide e-based training | Select & Implement system | 24/07/00 |
| 8 | What is the availability of systems outside of normal working hours | D+E=61%<br>A:18 B:7 C:14 | Publish any details of any system outages | Make information available by e-mail/Intranet | immediate |
| 9 | What is the response to new suggestions for improvement ( e.g. development of existing tools) | D+E=42%<br>A:17 B:15 C:26 | Formalise method for making IT improvement suggestions | Develop Intranet suggestion box with visible replies to suggestions | 10/07/00 |
| 10 | Are remote links (e.g. E-mail, MTS) between all alliance locations — adequate | D+E=52%<br>A:16 B:10 C:22 | Publish capabilities for remote site links between sites | Circulate info via e-mail/Intranet | 10/07/00 |
| | — (b) effective | D+E=47%<br>A:16 B:13 C:22 | | | |
| 11 | Are you satisfied with the level (quality, numbers) of peripherals (e.g. Notebooks, projectors) that are available for use both on and off site | D+E=62%<br>A:8 B:11 C:19 | Increase users knowledge on peripherals available | Create info-sheets with all available equipment and how to obtain use of those resources.<br>Input of the info-sheets on the HR induction sessions | 07/08/00 |
| 12 | Availability/efficiency of printing services | D+E=68%<br>A:6 B:6 C:20 | Maintain printing services to building capacity | Review printing facilities in parallel with the changes in office capacity | Ongoing |
| 13 | How long did it take to install new equipment upon your arrival to the company | 21% (within 1 or 2 days)<br>WITHIN<br>3days 11% / 4days 17% / More 51% | Better quality information for manpower loading on projects | Pre-order appropriate equipment for new starters | Ongoing |

Upon completion of the improvement plan, actions had to take place and an ''**OPEN WALL**'' tool where anyone could write their comment, question or suggestion to be introduced. This increased the visibility of this project and gave the opportunity to employees for direct involvement other than filling the questioner.

It was decided to repeat the whole process six months later (Chart 2) so that changes will take effect and the main objectives together with all the improvements suggested to fully service the Critical Success Factors for this Project.

After the completion of the second round the presentational Radar charts were as follows (Chart 4):

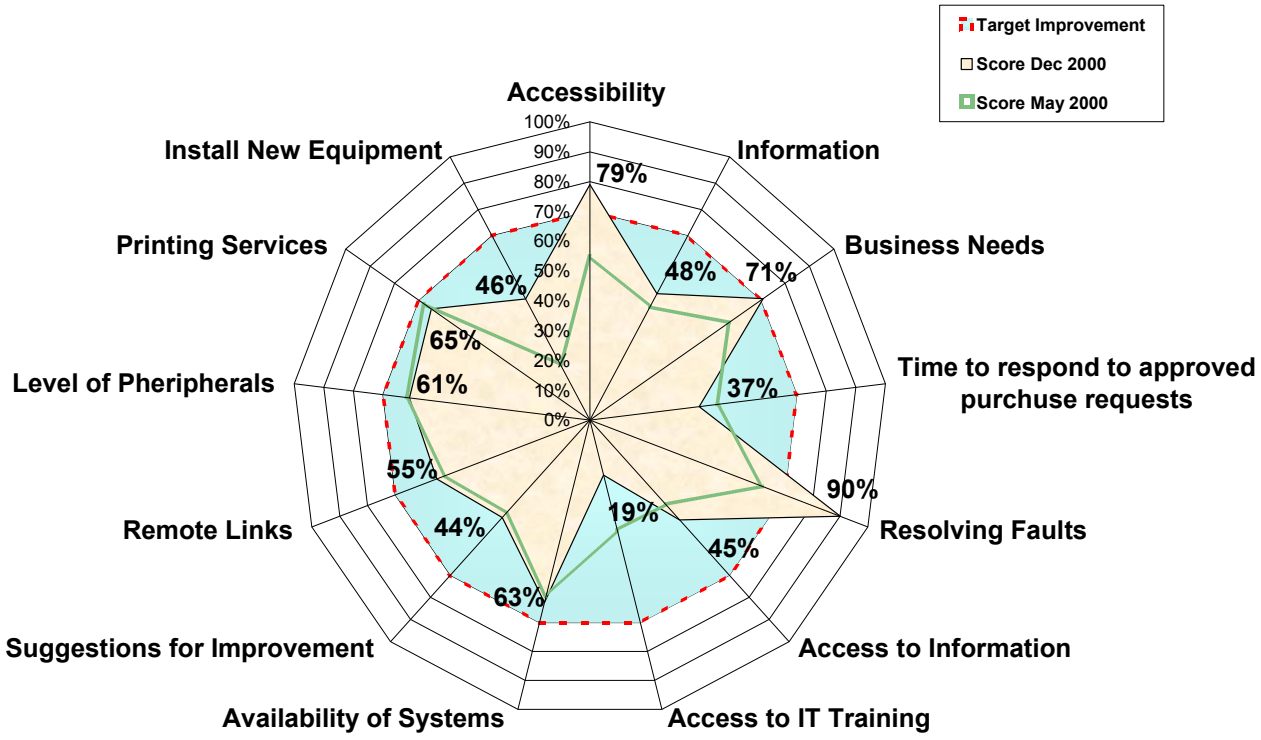



**Chart 4** Overall Results of IT Performance Survey (All Projects)
December 2000

A new evaluation & improvement plan was derived (Appendix1 - Table 4) and the whole process started again. It is very visible to all where improvements have taken place and where the process needed further improvements.

## 3. Conclusions

The company invested time and man-hours to develop a project management tool that will allow the measurement & improvement of its IT departments across a segment of projects in the nuclear area (Appendix 2).

Making the process visible to all via the introduction of a dedicated intranet site and in parallel introducing an Open-Wall policy for suggestions, comments & remarks, ensured the ''Buy-in'' of this project from all. Very important role played the managements support for the whole process and its dedication to continue improvements. As the process continued new higher KPI's were set (Appendix1 - Table 6 – September target) in order to continue the improvement process and reach higher performance.

After the completion of the second stage of this process it was clear that the whole IT service had been improved and IT staff was more aware of change than ever before. Finally, it was decided this process to be followed across the company and its characteristics to be branded as **Best Practice**.

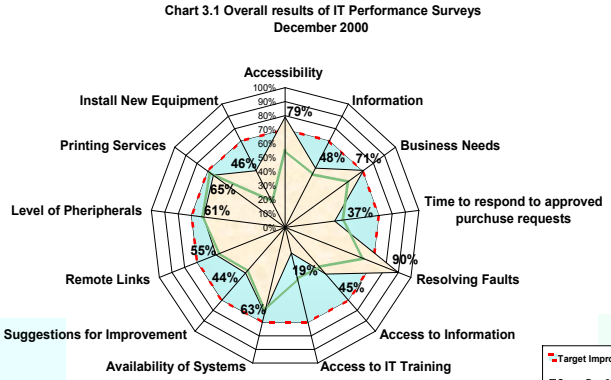
Appendix 1.

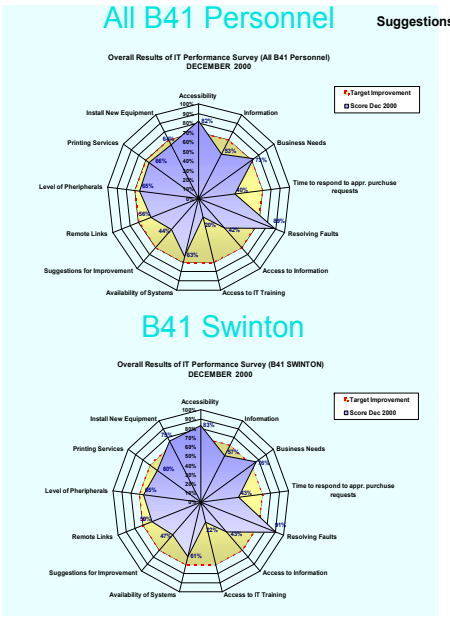
**TABLE 4. IT QUESTIONNAIRE EVALUATION AND IMPROVEMENT PLAN (ALL PROJECTS) – DECEMBER 2000**

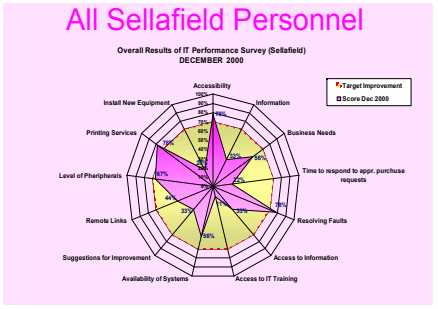
| No | Question | Score % (Target 70%) | May 2000 Score% | September Target % | Improvement | Action | Proposed date for completion |
|---|---|---|---|---|---|---|---|
| 1 | What is the accessibility of IT staff when you need them? | D+E=79%<br>A:0 B:5 C:16 | 55 | 80 | BTC project performance to be addressed | Inform A. Faulkner of result & establish why there is significant score difference from all other projects, and address | |
| 2 | What is the level of information you get for any systems changes and upgrades? | D+E=48%<br>A:15 B:11 C:34 | 43 | 60 | Continue e-mails for any system changes | Continue e-mails for any system changes | |
| 3 | How willing is the IT department personnel to address your business needs (e.g. new software, software licenses, etc.)? | D+E=71%<br>A:0 B:8 C:21 | 57 | 80 | BTC project performance to be addressed | Re-confirm IT service system procedure | |
| 4 | What is the average time to respond to approved requests for new equipment (software and hardware)? | 37% (within 1 or 2 weeks)<br>WITHIN<br>More: 39% 4weeks 15% 3weeks 10% | 43 | 80 | **B41-** No new equipment being procured without project authorisation **Magnox-** delays in obtaining BNFL authorisation to procure | Provide process & current issues around purchasing and attach to all hardware/software request forms | |
| 5 | Average time to respond for resolving reported faults? | 90% (within 1 or 2 days)<br>WITHIN<br>More 5% 4days 3% 3days 2% | 62 | 90 | Maintain same level of service | Maintain same level of service | |
| 6 | What rating would you give to the ease of access to information ( e.g. location of Documents, time-sheets, holiday-planner, etc.) for the systems? | D+E=45%<br>A:5 B:15 C:35 | 38 | 50 | Establishment of centralised area on Network for hosting Standard forms etc. | Investigate proposal | |
| 7 | How would you rate the access to appropriate IT training? | D+E=19%<br>A:21 B:31 C:29 | 38 | 50 | | HR to provide process map | DC |
| 8 | What is the availability of systems outside of normal working hours? | D+E=63%<br>A:8 B:5 C:24 | 61 | 70 | | | IB |
| 9 | What is the response to new suggestions for improvement ( e.g. development of existing tools) ? | D+E=44%<br>A:3 B:8 C:39 | 42 | 60 | Make process for suggestion more visible | Re-launch new suggestions system | |
| 10 | Are remote links (e.g. Email, MTS) between Alliance locations effective? | D+E=55%<br>A:6 B:8 C:31 | 55 | 70 | Examine capability of remote links and improve | Establish what are the problems with remote links | |
| 11 | Are you satisfied with the level (quality, numbers) of peripherals (e.g. Notebooks, projectors) that are available for use both on and off site | D+E=61%<br>A:3 B:8 C:27 | 62 | 70 | Improve communication levels | Confirm with customers 24 hours before hand their requirements | |
| 12 | Availability/efficiency of printing services | D+E=65%<br>A:3 B:3 C:25 | 68 | 70 | Maintain current capacity and examine new requirements for the Office move | To be addressed for new building | |
| 13 | How long did it take to install new equipment upon your arrival to the company | 46% (within 1 or 2 days) | 21 | 70 | Provide visibility to the current purchasing process & requisitions | Current purchasing process cannot be influenced by IT department | |

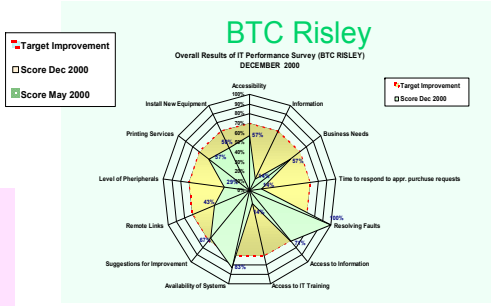
Appendix 2.

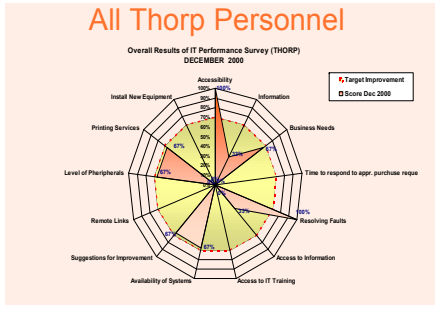
## December 2000 IT Performance Measurement Summary Results



*A002*

# Effectiveness of risk management: Barriers and solutions

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## Abstract
The effectiveness of risk management within the UK construction industry is discussed. A semi-structured questionnaire was used in collecting both qualitative and quantitative data. 113 construction professionals were sampled who included project managers, clients, quantity surveyors, and contract experts. 46 replies were received, representing a 40% response rate. The quantitative data were analysed by descriptive statistics while the qualitative data were synthesised by the content-identification of opinions made. Results of the analyses showed that most respondents use a structured approach; and manage risks throughout the different phases of a project. They also feel that the risk management process is fairly okay but some barriers were identified, e.g. making a late start, using inexperienced personnel, not fully pro-active, etc. In view of these, solutions for improvement were proffered such as providing adequate training, not circumventing some steps in the process, etc.

## Keywords
Project management, risk management, project success, contract management, tools and techniques.

## 1. Introduction

The construction industry is subject to more uncertainty and risk than many other industries because many of its projects are complex, generally bespoke and entail time consuming design and production processes. Risks in construction can also come from external factors which can be beyond the control of those involved in a project. The fact that most construction requires a multitude of people with varying skills, abilities and interests adds to the risks associated with projects as conflicts can arise in the relationships amongst participants. Risk can impact on project time and cost, sometimes significantly. According to Latham (1994) "No construction project is risk free". Therefore, all the underpinning sources of risks in a project should be addressed to forestall or minimise their consequences.

Risk management is not new and its techniques are well documented. So it is the implementation of risk management that has to be done efficiently. On this basis, a research was carried out to investigate the efficacy of risk management within the UK Construction Industry with particular emphasis on barriers and solutions to this activity. The next section of the article reviews risk management, after which the research method is discussed. The findings and conclusion are presented towards the end.

## 2. Risk Management

Risks are associated with uncertainty. A type of risk which is prevalent in construction is 'exposure to accidents or hazards'. This type of risk tends to emphasise a downside, however, uncertainty can yield an upside. Contractors' bids often include an allowance for risks and if some of these do not materialise in the course of a project, then the profit margin becomes higher than expected. So there is a positive dimension to risks.

Construction risks are always many and it is often impossible to eliminate these all (Simon et al., 1997). So means of coping with risks have to be established in each project (Kangari, 1995; Franks, 1998). Risk Management assists organisations to address the downsides attached to their activities. It adds sustainable value to an organisation's activities and increases their probability of success in their endeavours while limiting or controlling their chances of failure.

Bernstein (1996) and Boothroyd and Emmett (1996) reckon that modern risk management is about 350 years old. The process is now associated with many industries (Raftery, 1994). In the construction sector, the number of publications on this subject has increased continuously from 1960 onwards (Edwards and Bowen, 1998). A risk management process will tend to involve:

1) risk identification, analysis and response and
2) risk control and management.

These two broad aspects are now considered below, being informed by: PMI (2009) for the first aspect; and IRM (2002) for the second aspect.

### 2.1 Risk identification

A starting point is to identify the risks in a project. Various means are available and these include the use of: risk registers, experience, intuition, analysis of assumptions, analysis of hazards, etc. When risks have been identified, an organisation can begin to decide on what to do with the known risks. Some risks may remain unknown but that does not mean that they are not there. Unknown risks can spring up surprisingly and cause embarrassing and detrimental effects. So every endeavour must be exercised to identify all risks in a project.

### 2.2 Risk Analysis

Having identified risks, they should be quantified to establish their potential impacts on the project are. This should be done objectively and accurately and qualitatively or quantitatively.

*Qualitative risk Analysis*: This assessment is done by using the personal experiences of the risk analysts and reviewing past corporate experiences where records are available. It can also be achieved with the aid of checklists, interviews, brainstorming sessions, etc.

*Quantitative Analysis*: This involves a numerical assessment that may require the use of a computer software. A detailed quantitative analysis may be carried out following a qualitative analysis to enable the impacts of the risks to be quantified. A

quantitative analysis can be carried out by means of sensitivity analysis, scenario analysis, probability analysis, Monte Carlo simulation, etc.

Smith *et al*., (2006) observed that "in most analyses only a few key risks are investigated and … it should be easy to see which those risks are". This observation suggests that major risks should not be ignored at the expense of minor risks. Only a good and effective evaluation can inform the categorisation of risks as either major or minor.

Once assessed, risks can be categorised into high/low probability of occurrence and major/minor impact on the project. Also, actions can eliminate or minimise certain risks. Having mitigated some risks, the assessment is carried out again to establish the new risk profile of the project. This cycle is repeated several times until all outstanding risks cannot be mitigated.

### 2.3 Risk response

This stage of the process involves acting to deal with the risks identified from the above activities. The generic strategies that are often used to deal with risks are: Remove, Minimise, Transfer or Accept a risk (Baker *et al*. 1999). There are many tactics that can be used in this regard e.g.: identify preventative measures to avoid a risk or reduce its effect; consider risk transfer to insurers; consider risk allocation in contracts; etc. Risk response contributes to the iterative assessments referred to in the previous section.

### 2.4 Risk control and management

Ultimately, a contract will end up with a set of risks that are assigned to the various participants who have to own and manage these. A plan of action should be established for each risk so that an organisation will know what to do when a risk materialises and that way, avoid surprises. Not all risks will materialise in a project either by luck or prudent management. It is a welcome relive to an organisation when a risk fails to materialise.

Each time a risk lapses, it is struck-off the register. Consequently one can see the risks that are still live or outstanding at each stage of a project. This countdown continues till the project is finished and all risk issues are closed-off. The Risk Management process is a continuous process, but is ideally started in a project as early as possible and sustained throughout the different stages of the project and including the post-construction phase.

Ideally, a framework for dealing with risks is worth using and most organisations will have their approach e.g. Figure 1.

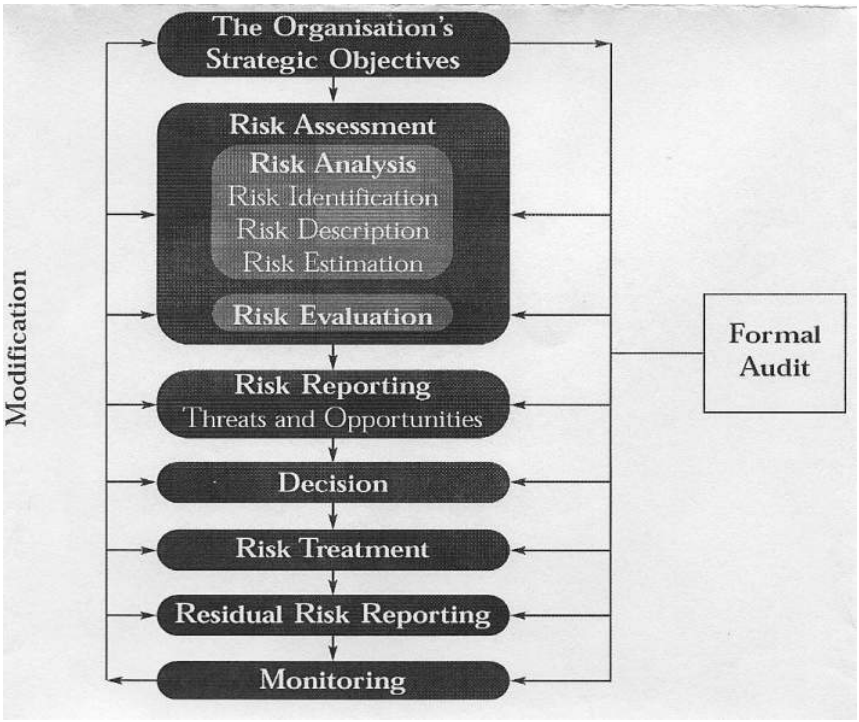



**Figure 1: A risk management process model** (Source: Institute of Risk Management, 2002).

### 2.5 The advantages and downsides of risk analysis and management

Risk analysis and management offers many upsides and these include (Boothroyd and Emmett, 1996; ICE and FIA, 1998; Burchett *et al*., 1999; Simon et al., 1997): Enhanced decision making where several alternatives can be compared objectively; greater confidence in realising the client's objectives of cost, time and quality; improved communication both; better choice of contract; ability to distinction between good/bad luck and good/bad management; etc.

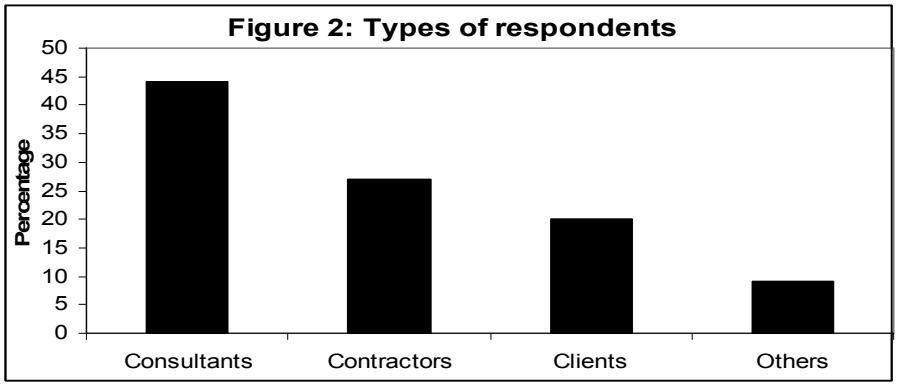
The process has disadvantages which include (Pouliquen, 1970; CIPFA, 1986; Ranasinghe, 1998; Bernstein, 1996): it does not replace skilful decision-making; consumes a lot of time; is at times subjective and unreliable; can be very complex; etc.

## 3. Research Method

A research was carried out to assess the efficacy of contemporary practice, any problems being faced and solutions for improvement. A mainly 'quantitative' approach was used via a questionnaire as means of data collection. The questionnaire was issued electronically in July and August 2008, to construction professionals who included Project Managers, Clients, Quantity Surveyors, and Contract Experts (Consultants). The questionnaire was administered electronically (via an internet link) and the results logged and stored externally by an external questionnaire company.

113 people were approached for data and 46 responses were received, representing a response rate of approximately 40%. Figure 2 details the types of

organisations surveyed, i.e. involving clients, contractors and consultants. The respondents were involved in risk management on a regular basis and could draw from their wealth of experience to answer the questionnaire.




Those sampled are professionals who can give independent and unbiased opinions; and their responses seem impartial on face value, especially that they discussed downsides pertaining current practice without reservation. These downsides are discussed fully in section 4.2 of this paper.

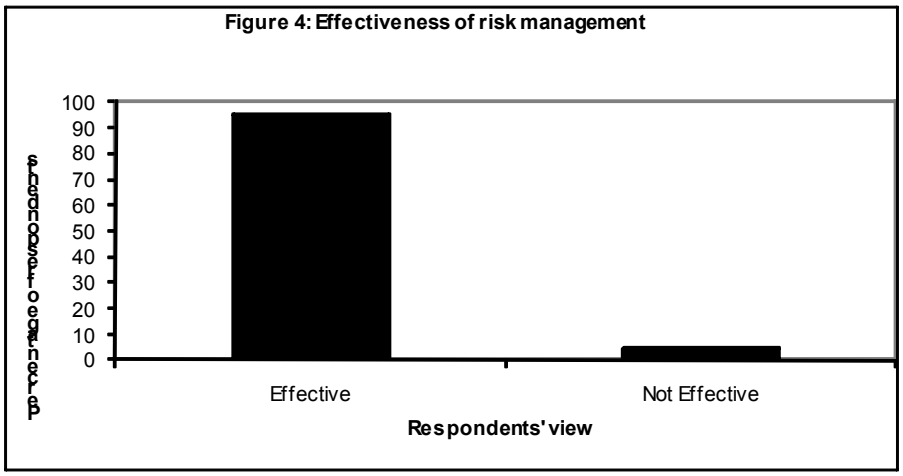
## 4. Findings

The respondents were asked whether they used a template for risk management such as in Figure 1. 91% answered in the affirmative. Most organisations would adapt a template to suit their own practice and may emphasise risk management at certain stages of a project.

Figure 3 shows who the respondents felt should drive the risk management process. The configuration of Figure 3 contrasts with Figure 2, suggesting that the respondents were not voting for themselves. Many respondents think that clients should play a leading role in risk (and project) management.

### 4.1 Effectiveness of the risk management process

As to whether risk management is effective within the project life cycle; Figure 4 is emphatic of the respondents' view. The opinion of the respondents is that risk management is worthwhile.




## 4.2 Barriers to risk management

However the respondents felt that the risk management process is not flawless. Both bespoke and generic flaws were identified as discussed below.

**4.2.1 Not sufficiently pro-active***:* According to one of the respondents: *"a lot of the risk management is reactive and more forward planning is needed. Also in this regard, the process is often hindered by late changes to the design scope."* This suggests that assessors sometimes struggle to quantify risks on time.

**4.2.2 Not robust enough**: The process is also not fully robust. It was suggested by one of the respondents that some *contractors do not often take all aspects of risk items into consideration. They do this e.g. at tender stage where the risks are not easily identifiable.* Designers too were identified as sometimes not robust with risk assessments. This practice is adopted either honestly or intentionally in order for the project to 'appear' healthier than it might be.

**4.2.3 Attitude towards risks**: The industry was seen as being risk-averse. It was explained by a respondent that there is *"too much focus on transferring risk as opposed to sharing and managing"*.

**4.2.4 Incompetency of risk managers**: The competency of those who manage risks was questioned. One of the respondents remarked that there is an *"increasing number of inexperienced staff within the construction industry who are managing risks".*

## 4.3 Improving risk management

The flaws identified in the foregoing section are pointers to where and how risk management can be improved. Accordingly, suggestions were offered by some respondents on how to improve and these are discussed below.

**4.3.1 Make an early start**: Risks should be examined very early even before the design stage and certainly before actual projects commence on site. A committed and pro-active approach is recommended in this regard where a respondent remarked that *'clients should allow programme time at developmental stage for rationalising risks that have been identified'.*

**4.3.2 A sustained process**: Having started early, the risk management process should be sustained throughout the project phases. This can be done through regular reviews and updates. It was explained that a full review of risk management at project completion should be carried out so that any lessons learnt can be carried forward to future schemes.

**4.3.3 Assess and prioritise well**: Practitioners should thus use every circumspect means of assessing risks in a project. The idea is to ensure that every risk is assessed accurately. Sometimes the assessment will point to the key risks that must be monitored closely. These *'show stoppers'* are most critical. A respondent suggested a concentration on ' *the top 20' risks which should be assessed at length while a % sum is added to allow for low risk items."* There is no standard recommendation on how-much an organisation should estimates for its risks, as the price is informed by several considerations. However, the assessment should be as accurate as possible.

**4.3.4 Maximise the use of your experience**: Experience is very valuable to risk assessment and management. As explained by one of the respondents, you *"need the right people at the right time".* Another respondent elaborated that *"people are also needed who are unemotionally attached to the project; are informed, and understand the complexities of the type of project being discussed."* The suggestion is not to rely on past experience alone but not to discount it.

**4.3.5 Right attitude towards risks***:* The interviews pointed out that rganisations must promote the concept of risk ownership and responsibility in their culture. An example should be set by clients and should permeate down the supply chain. There should be an increased focus on reporting and discussing risks. More openness is likewise required amongst the consultants in addressing risk issues. People who own risks should be treated fairly, e.g. a no-blame tactic is worthwhile as things can go sometimes wrong.

**4.3.6 Training***:* While experience informs risk analysis and management, training is also important. The quest is to ensure that project specific risks are identified, not just generic lists. A respondent advised thus: *"Involve many people; encourage geeks and out of the box thinkers."* Another respondent advocated for *"Better education and provision of site based training."* Employees should not be left alone to face risks. Management support is vital and where employees are seen to be lacking in knowledge, some form of training should be planned for them.

**4.3.7 Minimise informality***:* The process can be made more formal where financial penalties can be administered for non-compliance. A respondent suggested that *"regular risk register reviews should become a contract requirement."* The NEC standard form of contract promotes risk management. Other forms of contract can be updated to reflect similar or better standards in terms of risk assessment and management.

## 5. Conclusion

A response to risks is very important and the respondents in this survey reiterated this opinion. Construction practice is conversant with risk and often responds to it by using guides. However, most organisations use their own bespoke frameworks or templates albeit these include the assessment and management of risks.

Although risks are managed effectively in the course of construction projects, the process is not flawless. There is a need to keep reviewing the practices within organisations to identify lapses that can be corrected.

This research provides a cross-sectional view of construction practice that is coming from a sample of the population. So, while we cannot be quick to generalise the findings, we should not dismiss these outright either. What we can infer is that there are risk management processes that are workable in principle but are sometimes not implemented fully. One plausible reason for the poor implementation is the entrance of new employees into organisations. It can take some time to train fresh personnel in an organisation and while this training is going on, it is possible for these rookies to make mistakes. So it can be surmised that some of the poor risk management practices are attributable to inexperienced personnel who are still learning. If so, a note of caution to organisations is not to over task new or inexperienced employees hastily but to train them properly and ensure they are fit for any assignment.

Given the flaws identified by the respondents, it is worth recommending that organisations should improve on the way they manage the risk process. If need be, a risk champion could be utilised for this purpose. Lapses should not be allowed to manifest. Hopefully, many more organisations will work on improving their practices. Project reviews should have a sub-section devoted to risk management. That way, experiences gained and mistakes made are captured and the information exploited in future projects to improve on risk management. A benchmarking approach is worth recommending at this stage. Each year, an organisation should evaluate its performance in terms of risk management and aim to improve on it the following year. By doing so, their efficiency in this process will keep growing while flaws are minimised.

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***Abbreviations***

| | |
|---|---|
| CIPFA | Chartered Institute of Public Finance and Accountancy |
| FIA | Faculty and Institute of Actuaries |
| ICE | The Institution of Civil Engineers |

*AA015*

# A Research Framework for Developing a Performance Evaluation Model for Target Cost Contracts in Construction

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## Abstract
The aims of this research study are to establish an Overall Performance Index (OPI) and to develop a performance evaluation model for projects with Target Cost Contracts (TCC) in Hong Kong. Four rounds of Delphi questionnaire survey will be launched to identify the Key Performance Index (KPIs) for TCC projects and investigate their corresponding weightings. A composite OPI will then be complied for evaluating the performance level of TCC construction projects. Quantitative Indicators (QI) and Fuzzy Quantitative Ranges (QRs) pertinent to each KPI will be determined to minimise the subjective interpretation and value judgment to enhance the reliability and practicality of the model. The proposed model is expected to be developed into an online computerised system to enable industrial practitioners to measure, assess and compare the performance levels of their own TCC projects for benchmarking purposes.

## Keywords
Target cost contracts, Overall performance index, Performance evaluation model, Construction industry, Hong Kong

## 1. Introduction

The Report of the Construction Industry Review Committee (CIRC) published by the Hong Kong Special Administrative Region advocated that better project performance can be achieved by the adoption of more innovative integrated procurement strategies, e.g. Guaranteed Maximum Price (GMP) and Target Cost Contracting (TCC) with a gain-share/ pain-share arrangement (CIRC, 2001).

Client organisations have been increasingly observed to adopt the TCC approach to their building and construction projects in Hong Kong over the past decade. With

the perceived benefits of TCC, research into determining those Key Performance Indicators (KPIs) which can be used to evaluate the overall success of TCC construction projects becomes vital in order to help set up a benchmark model for measuring the performance levels of these projects. However, few, if any, comprehensive and systematic research studies have focused on developing a comprehensive, objective, reliable and practical performance evaluation model for TCC projects. There is an urgent need for systematic in-depth research to examine the performance measures in delivering TCC projects.

The proposed research study aims to generate, for TCC projects, new knowledge and clear understanding of these key factors of performance which can be measured, and give the most appropriate profile of how well a TCC contract has performed via the lessons and cases learned from Hong Kong. A secondary aim based on this understanding is the production of a model for quantifying overall performance of TCC construction projects. The model will be established based on relevant literature review, in-depth interview, Delphi survey and fuzzy set theory.

## 2. Literature Review

## a. Definitions of TCC and GMP

The National Economic Development Office (NEDO) (1982) based in the United Kingdom considered that "target cost contracts specify a 'best' estimate of the cost of the works to be carried out. During the course of the works, the initial target cost will be adjusted by agreement between the client or his nominated representative and the contractor to allow for any changes to the original specifications". According to Trench (1991), target cost contracting scheme is a contractual arrangement under which the actual cost of completing the work is evaluated and compared with an estimate or a target cost of the works, the differences within a cost band are shared between the client and the contractor based on a pre-determined ratio. Wong (2006) took a similar view that the contractor is paid the actual cost for the work done during the contract stage. When the final construction cost, termed the final total cost differed from the initial target cost, the difference would be shared between the employer and the contractor based on a pre-determined gain-share/pain-share ratio stated in the contract.

GMP is a type of contract works that is more suitable when the design is based on conventional means. However, the scope of works is not clear for fixed price bidding at the time of contract award (Saporita, 2006). The American Institute of Architects (AIA) (2001) viewed GMP as a sum established in an agreement between a client and a contractor as the cap of overall project cost to be paid by the client to the contractor for performing specified works on the basis of cost of labour and materials plus overhead and profit. The contractor receives a prescribed sum, along with a share of any savings to the client under this procurement approach. If the cost of the work exceeds the assured maximum, the contractor bears the excessive costs (Walker et al. 2000). Under this situation, a ceiling price is established, and the contractor is responsible for any additional cost (Gould and Joyce, 2003). However, the project is often started with considerable unknowns, and the quality and scope may be sacrificed at the expense of GMP (Gould, 2005).

## b. Recent Studies on TCC/GMP

Perry and Barnes (2000) proposed methods of tender evaluation of TCC and suggested that the contractor's share of cost overrun and saving should not be less than 50%. Both Broome and Perry (2002) and Badenfelt (2008) explored how the pain-share/gain-share ratio in TCC should be determined in the British and Swedish perspectives respectively.

Boukendour and Bah (2001) analysed GMP with option pricing theory and considered GMP as a hybrid system of cost reimbursement contract and optional contract hedging the owner from over-budget and provide him possibility of cost savings. Bower et al. (2002) examined three projects with different contractual arrangements, including one with TCC, to illustrate the effective use of incentive mechanisms. They concluded that contract incentive structures should provide appropriate incentives to contractors to meet the targets of cost, schedule and quality; correctly allocate risks and allow a suitable level of client's involvement in the projects.

Both Walker et al. (2002) and Hauck et al. (2004) investigated the case of the Australian National Museum procured with TCC arrangement. Bubshait (2003) conducted a questionnaire survey on incentive/disincentive contracting to the clients and contractors of industrial projects in Saudi Arabia and his findings supported the use of this kind of contract.

Wong (2006) introduced a computerized system for cost management in a cable car project in Hong Kong. Chan et al (2007) reported on the findings of 8 structured interviews in respect of the motives behind, perceived benefits, potential difficulties, key risks, critical success factors of launching the TCC/GMP scheme and the suitability of application. Furthermore, Chan et al. (2008) also evaluated the effectiveness of partnering for an underground railway extension project with TCC arrangement in Hong Kong via another research study. Kaplanogu and Arditi (2009) explored the practice of pre-project peer reviews in construction companies in the United States, suggesting that this kind of review was critical in reducing the risks of a proposed project.

Interestingly, the literature survey indicated that there are several research studies on the advantages and disadvantages, the operational mechanism, sharing ratio and overall performance of TCC and GMP projects. However, few, if any, research studies have been carried out on measuring the performance of these forms of procurement. Therefore, this research study is an attempt to fill up the gap in this area.

# 3. Proposed Research Framework

## a. Overall research approach

The research process will consist of the following stages: (1) literature review; (2) face-to-face structured interview; (3) Delphi questionnaire survey; (4) empirical questionnaire survey; (5) data collection; (6) data analysis; and (7) validation of the developed performance evaluation model. The two questionnaire surveys are different in nature. The Delphi method will be used for collecting the data and analysing the Delphi questionnaire survey in one case while the application of Fuzzy Set Theory will be adopted for analysing the empirical questionnaire survey.

However, both of surveys will be undertaken with the same group of relevant panel experts in Hong Kong.

The target TCC/GMP projects construction projects in Hong Kong are listed as follows:

1. Chater House (GMP)
2. 1063 King's Road (GMP)
3. The Orchards (GMP)
4. York House (GMP)
5. Three Pacific Place (GMP)
6. One Island East (GMP)
7. Renovation of Mandarin Oriental Hotel (GMP)
8. Yau Tong Estate Redevelopment Phase 4 (Modified GMP)
9. Tseung Kwan O Railway Extension Project (with five stations) (TCC)
10. Tsim Sha Tsui Metro Station Modification Works (TCC)
11. Tung Chung Cable Car Project (TCC)
12. West Island Line Railway Extension Project (with four stations) (TCC)
13. Improvement of Fuk Man Road Nullah in Sai Kung (TCC)

## b. Literature Review

This study will begin with an extensive review of recent literature on various performance measures for construction in general as well as partnering projects in particular from international scholar journals, internationally referred conferences papers, textbooks, professional journals and the like. In fact, all the participating client organizations introduced partnering concepts to their TCC/GMP projects as partnering could help facilitate the implementation of the TCC/GMP philosophy. The literature review aims to develop the overall research framework and to prepare an appropriate template for the structured interviews and questionnaire surveys. The performance measures used to evaluate the success of construction projects and partnering projects in general will be used for determining the potential KPIs for measuring the TCC/GMP projects in Hong Kong.

## c. Delphi Surveys

Delphi technique is the primary research tool applied in this study in which a consensus needs to be reached. The Delphi concept was developed by the defence industry in the US. According to Robinson (1991), the Project Delphi was the name of a study conducted by the Rand Corporation for the US Air Force in the early 1950s about the use of expert opinion. The Delphi method is a highly formalised method of communication that is designed to extract the maximum amount of unbiased information from a panel of experts (Chan et al 2001). It is generally conducted in several rounds interspersed with group opinion and information feedback in the form of relevant statistical data. Generally, the number of rounds ranges from 2 to 7 and the number of participants varies between 3 and 15 (Rowe and Wright 1999). The desired outcome is that, by using an iterative forecasting procedure, on reaching the final round, the experts will have achieved unanimity on the issues put before them (Manoliadis et al 2006). Therefore, the Delphi method is appropriate for obtaining a series of the most important KPIs for evaluating the success of TCC projects in construction.

Four rounds of Delphi surveys will be conducted to select the most important KPIs for measuring the project performance of TCC/GMP projects. Industrial practitioners with extensive hands-on experience working experience on TCC/GMP projects or

prominent academics with research experience in TCC/GMP will be selected as the panel of experts and invited to participate in the Delphi surveys. The iterations of the Delphi exercise enable the panel to select a series of the most important KPIs and then to provide suitable ratings to each of them for the TCC projects in Hong Kong. Table 1 serves as a summary of the four rounds of Delphi surveys.

**Table 1: Summary of four rounds of proposed Delphi survey**

| | |
|---|---|
| Round 1 | Expert panel to select a minimum of 5 to a maximum of 10 KPIs from a summary list of KPIs identified from literature |
| Round 2 | Respondents will be provided a consolidated list of results from Round 1 and requested to re-consider their options |
| Round 3 | Respondents to provide ratings on the most important KPIs identified (the most important KPIs for further consideration had to have been selected by at least 50% of experts as advocated by Chan et al 2001) based on a 5-point Likert scale (say 1 = least important and 5 = most important) |
| Round 4 | Similar to Round 4, respondents will be given a consolidated list of results from Round 3 and requested to re-consider their options |

After deriving a series of the most important KPIs, it is necessary to compile a composite Performance Index (PI) for use in evaluating the overall success of a TCC construction project. The PI will be developed based on the mean ratings advocated by the Delphi group of panel experts obtained in the fourth round of the Delphi survey. The PI presented in the form of an equation will be composed of the most important KPIs identified in Round 3, and the coefficients will be their individual weightings, which will be calculated as their individual mean ratings divided by the total mean ratings of all the most important KPIs identified (Yeung et al. 2007). In addition, principal components analysis (PCA) will also be applied to develop the composite Performance Index (PI) as adopted by Chan and Chan (2004) and Lam et al (2005). Thus a composite Performance Index (PI) for measuring the overall performance levels of TCC projects will be established. By doing so, different TCC projects can be assessed and compared objectively based on the composite PI on the same basis for benchmarking and monitoring purposes.

Despite the development of the composite PI, it is likely that different assessors may have their own semantic interpretation on each KPI identified. In order to eradicate any possible discrepancies in interpreting the meaning of each of the selected most important KPIs, a set of Quantitative Indicators (QIs) appropriate for measuring each of these KPIs will be proposed or established via five structured face-to-face interviews with leading industrial practitioners with rich hands-on experience in procuring TCC projects in Hong Kong. After that, 2 rounds of the second Delphi questionnaire survey with the same group of panel experts as with the previous four rounds of the first Delphi survey will be launched to objectively assess the appropriateness of the proposed QIs by rating them against their levels of importance, measurability and obtainability based on 5-point Likert scales where 1 = very unimportant / very difficult to measure or obtain and 5 = very important / very easy to measure or obtain. The QIs identified with the highest mean ratings for each of the selected most important KPIs will be adopted to be the most suitable measures for the performance of TCC projects in Hong Kong. By doing so, a list of QIs pertinent to the identified KPIs for TCC projects will have been derived. By incorporating various QIs into the performance evaluation model, different assessors could perform their evaluation process based on quantitative evidences.

Although a set of QIs established can provide a mutually agreed set of linguistic interpretation and lead to more objective performance evaluation for TCC projects,

it cannot fully eliminate the subjectivity of performance evaluation as different assessors may perceive the same performance level with different numerical measures. For example, should a TCC project be classified as 'good' or 'very good' in terms of cost performance in case of 2.5% reduction in project cost? In order to remedy this inherent deficiency, this research study will further apply a Fuzzy Set Theory approach (FST) (Baloi and Price 2003) through conducting an empirical questionnaire survey with the same group of panel experts in Hong Kong to capture their professional expectations or perceptions on the possible ranges of various performance levels for each QI identified. Fuzzy sets are typically able to represent linguistic terms, for instance, what is good or bad, hot or cold, fast or slow, etc. Therefore, FST will be applied to define reasonable quantitative ranges (QRs) for each QI measured at five different performance levels, namely, 'poor', 'average', 'good', 'very good', and 'excellent' by using the MATLAB 12.0 software package as adopted by Ng et al 2002. By adding these quantitative indicators and quantitative ranges to the evaluation process, assessors can determine which performance levels should be assigned in accordance with the actual project performance rather than applying their own subjective value judgment.

### d. An online computerised system for compiling the overall PI and other various key performance measures

An online computerised system for compiling the overall PI and other various key performance measures (e.g. time performance or cost performance) of TCC projects will be developed using some common software programs/languages (e.g. PHP, HTML and Javascript) for industrial practitioners to benchmark and monitor their own projects in Hong Kong. Project team members can just input their necessary individual project information and data. The computerised system can then directly provide a value of the composite overall PI to compare the levels of project performance with those of other counterparts to see where their TCC projects stand in relative term. The following results will be displayed graphically by the computerised system:

(1) Overall performance of a TCC project (i.e. overall PI score)
(2) Actual performance of individual KPIs for a TCC project (e.g. ahead of schedule by 1% for time performance)
(3) Relative performance of a TCC project when compared with other similar projects (e.g. classified as "very good" time performance)
(4) Benchmarking performance (e.g. standing at 85th percentile in the database meaning that the project outperforms 85% of those projects contained in the data set)

## 4. Validation of the proposed performance evaluation model

The validation of the developed performance evaluation model for TCC projects will be undertaken by inviting a few of the expert interviewees to complete a validation scoring sheet according to a five-point Likert scale (1 = poor, 3 = average and 5 = excellent) in terms of degrees of appropriateness, objectivity, replicability, practicality, reliability and overall suitability for application.

## 5. Significance of this research

Although TCC/GMP has been practiced in Hong Kong for a number of years, not all

the projects procured with those procurement strategies are equally successful. It is thus important to identify the important KPIs and establish an online computerised system to compare the performance of TCC/GMP projects in Hong Kong for further improving the performance of similar projects in the future.

## 6. Concluding Remarks

This paper describes the research framework to develop a composite performance index to measure the performance of TCC projects in Hong Kong via a series of Delphi surveys. The proposed model is expected to be developed into an online computerised system to enable industrial practitioners to measure, assess and compare the individual performance levels of their own TCC projects for benchmarking purposes.

## 7. Acknowledgements

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*AA104*

# Delivering the Design Services and Other Professional Services

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## Abstract
Design Services have been not meeting the value and expectations of the clients and their project managers. A research project has studied the impact of the low bid award environment on construction practices, and has proposed that designers' current practices and expectations are price based and not performance based. The authors also propose that the qualification based system is a price based system and should be replaced by a best value system which includes a best value selection process such as the Performance Information Procurement System (PIPS.) The new design model will give control and risk management capability back to designers by utilizing a weekly risk report (WRR) and the risk management plan (RMP.) The new PM model managing design firms will create transparency; will give the advantage to the higher performing professionals. The researcher interviewed over 400 designers to validate the concepts of the new designer model.

## Keywords
Delivery of Design Services, Designer Risk Management

## 1. Introduction

There is a great deal of inefficiency throughout the A/E/C (Architectural, Engineering and Construction) industry. Many believe the design professional to be the major source of risk and inefficiency, ultimately leading to poor delivery of construction services (Tucker (2003)). However, there may be multiple issues causing poor performance throughout the design and construction industry (Rubin (2005)). One of these issues may be the procurement system itself (Sullivan, Kashiwagi, & Kashiwagi (2009)). Since the enactment of The Brooks Act (Public Law 92-582 for Federal Procurement) in 1972, the majority of A/E design services, for public projects, have been procured through QBS (Qualification Based Selection). QBS is good in theory but not always the most efficient method and could be better if it were moved into a Best Value environment. Best Value procurement is a performance based environment, considering performance and price (Kashiwagi (2010)). Qualifications is a minimum requirement that levels the playing field and results in a price based environment. Performance accepts the differential between entities, and allows the high performers to skew the playing field in favour of the high performers. An efficient Best Value system considers more performance based factors instead of qualifications, such as minimization of risk, added value, and past performance measurement of the firm and its individuals (Kashiwagi (2010)).

## 2. Problem Statement

The delivery of design services through QBS (Qualification Based Selection) does not always procure the most performing consulting design professionals. The procurement process itself may be the cause of poor designer/professional engineering performance (Sullivan, Kashiwagi, & Kashiwagi (2009)). As a result, design professionals are not being held accountable for delivering designs that meet the expectations (on time, on budget and minimized change orders) of the client (Touran (2006); Tucker (2003)). Design performance has deteriorated, has not met the expectations of the client/user, and has minimized the professionalism and importance of designers (Egan (1998); FMI / CMAA (2004))

## 3. Hypothesis

Owners can improve design and construction performance by improving the selection and delivery process of professional services. Design professionals (DP) need to move to a best value environment to increase professionalism and performance. The current environment for DPs is an inefficient, price based, and relationship based environment.

## 4. Methodology

To validate the hypothesis the following steps will be performed:

1. Research literature to verify inefficiencies of existing conditions and how those inefficiencies hamper the design professional's performance.
2. Use deductive logic to demonstrate that design professionals currently work in a price based environment and need to move into a best value environment.
3. Validate the concepts by conducting a survey amongst A/E/C Professionals.

## 5. Confirming the Price Based Environment of Designers

In today's construction industry, design, engineering, and construction entities have become commodities, which are often misaligned. The selection of the lowest responsible bidding contractor has increased the risk of the client/owner. Owners try to protect themselves by employing legal representation. Facilitators, mediators, arbitrators, judges, juries, special masters, and neutral advisors are also often major players of a project. Indemnification provisions are longer than the scope of services in service agreements. The party least prepared to control risk is often contracted to do so (Berman (2003)).

Another major problem with today's professional design environment is that it is relationship based and not performance based. Architects and engineers are often hired based on relationships. In 2007, SMPS conducted a survey where almost 60 percent of the respondents said that key client relationships are in jeopardy if a particular staff member retires or leaves (Schriener (2007)). Relationships are so important to owners and architects that current AIA contracts are set up to protect and preserve relationships during disputes (Berman (2002)).

Another problem in today's design-construction environment is that architectural, engineering and contracting services are being treated as commodities. For example, Maricopa County (Arizona) has considered changing its procurement

code. The proposed amendment of the Maricopa County Procurement Code of September 2009 would consolidate procurement functions into the Department of Materials Management where commodities are purchased. J. Burnett (2009), Executive Director of ACEC of Arizona, stated, "What this means is, if adopted, 'procurement' for engineers, architects and contractors would go through Materials Management…" ACEC of Arizona is adamantly opposed to taking the procurement of professional engineering services from the engineering experts and placing this function in the hands of procurement officers who buy commodities."

## 6. The Construction Industry Structure

The construction industry consists of project owners, contractors and design professionals. The Construction Industry Structure (CIS) (Figure 1) (Kashiwagi (2010)) segments any industry based on performance and competition.

**Fig 1**: Construction Industry Structure (Kashiwagi, 2010)

The price based environment includes the following characteristics (Kashiwagi, 2010):

1. Projects being awarded based on price, relationships, and the designers/contractors being perceived as commodities.
2. The client's representative directs and controls both design and construction.
3. There is no transfer of control and accountability to the vendors.
4. Designers use minimum standards to identify requirements.
5. The minimum standards are turned to maximums by the vendors due to the price based environment and driven downward by vendors (Figure 2).
6. Contractors who are short on experience and only do what they are directed to do become more competitive because they can give a lower price.
7. Contractors who manage and minimize risk and who are the better value when considering total project cost, become less competitive (Figure 3).

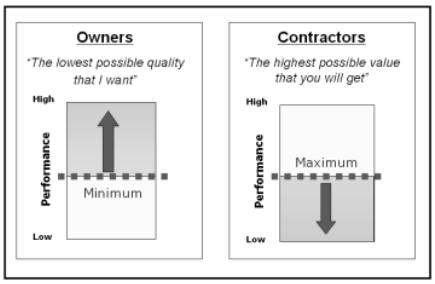


**Fig 2**: Min/Max Dilemma (Kashiwagi, 2010)

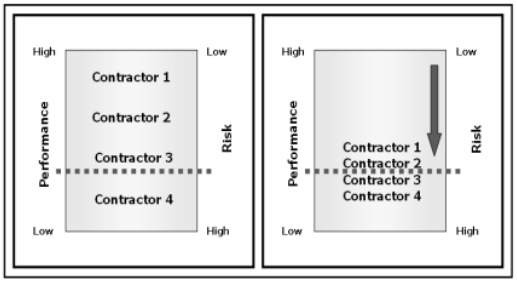


**Fig 3**: Price-Based Award (Kashiwagi, 2010)

In the best value environment, risk is transferred to the best value, which is usually the high performance vendor (designer and contractor). In the Best Value or value based environment, designers and contractors must do the following to be awarded work (Kashiwagi (2010)):

1. Compete based on past performance of the company and key individuals.
2. Quantify the technical risk/scope of work and the risk that they do not control (not in the scope of the project) and have a plan to manage and minimize the risk.
3. Key personnel must be interviewed to identify if they can be proactive and accountable, minimize the risk that they do not control, pre-plan, and to identify if they have the expertise to manage the project.
4. Price is determined by the professional/vendor, and it must be competitive. The low price proposer will be awarded the project, if the value of the different proposers cannot be identified.

The difference between the two environments is that the price based environment has the following negative and unstable characteristics (Kashiwagi (2010)):

1. No transfer of risk and accountability.
2. Non-expert directing the expert.
3. Increased confusion, and higher flow of communication and documentation.
4. Requires more individuals to make more decisions.
5. Allows less qualified personnel to do the work due to the lack of accountability.
6. Participants are reactive.
7. Requires increased management.

The price based environment is setup and controlled by the owner/client. Deductive logic shows that the solution might be in changing the system from a price based system to a best value environment. The participant who can implement system change most efficiently is the owner/client because they have set up and control the current delivery system (Beemer, et al. (n.d.)).

## 7. PIPS (Performance Information Procurement System

An example of an efficient BV system is PIPS (Performance Information Procurement System). "PIPS is an information based procurement system that uses Best Value selection and a performance contracting approach. It minimizes the liability and risk of the designer and owner, maximizes the profit of the contractor, uses partnering as a perception but not a function, and transfers the risk to the contractor. It motivates contractors to improve on every project and do their own quality control. PIPS has a methodology to find the best available value and motivate the contractor to assign the best performers to the project. PIPS uses performance information to select the Best Value contractor, and then uses the rating on the Best Value on the project to alter the contractor's future competitiveness and performance (Kashiwagi (2002))." PIPS is a project management (PM) model, a risk management (RM) model, a selection process, a procurement delivery process and a Best Value structure. PIPS uses all of the Best Value practices. PIPS can be run with DBB, DB, CM@Risk, CM, IDIQ, JOC, Performance Contracting, and Best Value contracting. PIPS is a Best Value model that aligns expertise and resources; minimizes transactions; minimizes transaction time and cost; minimizes information flow, decision making, and risk. PIPS can be run in either the price based environment or the Best Value environment. It can be used for the delivery of any service in any industry. Information on PIPS is

available at www.pbsrg.com. ASU researchers developed the PIPS for contractor selection. The system has been tested on over $800M of construction projects with a variety of owners. "ASU reports 98 percent on-time delivery, no change orders and an 80 percent reduction in management functions" (Angelo (2006)).

## 8. A/E/C Industry Survey

In October of 2009, an online (internet based) survey was prepared and invitations were sent via email to over 1,200 professionals (architects, engineers and contractors) with 449 responses received. The survey was sent out using the survey hosting website www.survkeymonkey.com. The survey was sent, by the author, with the objective to identify issues and concepts within the price based marketplace as well as the best value marketplace. The majority of the survey recipients/participants were design professionals from the Arizona marketplace. Responses were received from professionals working for municipalities, engineering consulting firms, architectural consulting firms, contractors, utility providers, etc. The majority of the respondents came from municipalities and consulting firms, representing two distinct sides from within the design-construction market. Municipalities represent the public owner/client while the consulting firms represent the supply side of the industry. There are over 40,000 Licensed Professional Engineers, 28,000 Licensed Professional Architects, and 50,000 licensed contractors in the state of Arizona (Arizona Board of Technical Registration (2009); Arizona Registrar of Contractors (2009)). From a statistical standpoint the A/E/C population size is considerably large. This equates to a greater than 95 percent confidence level with a plus or minus of five percent (± 5%) margin of error, using commonly accepted statistical analysis standards.

The survey consisted of some identifying questions to determine such things as the respondents' organization type, title, and whether or not they are a licensed engineer or licensed architect. The next section of the survey then asked the respondents to rate 18 statements on a scale of 1-10 (1 Strongly Disagree, 3 Disagree, 5 Don't Know, 7 Agree, 10 Strongly Agree). The first 12 statements were related to verify the existence of Quadrant I and the last six statements were related to relative understanding of Quadrant II of the Construction Industry Structure (Figure 1). The survey respondent's organization type had a nearly even split between the public and supply side of the marketplace. Private consulting services comprised 45% of the survey respondents (Engineering 28% and Architectural 17%). The public owners/clients response made up 41% of the survey. The remaining 14% of the survey respondents included contractors, developers, private utility owners and others. The results of the survey were analyzed in three distinct groups. The first group was the "All A/E/C Respondents" group, consisting of all the respondents. The second group was the "Private Consulting A/E" group. The third group was the "Public Owner/Client" group.

## 9. Survey Results

Overall the survey results lean heavily towards agreement of the identified issues within the price based environment and important concepts of the best value environment. The most frequent rating throughout the entire survey was seven (7). It was chosen 1,457 times. The next highest was eight (8) at 1,317 times. This was followed by nine (9) and ten (10) at 1,017 and 1,011 respectively. After this, five (5) was the next most selected at 825 times. Sixty percent of the time "Agree" (7-10) was chosen, 26 percent of the time "Don't Know" (4-6) was chosen

and only 14% of the time "Disagree" (1-3) was chosen. The results of the survey show that the majority of designers either agree with the previous discussion or don't know, with only 14% disagreeing.

There are a few obvious disagreements on some of the issues. Upon analyzing the data it was determined that the major disagreements exist between the public (client) and private sectors (design firms.) This demonstrates the confusion that exists within the existing QBS (Qualification Based System), and may be one of the major factors contributing to a price based environment.) The industry agrees that in the QBS (Qualification Based Selection) process, relationships with public owners/clients are very important in order to get work. Seventy seven percent of the industry agrees with Question 1 "Relationships are important for design firms to get work from project owners in the existing QBS process". Sixty five percent of the industry agrees with Question 2 "The QBS system results in relationships being very important". The results of Questions 1 and 2 have an average rating of 7.60 and 7.01 respectively. However, when answering Question 3 "Design firms are often hired based on relationships instead of capability and performance," is in the "Don't Know" range (5.58.) The disagreement between the clients and design firms can be easily seen in the histograms of Figure 4. Clients didn't think relationships mattered, but the design firms respondents were in direct conflict. Fifty seven percent of the private A&E respondents agree with Question 3, 29% don't know and 14% disagree. To the contrary, 45% of the public owners/clients disagree with Question 3, 32% don't know and only 23% agree.

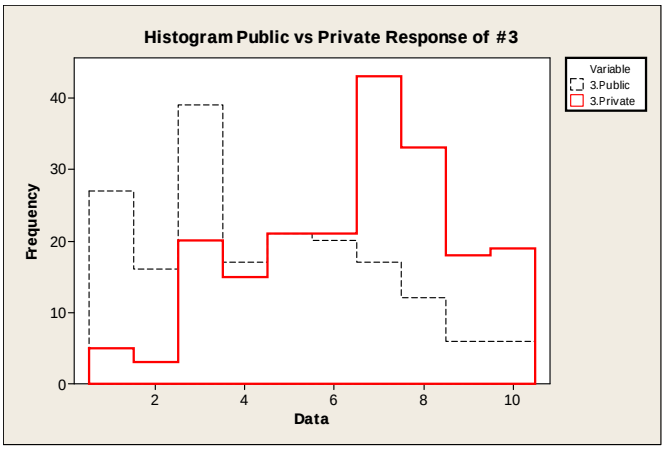


**Fig 4**: Disagreement between Clients and Designers

In order to verify that there was a significance difference between the public and private ratings (for Question 3) a T-test was performed, which verified that the observation was accurate, showing that the probability of making the wrong assumption was 1.52x10-15 percent. This level of error is far under the acceptable 5% at 0.01 percent (0.01%). Seventy six percent of the industry agrees with Question 4 "The major objective of contractors and design consultants at a conference is to network with owners/agencies and form relationships". The average rating was 7.35. The results are further demonstration of the importance of relationships in the existing QBS, price based, and commodity based market.

Question 5 "Differentiation between qualified firms can be difficult using QBS" only had an average rating of 5.71 throughout the industry. However, 43% of the responses fall in the "Agree" group, 31% in the "Don't Know" group, and 26% in

the "Disagree" group. The results of this section support the notion that it is difficult to clearly differentiate one qualified firm from another in the QBS process. The overall response to Question 7 "Construction and design services are often perceived as commodities by owners" was interesting. The average rating was 6.51, which is right in between "Don't Know" and "Agree". Looking at the responses even further, yields some more interesting information. Sixty five percent of the private A&E side agree with Question 7 by giving it an average rating of 7.11. However, only 40% of the public owners/clients agree and 44% don't know, giving them an average rating of 5.8. Much like Question 3, the difference on commodity perception between private and public supports the theory that the existing QBS, price based, commodity based environment is an inefficient and confusing market where private and public disagree.

Eighty percent of the industry agrees with Question 13 "Measuring the performance of the design firm and their key individuals on a project would increase their accountability and performance". The average rating was 7.43. The majority of the industry agrees with Question 14 "Designers should manage risk and deviation on the project". Sixty three percent of all responses fell within the "Agree" range, 28% within "Don't Know" and only 9 percent within the "Disagree" range.

Seventy one percent of the industry "Agree" with the concepts of Question 15 "On design related issues, project owners should rely on the expertise of the design professional to identify the best course of action." The average rating was 7.2, and only seven percent disagree. Designers also agreed that designers cannot scope and cost projects, and require the assistance of high performance contractors. Question 16, "Designers should seek the assistance of experienced contractors to provide accurate cost estimates and scope of projects", received the second highest rating of all the questions with an 8.04 and 87% of the industry agreed with the Best Value concept. Designers agreed that owners still control the level of performance and quality of design and construction with a 6.23 with 53% rating it within the "Agree" range. These results seem to provide more support to the fact that the current design-construction industry is working in Quadrant I of the CIS and that the industry doesn't know who controls performance and quality on a project. However, designers all agreed in Question 18 "Qualifications, competitive price, minimization of risk, added value, and past performance of the firm and its individuals are all important factors an owner should consider when selecting/procuring a design firm", was the highest rated question in the entire survey. This question contains the majority of the characteristics and attributes of an efficient Best Value delivery system. Eighty nine percent of the industry agrees with its concepts. The average rating was 8.4, and only six percent disagree.

## 10. Conclusions and Recommendations

The current delivery of construction environment is in the price based environment. The survey of designers representing both the clients/owners and the design firms validates these concepts. The current QBS selection process, which is touted as a professional value based approach is actually perceived as a price and relationship based practice. The hypothesis of moving to a best value approach where the risk and control of projects is shifted to designers is validated by the designers. Project managers who represent clients should select designers by performance and value, transfer the risk and control of design to the design firm and their designers and measure their performance. Survey results suggest that the A/E/C industry is strongly in favour of moving design professionals into a best value environment.

The authors also suggest that the Performance Information Procurement System (PIPS) can be used as a mechanism to move the design environment.

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*AA038*

# Does the use of partnering lead to improved project performance?

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## Abstract
The objective for this study is to ascertain whether the adoption of partnering and other construction best practice principles lead to improvements in the project outcomes and deliverables on UK construction projects where financing is from public funds.

A series of pilot interviews are carried out with client, main and subcontractor representatives to address this question.

The main findings from the pilot research are that the use of partnering is seen as having a positive impact on projects in terms of time, cost and end quality, albeit not to the levels expected. The use of partnering also leads to the project team embracing other best practice tools. However results indicate one barrier to partnering realising its full potential is the lack of trust within in the construction industry and this stops the sector fully committing to more open project relationships as best practice principles envisage.

## Keywords
Partnering, improved performance, best practice.

## 1. Introduction

In the mid 1990's the United Kingdom (UK) construction industry was seen as failing to deliver construction projects on time and to budget, with only around 25% of projects being delivered within budget and 34% of projects delivered on time, (OGC, 2009). With the industry being important to the country's economy, contributing almost 20% of GDP (Constructing Excellence, 2009a), this gross inefficiency could not be tolerated.

Latham, 1994 and Egan, 1998 identified wider failings within the construction industry such as poor management, focus on low cost rather than value for money, the presence of short term relationships, a lack of integration and a generally risk averse culture. Latham, 1994 noted little or no consideration was given to how realistic the received bids were or to the quality of the end product and the satisfaction of the end user. This resulted in firms tendering for projects at a loss, with a view to clawing back enough money to turn a profit through the claims process. Greaves et al, 1998 associated these failings with procurement strategies being selected for projects which were not appropriate for the features of the projects for which they were being selected. In addition to this there was no presence of any form of industry benchmarking, or any structured recording of

results to assess whether indeed the company or project had performed well (McCabe, 2001) and how future improvements could be made.

Possible solutions were advocated (Murray et al, 2003; Leading Edge, 2008), with the result that the UK government would lead the industry as a best practice client, and by example, would develop, implement and use a set of construction best practice principles that the whole industry would be able to adopt to enable it to improve its performance.

Best practice is a term used for the method of finding and using the best ways to achieve business objectives through continually learning from past experiences and seeking to improve upon them, and is a set of practices which are now widely accepted and used within the UK construction industry. The best practice themes as identified by Constructing Excellence, 2009a are grouped under three main banners namely, Business Processes, Internal Cultures and External Relations.

Business Processes looks at a company's business processes and practices with a view to improving overall performance. Benchmarking typifies the process by measuring own company performance against other similar companies (Constructing Excellence, 2009b), and identifying where improvements can be made by asking the questions, who does it better, how do they do it better? Then adapting / adopting the better practices in order to improve performance (Ashworth & Hogg, 2000), thus achieving continuous improvement (McGeorge & Palmer, 1997). Organisations must be responsive to change if they are to survive (McCabe, 2001) and it is through effective benchmarking that they are able to quickly identify successful or under-performing areas of their business operations and highlight the areas requiring improvement or change (McGeorge & Palmer, 1997). Other business processes recommended for adoption included the greater use of IT and knowledge management systems on projects, the use of lean construction principles, increased standardisation and pre-assembly of components, and management tools such as risk and value management and whole life costing.

A best practice Internal Culture focus promotes a company to be open, honest and respectful in order to facilitate the successful delivery of projects by the quality of its contract participants (Constructing Excellence, 2009b) via improved leadership, motivation, team working, training and valuing of the workforce. This focus, through the use of key performance indicators (KPI's) and benchmarking, would continuously measure progress and identify improvements from previous performances.

External Relations are to be in place to handle the issues of understanding what the client wants and having effective relationships with all parties to a contract or project extending beyond the client into the supply chain, key stakeholders and the wider community, ensuring that the business is run in a responsible and socially conscious way (Constructing Excellence, 2009b). The one key development being the recommended adoption on projects of partnering as the procurement route used to consolidate these external relations**.**

The concept of partnering originated from the successful use and performance in the manufacturing industries of the Far East and was introduced to the British construction industry, in a limited way, in the late 1980's / early 1990's, after being used in the construction industries of America and Australia around this time.

Mosey, 2009 sees partnering an approach to undertake construction business objectives in a collaborative manner, which aims to move away from the features of traditional procurement and their relationships which were seen to be the root cause of the industry's failings of cost overruns, late delivery and perceived poor quality of the final product towards a culture where trust, openness and continuous improvement were the norm and where performance is measured, monitored and improved.

It is a construction practice which is said to be most effective over a number of projects in the form of 'strategic' partnering', but has been shown in a number of examples to be effective in improving areas of time and cost for projects over both the short and long term (OGC, 2005; Local Government Task Force, 2005), although it is said that not all examples are likely to demonstrate these kinds of predicted improvements (Akintoye & Main, 2007).

Whilst some authors such as Bennet & Jayes, 1995; Rowlinson and Mcdermot, 1999; Holt, 2000 and Egan, 2002 take the view that partnering sits at the heart of best practices which aim to bring about positive change by enabling other practices such as constantly measuring, assessing and improving upon performance. Others such as Bresnen & Marshal, 2000 have the opinion that not all collaborative partnerships in construction will necessarily be as successful as the examples highlighted by the Office of Government Commerce (OGC, 2007).

It was hoped that the use of partnering on construction projects would yield significant improvements, with the potential to reduce project costs by 30% and time by 40%, whilst giving greater certainty on all issues and a potential for zero defects (CIOB, 2006).

Thus the identified best practice theme of partnering procurement is highlighted as a means by which the required improvements of construction project performance can be made, as it encompasses a theme of continuous improvement through key performance indicators and collaborative contractual relationships which encourage long term commitments that are able, in theory, to put in place an operational framework in which many best practice areas can be implemented and the resultant benefits gained.

## 2. Research

The objective for this pilot study is to observe whether the adoption of construction best practice principles would lead to improvements in the project outcomes and deliverables on UK construction projects where the key source of financing was from public funds.

Interviews were carried out among a small sample of construction professionals. The identification of likely participants for the pilot study was then considered. The primary factor for eligibility for participation was initially to identify and select a range of construction professionals employed on a high profile government funded projects. The professionals would be chosen from all parts of the project chain in order to acquire different perspectives on the interview subject matter and to ensure that the results are not biased towards a single perspective.

The interviewees have been approached from sub-contractor, main contractor & client backgrounds. A total of 5 interviews were conducted with the interviewees, who were chosen from a key centrally funded project, namely The Birmingham Construction Partnership (BCP). This partnership operates within the UK's second largest city and delivers the city's £500 million capital building programme. The BCP has been hailed by the Office of Government Commerce (OGC) and the Local Government Task Force (LGTF) as an exemplar project in the government sector. The BCP has moved away from lowest price tendering and instead operates via a collaboration of contractors, designers, and specialist supply chains that are tasked with delivering every project in the city with a value of over £100,000.

The pilot study comprised interviews which followed a schedule with a set of predetermined open ended questions, seventeen in total, grouped into three main areas. The first part defined the respondents' job description within the construction industry and the duration of their experience in the industry and their general impressions of the industry during their careers. The second part of the interview concerned the area of best practice. The final area of questions was designed to establish the respondents' opinions as to the key best practice area which would lead to improved project performance.

## Research results

*General details*
A total of 5 interviews were conducted with the following details:

| **Role in Partnership** | **Participant Profile** | **Number of years construction experience** |
|---|---|---|
| Client | An operations and compliance manager currently working for the client in a Local Education Partnership | 23 years |
| Main Contractor | **PM1,** A project manager with an international building and civil engineering company. | 12 years |
| | **QS2**, A project quantity surveyor with the same international building and civil engineering company. | 12 years |
| Sub-Contractor | **CM1,** A Contracts Manager for a large ground works sub-contractor. | 23 years |
| | **QS1**, A Quantity Surveyor for a large structural steel sub-contractor. | 14 years |

**Table 1** – Participant details

*Best practice awareness*
This section asked the respondents specifically about their awareness of best practice principles; their understanding of the term and whether the adoption of such an approach would lead to project efficiency gains (see Table 2 – Answers to Best Practice questions).

| **Best Practice Question** | Are you aware of the term 'best practice'? | What is your definition of 'best practice'? |
|---|---|---|
| **Client** | Yes | An efficient process giving value for money to meet or exceed expectations |
| **Main Contractor (PM1)** | Vaguely | Exceeding traditional expectations for time, cost, quality and safety. |
| **Main Contractor (QS2)** | No | The best way of doing something in a fair and reasonable way. |
| **Sub Contractor (CM1)** | No | Best practices are going that extra mile and using your own knowledge and experience |
| **Sub Contractor (QS1)** | Yes | Achieving high standards, profitability and knowing everyone's needs. |

**Table 2** – Answers to Best Practice Questions

*Key best practice area*
The interviewees were then asked to identify from a list of best practice themes i.e. business process, internal culture and external relations, the themes applicable to the BCP project. (See Table 3 – Best Practice areas used).

| **Best Practice Question** | In your experience do partnered projects have a better uptake of the best practice principles, and if so which are most common? |
|---|---|
| **Client** | Definitely. The most common would probable be health and safety and sustainability, but that's the same with all projects these days. |
| **Main Contractor (PM1)** | Yes, Benchmarking, risk & value management and also improved briefings and better client focus are all more commonly present on partnered projects. |
| **Main Contractor (QS2)** | Yes, these things are driven by the requirements of the client so features such as benchmarking, improving relationships with supply chain and training being ongoing are more prevalent. |
| **Sub Contractor (CM1)** | In my experience within a major contractor I would say no as these things that you have described are in place within the policy of the company on most projects anyway. |
| **Sub Contractor (QS1)** | Yes definitely. My background is with a Japanese company where these things are common place and you do see a lot of them such as Lean construction, standardisation and pre-assembly, continuous improvement, supply chain management and the focus on teams and business processes. |

**Table 3** – Best Practice areas used

*Key best practice improvements*
The interviewees were then asked whether, and to what extent, had the use of best practice principles improved project performance (see Table 4 – Improved project performance when using Best Practice principles).

| | | |
|---|---|---|
| **Best Practice Question** | Would you say that best practice has had a positive impact on projects in terms of time, cost and end quality? | From your experiences would you say that the reported benefits of partnered projects such as 30% to 50% improvements in time and cost when compared to non partnered projects are the 'norm'? |
| **Client** | Yes definitely | Unsure, but it sounds high. Wouldn't everyone be using it if those were the savings all of the time!? |
| **Main Contractor (PM1)** | Yes massively | I would say they are cherry picked. Those levels seem high! |
| **Main Contractor (QS2)** | Yes | I'm afraid I'd say cherry picked as they do or can bring about improvements but much smaller increments than 30% to 50%. |
| **Sub Contractor (CM1)** | Yes. Having a greater involvement with the contractor means knowledge is widespread and that enables forward planning giving better project results. | In my opinion I would say that those results are cherry picked yes. |
| **Sub Contractor (QS1)** | Yes, in terms of quality and cost. Maybe not time though. | Definitely cherry picked. Those results are there but they are not the norm. That type of performance is only available when everyone is willing to take the risk and when the principles are embraced across the board. |

**Table 4** – Improved project performance when using Best Practice principles

*Best practice barriers*
This section asked the respondents about the main obstacles to partnering realising its full potential and being fully embraced by the industry (see Table 5 – Best practice barriers).

| | |
|---|---|
| **Best Practice Question** | What in your opinion are the main obstacles to partnering realising its full potential and being fully embraced by the industry? |
| **Client** | Old habits towards relationships being hard to break. |
| **Main Contractor (PM1)** | Peoples personalities and the culture within the industry. |

| | |
|---|---|
| **Main Contractor (QS2)** | People are nervous of entering into these arrangements because of past experiences and attitudes towards trust. |
| **Sub Contractor (CM1)** | Inherent distrust that exists within the industry at operational levels, i.e. site management. Plus the economic climate as it is which is probably the biggest barrier at present. |
| **Sub Contractor (QS1)** | Trust. |

**Table 5** – Answers to Best Practice Questions

## Conclusions and further work

Whilst the research may be limited by the small numbers of respondents representing the various parties to construction projects, it clearly established that best practice has no one clear definition. Best practice is seen as a process, or a collection of working methods or just a different way of delivering projects. Those construction projects that used the best practice partnering approach were seen to have a greater uptake of other best practices such as benchmarking, teamwork, and supply chain management, which are all practices seen to contribute to the success of a project.

Partnering was also seen to bring about improvements to projects when compared to similar non partnered projects and it was unanimously viewed that best practices principles did have a positive impact on projects in terms of time, cost and end quality. However the reported benefits of partnered projects such as 30% to 50% improvements in time and cost when compared to non partnered projects were rejected by the study. Reasons for this were indicated as those projects exhibiting the levels of success that partnering promised to deliver are often carefully chosen i.e. cherry picked. However smaller levels of improvement were identified, albeit no respondent gave it a value.

The barriers to partnering realising its potential were identified as continued participant behaviour issues, a lack of trust in the industry and also that there still remains a nervousness by construction participants to fully committing to these best practice open relationships which appear to potentially render parties commercially vulnerable.

In response to the question does the use of partnering result in the greater use of best practices and does the use of partnering lead to improved project performance the answer was seen as yes. However it must also be noted that the industry was viewed as still having a lot of progress needed to fully embrace the new best practice working practices which will move it away from the traditional confrontational culture and towards the full realisation of the benefits that partnering and adoption of other construction best practices can bring to construction projects.

The next stage in this research area is to adopt a qualitative approach and carry out a higher number of interviews to further ascertain whether the use of partnering does lead to improved project performance and to quantify that extent.

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# Decision Support System (DSS): A Strategic Tool for the Affordable Housing Industry

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## Abstract
The housing industry in the Developing World and for long time has suffered from underinvestment, the lack of knowhow and the lack of sufficient strategies and policies. This in turn, led to a total failure in performance, accumulative massive housing demand and underachieving. Consequently, and because of the massive growth in the world's population, especially the Islamic World, people in the poorest countries have been the most affected and forced to live in slums and shanty towns which some worldwide have millions of occupants.
This research paper presents a scientific approach to assist governments and decision makers in the Islamic World setting up most sufficient and effective strategies and policies on the mega-level (country level) for the housing industry. The final outcome of this research will produce a Decision Support System Model (DSS) which could be used by decision makers to setting up holistic, realistic and achievable strategies and policies based on the scientific interpretation of the interface of the DSS Model.

## Keywords
Housing Industry, Housing Industry Factors, Decision Support System Model (DSS).

**Note:** It is important to keep in mind first that the purpose of this research is neither about the house's or project's design, style, size, type of coating, quality of building materials nor about types of land.

## 1. Introduction

The housing industry in the Developing World and for long time has suffered from underinvestment, the lack of knowhow and the lack of sufficient strategies and policies. This in turn, led to a total failure in performance, accumulative massive housing demand and underachieving. Consequently, and because of the massive growth in the world's population, especially the Islamic World, people in the poorest countries have been the most affected and forced to live in slums and shanty towns which some worldwide have millions of occupants.
Planning and setting strategies and policies is not an easy task facing managers, leaders and decision makers at all levels such as SMEs, organisations and industries. This means that managers, leaders and decision makers at micro, macro and mega level facing a dilemma in making their decision because decision making may lead to either prosperity or disaster affecting the entire nation. Thus, there are tools, methods, mechanisms and systems: computer assisted, mathematical and statistical, contextual and logical, etc. introduced to assist and help managers,

leaders and decision makers making appropriate decisions that keep their organisations in business and deliver products and services to customers on time, reasonably priced and high quality. In other words, these tools assist managers and leader making decision aiming at high satisfaction for stakeholders including organisations, employees, customers, etc.
This research paper will only focus on Decision Support System (DSS) Model and presents a scientific approach to assist governments and decision makers in the Developing World setting up most sufficient and effective strategies and policies on the mega-level (country level) for the housing industry.
The research methodology will consist of two parts; literature review which shed light on DSS Model in terms of definition, stages, purposes, mechanism, how it functions, etc. The second will introduce Interpretive Structural Model (ISM), which is used previously in a different stage of research to identify and prioritise Housing Industry Variables and DSS Model. Finally, the DSS Model will be examined and tested using different scenarios for validation. The findings will be stated in the concluding section.

## 2. ISM: Prioritising Housing Industry Variables

Our detailed investigation has revealed that there are 14 major factors that could influence the rebuilding of the housing industry. These are:

1. Regulation & Legislations
2. Finance
3. Size of Projects
4. Availability of Local Professionals mainly Engineers and Project Managers
5. Availability of Foreign Know How
6. Availability of Building Materials
7. Availability Local Labour
8. Availability of Foreign Labour
9. Availability of Land
10. Development of Private Sector (SMEs)
11. Training required to build up local capacity
12. Types of Construction Method (traditional building Vs off-site manufacturing)
13. Design of affordable housing to meet the demand
14. Procurement/ type of contract

When a prioritising test was implemented to rank the above variables according to their power and dependency, it was interesting to find that Regulation is the main driver and enabler, see Figure 1 (in the Appendix at the end).

# 3. Decision Support System Model (DSS)

In this section, Literature Review will thoroughly investigate and discuss Decision Support System (DSS) in terms of definitions, mechanism, advantages, disadvantages, etc. Moreover, the discussion will display how this tool could assist managers in making appropriate decision at all levels.

## 3.1 Definition

Gerson M. et al (1992) suggest that various forms of decision making occur at various levels. DSS does not specify an optimum decision, but rather helps a decision maker to clarify options. In other words, a DSS includes applications used by decision makers which specifically assist in understanding or structuring the decision. Moreover a DSS looks at the ability of an application to generate stochastic measures and to implement sensitivity analyses on data.

## 3.2 Rules for Building Successful DSS

Power (2003) presents five recommendations and six rules should be considered when building a computerised DSS model. Moreover, Power (2003) and McCosh & Scott-Morton (1978) share the same views and classify similarly the rules on how to build a successful DSS. These rules are as follows:

***Rule 1***: Novel, innovative model-driven Decision Support Systems should be initiated by the managers who would use them.
***Rule 2***: Users and technical specialists should periodically review, evaluate and adjust existing model-driven Decision Support Systems. Many model-driven DSS are "legacy" applications that potentially could be upgraded and improved.
***Rule 3:*** Decision Support System projects must meet a need and provide benefits that justify the ongoing cost of operating, maintaining and upgrading the system as well as the cost of building them.
***Rule 4***: Model-driven DSS should be built by teams that include potential users and technical specialists. Conceptualising a model in its "gross form" for a model-driven DSS is not the major issue.
***Rule 5***: In every case, all things being equal, choose the path of least resistance when building and implementing DSS.

## 3.3 Spreadsheet Based DSS

Computer applications such as Word-processor, Spreadsheet and Database can be used as tools in DSS to provide accurate information and interpretation based on data that assist managers and leaders making decision upon sensitivity analysis.

Power (2000) argues that a DSS that has been or will be implemented using a spreadsheet package can be termed a spreadsheet-based DSS. Moreover, a spreadsheet-based DSS presents a simple and friendly use interface for managers because it a collection of cells whose values can be displayed on a computer screen. An electronic spreadsheet organises data into columns and rows. The data can then be manipulated by a formula to give an average, maximum or sum. By changing cell definitions and having all cell values re-evaluated, a user performs "What-If?" analysis and observes the effects of those changes.

Power (2000) suggests that there are two Models: Model-driven and Data-driven, of spreadsheet-based DSS, and are the most common types of DSS one would consider developing using a spreadsheet package. These two models are as follows:

1. Model-driven is spreadsheets seem especially appropriate for building a DSS with one or more small models. A developer would then add buttons, spinners and other tools to support a decision maker in "What-If?" and sensitivity analysis.
2. Data-driven DSS can be implemented using a spreadsheet. A large data set can be downloaded to the DSS application from a Database Management System (DBMS), a website or a delimited flat file. Then, tables and charts can be developed to help a decision maker summarise and manipulate the data.

Power (2000) adds that spreadsheet packages qualify as DSS generators because:

a. they have sophisticated data handling and graphic capabilities;

b. they can be used for "What-If" analysis; and

c. spreadsheet software can facilitate the building of a DSS.

## 3.4 What-If Analysis

Power (2006) argues that Microsoft Excel 2002 help defines "What-If analysis" as a process of changing the values in cells to see how those changes affect the outcome of formulas on the worksheet. Winston (2004) identifies four tools in Excel that are commonly categorised as "What-If?" or sensitivity analysis tools. These tools are such as Data Tables, Goal Seek, Scenarios, and Solver. The simplest type of "What-If?" analysis is manually changing a value in a cell that is used in a formula to see the result. Excel experts seem to use the terms sensitivity and "What-If?" analysis interchangeably.

## 3.5 Advantages/Benefits

Power (2002), argues that the advantages and benefits of DSS are as follows:

1. Cost reduction: Reduce costs of inputs from suppliers, decrease the lead times and holding costs.
2. Decision cycle time reduction: Speed up decision making by a stakeholder and potentially reduce internal decision cycle times.
3. Collaboration: Increase collaboration and information sharing.
4. Competitive situation: Alter competition in the industry by better meeting needs of a customer.
5. Revenue: Create new sources of revenue.
6. Participative design: Allow customers and other stakeholders to participate in product/service design decisions.
7. Repeat purchase and use: Create relational or product dependency and encourage repeated use of the DSS for decision making.
8. Process improvements: Reduce decision process and decision making inefficiencies.

It seems there are several advantages resulted from using DSS. Managers, executive and leaders could improve the organisational and their performances by resorting to implementing DSS. DSS offers scientific, computerised and sophisticated tools that assist managers making decisions and taking appropriate actions.

## 3.6 DSS Limitations

EL-Najdawi and Stylianou (1993) argue that a DSS is a set of computer-based tools used by managers to assist them in their decision making. Some of the problems and limitations of DSS are listed below:

- A DSS is useful when dealing with only a subset of all possible semi-structured problems.
- The DSS's contribution to the problem-solving process is limited to the evaluation of alternatives.
- A DSS does not relieve the manager from making the actual decisions.
- Problems suitable for a DSS must have a quantifiable dimension.
- The structure of a problem and the criteria involved in evaluating the problem must be defined by the decision maker.
- Users are frequently unable to effectively communicate their needs to the computer.

## 3.7 DSS Model Initial Structure

The DSS structure will be of five engines and an interface. The engines will be responsible for the calculations using formula where as the interface will display and reveal the changes desired and required by decision makers. The DSS Model structure would look like Figure 4 see (in the Appendix at the end).

Figure 5 listed in the Appendix below is an MS Excel image of the Interface of the DSS Model.

## 4. Conclusion

Decision Support System (DSS) Model as a TOOL produced by this research study has proven its efficiency and effectiveness not only to the housing industry, but also to improve other industries and therefore the entire economy. A person could ask a question that the DSS Model for the housing industry operates on the elements and factors of this particular industry; who is the DSS Model going to affect other industries and the entire economy? The answer is that the DSS Model negotiates housing industry factors such as Labour (Local, Foreign, Skilled, Unskilled, Training, etc.), Project Management (Local, Foreign, Training, etc.), Administrative and Office Staff, Building Materials (Local Factories and Plants, Capacity of Productions, Labour to run the Plants, Import, SMEs, etc), Land (Government, Private, etc.). All the Factors of the housing industry are also related to different ministries such as Work and Social Assurance, Education, Higher Education, Planning, Finance, Economics, Foreign Affairs, Interior, etc. In other words, in order to improve the performance of the housing industry to meet its mammoth tasks, governments and decision makers have to realise that this process must be synchronised and carried out simultaneously with the improvement of other industries such as Work and Social

Assurance, Education, Higher Education, Planning, Finance, Economics, Foreign Affairs, Interior, etc.

Moreover, according to the ISM Model; Regulations and Legislations are the most powerful and driver power among the 14 factors identified by literature. Therefore; governments and decision makers have to realise that setting New Regulations and Legislations are not only for the housing industry, but also for other industries because other industries in one or another are closely linked and involved in providing Finance, Labour, Project Management, Administration, Building Materials, Land, etc.

The message to governments and decision makers is that to improve the performance of the housing industry requires a holistic re-consideration of the entire economy in terms of setting New Regulations and Legislations. This means that improving a performance of an industry (in this case the Housing Industry) requires genuine steps from governments, parliaments and decision makers to REFORM the entire economy.

Finally, the DSS Model can be used as a TOOL by governments, parliaments and decision makers to identify the CRITICAL FACTOR(S), size potential problems, vulnerable areas in the economy, prioritise of Factors, clarify the starting point of Reform and so on and so forth.

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## 6. Appendix

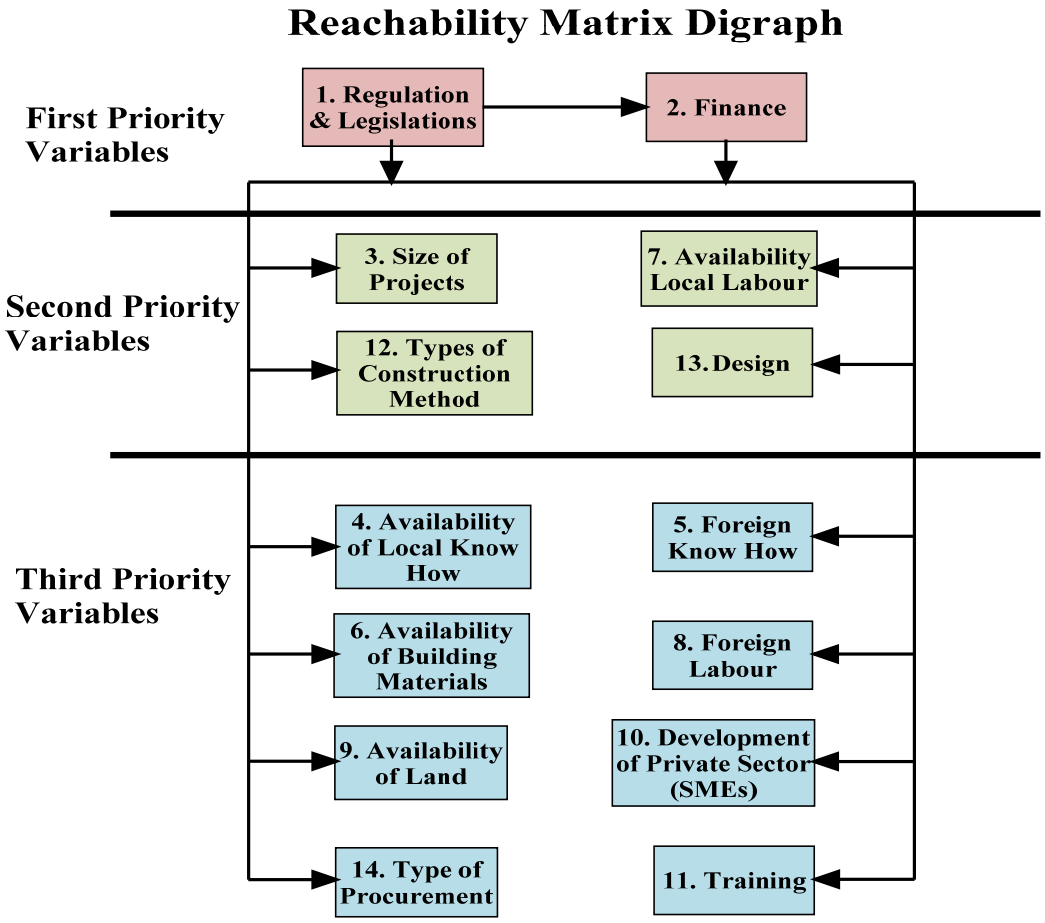



Figure 1: Hierarchy of Housing Industry Variables by ISM (Dawood and Alshawi 2009)

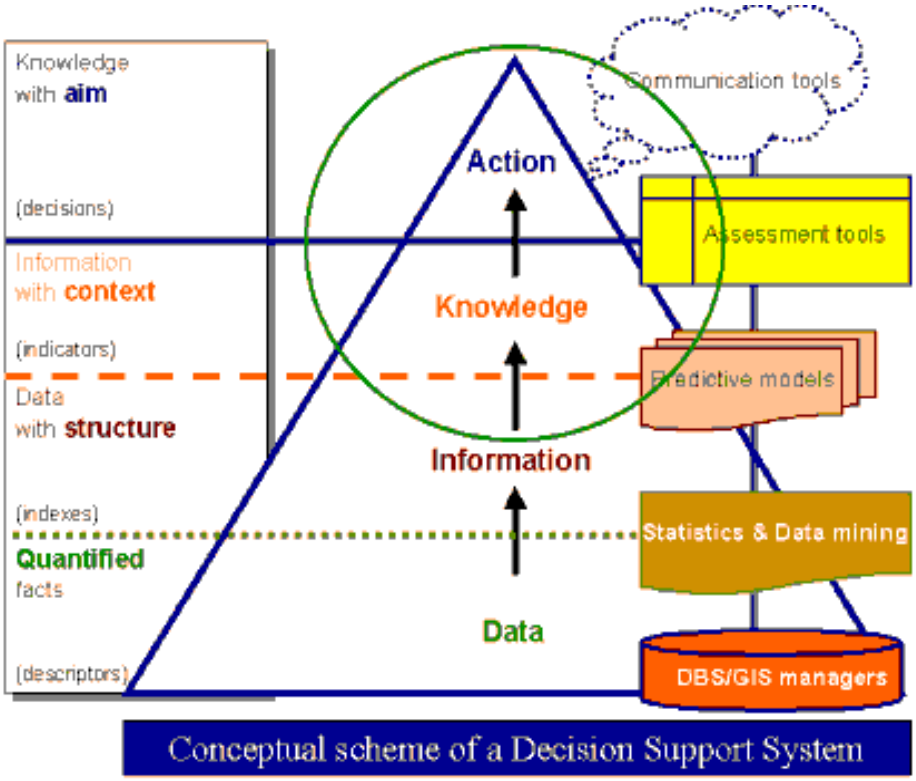



Figure 2: DSS Stages (Mcrit.com, 2008)

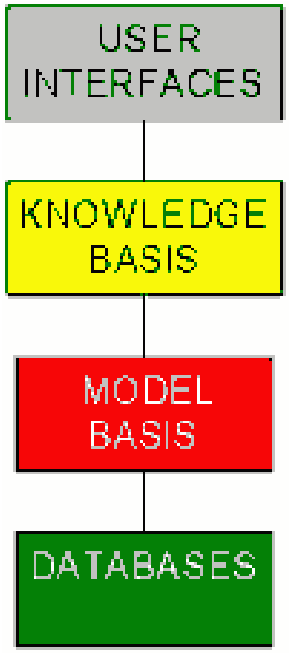



Figure 3: DSS Stages (Mcrit.com, 2008)

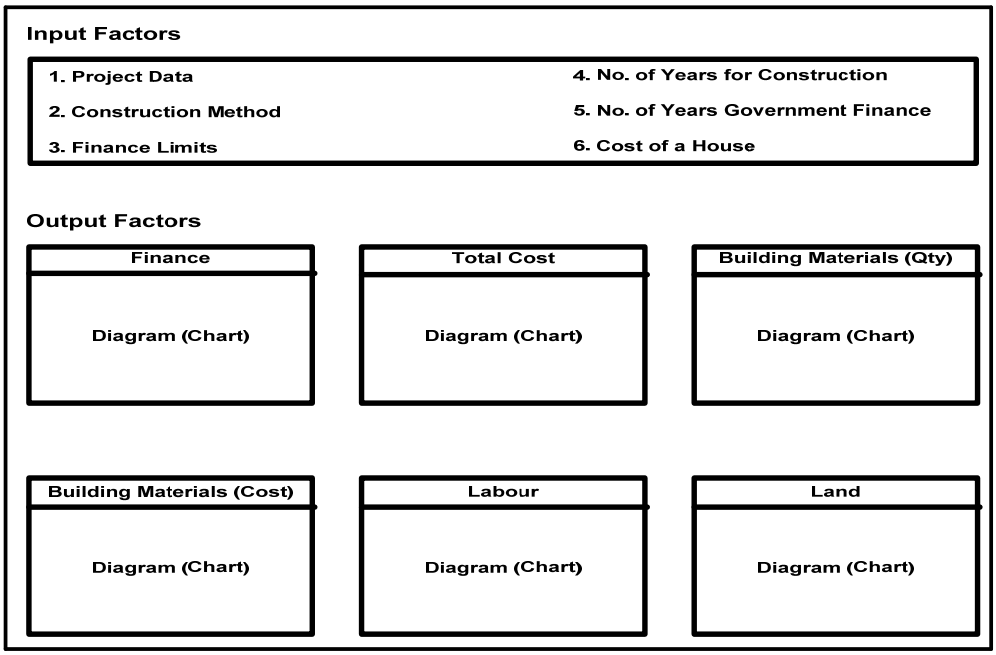
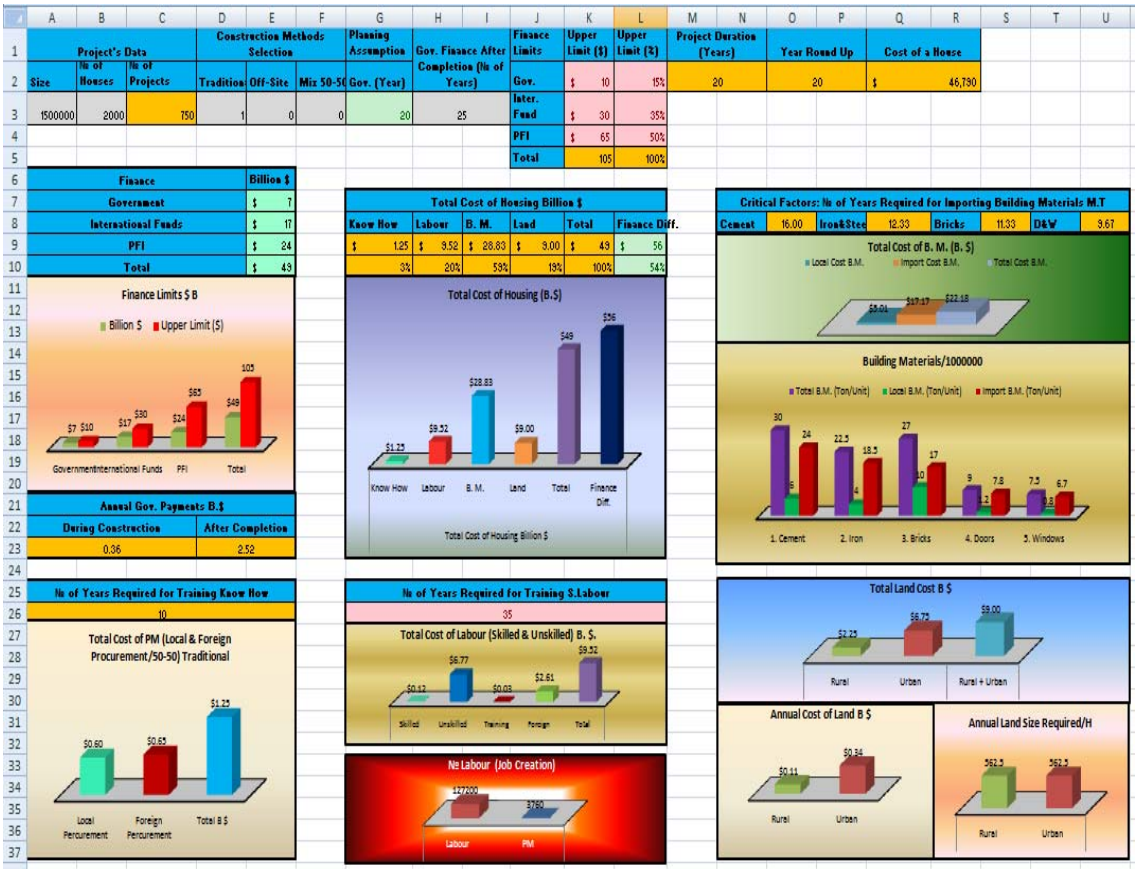



Figure 4: DSS Model Structure



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# Research Methodology Explained

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## Abstract
Research Methodology is one of the nightmares a researcher has to endure. It is so confusing and misleading because it is derived from philosophy. Philosophy itself is hard to comprehend and explain even by experts in the field. The reason is that philosophy was first explored in the 5th Century BC by the infamous Greek philosophers such as Aristotle, Socrates, and Plato who are regarded as the fathers of philosophy.
Scholars and Experts in the field of Research Methodology have invested so much time and effort attempting to draw a clear picture of the Process of Research Methodology which is derived from Philosophy. However, most attempts or perhaps models of research are still hard to comprehend, understand and follow. In the light of this, Saunders et al (2003, 2006) have introduced great Models namely The Research Process Onion, which is widely used by researchers to justify their research. However, Saunders Research Process Onion Models (2003, 2006) can be greatly improved by including and positioning Epistemology and Ontology on the model. This attempt will draw a clearer picture about research process and make it easier to understand and follow by researchers.
The outcome of this research is expected to produce a comprehensive Research Methodology Model which is broader, clearer and links and displays the relations and hierarchy among philosophical and technical terms and domains such as Axiology, Epistemology, Ontology, Research Philosophy, Research Approach, Research Strategy, Research Choices, Time Horizons and Data Techniques.

## Keywords
Philosophy, Epistemology, Ontology, Axiology, Research Methodology.

## 1. Introduction

The first challenge a postgraduate researcher encounters is understanding research methodologies available and then select a method that is most suitable for his research, not to mention the struggle against time and cost to getting results. Philosophy and research methodology is really so hard to comprehend and follow by researchers, therefore, most researchers are scared to enter and forced to out this particular field. So, what is the problem? Is it Philosophy/Research Methodology, the researcher, or the way Philosophy/Research Methodology is interpreted and presented? The answer is, neither Philosophy/Research Methodology, nor the researcher is the problem. It is in fact the interpretation of philosophy, philosophical terms, diagrams, models, etc. related to the field of research methodology presented by scholars and writers which are not adequate, complicated, confusing, misleading, etc. Nowaday; there are several schools and

branches of philosophy. The discipline of philosophy is also taught at universities worldwide. Moreover, there are a number of attempts to explore and exploit research methodology for scientific disciplines and social sciences. The work of scholars and experts results in producing models which explain research nature, path stages, etc.

This paper presents an attempt to draw a holistic and clearer picture about research process and make it easier to understand and follow by researchers. Moreover, a critical analysis will be presented on a presentation in a workshop of Research Methodology entitled "PhD Research: Axiological Purposes, Ontological Cages and Epistemological Keys". The Presentation was given in March 2007 by Prof. Martin Sexton, Built Environment, University of Salford, UK. The Presentation was 81 Slides long. The aims of including Prof. Sexton Model are to display the confusion and dilemma a new PhD researcher has to endure when such a thing is presented in such a way.

This research is based on literature review. The outcome is expected to produce a comprehensive Research Methodology Model which is broader, clearer and links and displays the relations and hierarchy among philosophical and technical terms and domains such as Philosophy, Epistemology, Ontology, Research Approach, Research Strategy, Research Choices, Time Horizons and Axiology/Data Techniques and Procedures.

## 2. Philosophy

In this section; a brief discussion (definition, branches) of the term philosophy will be given to understand the dimensions and domains of this illusive term.

### 2.1 Definition

Britannica Dictionary Online (2009) state that the word Philosophy is of Greek origin: φιλοσοφία, philosophía. Philosophy means "Love of Wisdom or Love of Knowledge".
The Dictionary of Philosophy defines Philosophy as seeking of wisdom and the wisdom sought. Originally, philosophy is the rational explanation of anything; the general principles under which all facts could be explained; in this sense, indistinguishable from science.

### 2.2 Philosophy Branches

Landauer and Rowlands (2001) argue that there are five branches of philosophy namely Metaphysics, Epistemology, Ethics, Politics and Atheistic, whereas the Dictionary of Philosophy suggests that Philosophy includes metaphysics, epistemology, logic, ethics, aesthetics, etc. There is not much different between the two classifications. Politics in Landauer and Rowlands (2001) is replaced by Logic. This is not a major difference and politic depends on a logical explanation to justify beliefs. According to the two arguments the five philosophical branches could be could be extracted and explained in Table 1 as follows:

| | | |
|---|---|---|
| Metaphysics | Study of Existence | What's out there? |
| Epistemology | Study of Knowledge | How do I know about it? |

| | | |
|---|---|---|
| Ethics | Study of Action | What should I do? |
| Logic | Study of Linguistics | What reasoning and argumentation are permissible? |
| Aesthetics | Study of Art | What can life be like? |

Table 1: Five Branches of Philosophy (Landauer and Rowlands, 2001, Dictionary of Philosophy, 2009)

## 3. Epistemology

Phillimore and Goodson (2004) claim that Epistemology is the theory of knowledge, and is interested in the origins and nature of knowing and the construction of knowledge, and the claims and assumptions that are made about what the nature of knowledge is. Moreover, Stanford Encyclopaedia of Philosophy (2005) defines Epistemology is the study of knowledge and justified belief. As the study of knowledge, epistemology is concerned with the following questions: What are the necessary and sufficient conditions of knowledge? What are its sources? What is its structure, and what are its limits? As the study of justified belief, epistemology aims to answer questions such as: How we are to understand the concept of justification? What makes justified beliefs justified? Is justification internal or external to one's own mind? Understood more broadly, epistemology is about issues having to do with the creation and dissemination of knowledge in particular areas of inquiry.

## 4. Ontology

Weber (2004) claims that ontology is a person (researcher) and reality are separate (positivism) and a person (researcher) and reality are inseparable in life-world (interpretivisim). Moreover, Lowe (2006) claims that Ontology has two aspects; the first is objectivism which portrays the position that social entities exist in reality external to social actors concerned with their existence. The second is subjectivism which holds that social phenomena are created from the perceptions and consequent actions of those social actors concerned with their existence. Thus, Ontology is analysing the nature of the universe itself and everything within the universe through two aspects: objectivism and subjectivism.

## 5. Axiology/ Data Collection Techniques, Procedures & Evaluation

Britannica Encyclopaedia Online (2009) state that Axiology from the Greek axia (αξια, value, worth), is the study of value or quality. It is often thought to include ethics and aesthetics philosophical fields that depend crucially on notions of value, and sometimes it is held to lay the groundwork for these fields, and thus to be similar to value theory and meta-ethics. Moreover, Bahm (1993) argues that the term was used in the 19th and early 20th centuries, but in recent decades, value theory has tended to replace it in discussions of the nature of value or goodness in general. Thus, testing the value of knowledge can be achieved by the benefits it creates to humans. In research, this can be done by investigating the clients'/end-users' views and opinions in forms of qualitative and quantitative surveys. Perhaps some times a researcher ought to use both methods (qualitative and quantitative) to better assess the value of his product. It is important to notice that Saunders et al (2006) did not state the relation between values and knowledge. Saunders et al

(2006) focus on data collection techniques and procedures to assess the value and quality of a research, which is widely known as Axiology.

## 6. Research Reasoning/Approaches

Although Saunders et al (2003) believe that making a link between a particular research philosophy and either of the two research approaches, deductive and inductive, "is potentially misleading and of no practical value", they do, in fact, link the deductive approach to positivism and the inductive approach to interpretivism. A third approach (Abductive) was named which links together inductive and detective reasoning. Levin-Rozalis (2004) calls the logical process of discovery "abduction" and state that we cannot ignore the process of discovery in science, leaving it to the history of science or psychology. The process of discovery that intends to provide an explanation of a new or surprising fact is subject to logical categories and criteria such as the process of proof. A new or surprising fact is one we did not expect to find, either because we did not know what to look for in the first place, or because the fact was beyond our expectations of what we were about to, or should find. Discovery is the process that leads us from the fact to an established scientific explanation of it.

## 7. Research Strategies

Saunders et al (2006) claim that research strategies available are such as experiment, survey, case study, grounded theory, ethnography, action research, etc.

## 8. Research Choices

Saunders et al (2006) argue that a researcher has more than one option to select research strategies. These choices are namely Mono Method (single method), Mixed Methods and Multi-Methods.

## 9. Time Horizons

Saunders et al (2006) suggest that Time Horizon is the process where the researcher dedicates his time to perform his research. Since a research could be divided into processes, therefore a researcher could work on a single and use the results into the following. If the research is not process dependant, then a researcher could work on multi-process to utilise and manage time.

## 10. Existing Models

In the following two existing Research Models will be discussed, analysed and criticised. These Models are Saunders et al (2006) so-called Research Process Onion and Sexton (2007) PhD Research Methodology Model.

### 10.1 Research Process Onion

In this part, the discussion focuses and analyses The Research Process "Onion" proposed by Saunders et al (2003, 2006). The following Figure 1 shows the Saunders (2003) Research Process Onion:

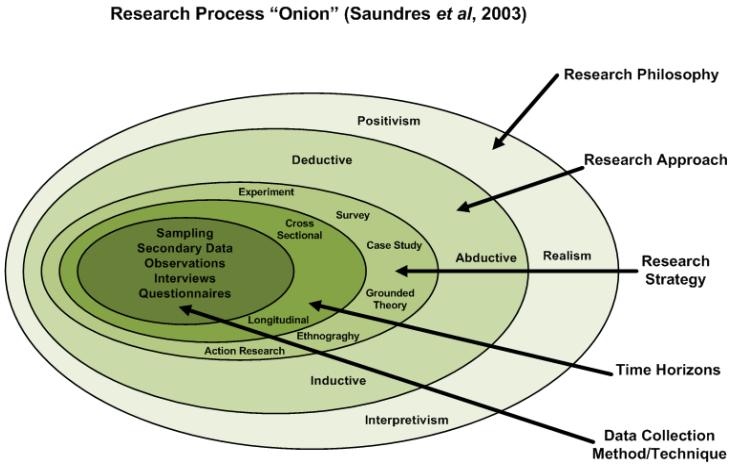


Figure 1: Research Process Onion (Saunders et al, 2003).

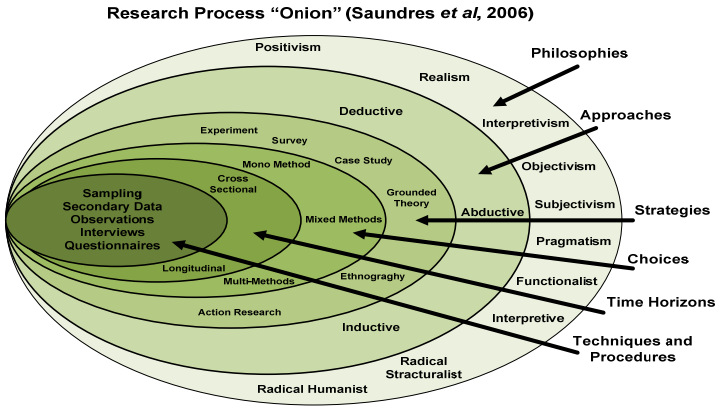


Figure 2: Research Process Onion (Saunders et al, 2006).

The models in Figures 1&2 are good to some extents. Researchers have utilised and use it to justify their research. However, Saunders Onion Model lacks many things as follows:

1. The Models are ambiguous and complicated.

2. Axiology, Ontology and Epistemology are not clearly positioned and do not appear on the Model.

3. There is no clear identification of Philosophy and its five branches such as Metaphysics, Epistemology, Ethics, Logic and Atheistic.

4. The outside layer is so congested (Saunders 2006) and has mix terms and branches of different nature and purpose such as Epistemology and Ontology.

5. The inside layer should be marked as Axiology which will help a research understand the meaning, purpose and domain of the term itself.

The above criticism to Saunders (2003-2006) Research Onion Models will be used to structure and justify the New Research Methodology Model at the end.

## 10.2 PhD Research Methodology Model

The following discussion focuses on Saxton (2007) Model which has been given in seminars and training session for PhD researchers at the University of Salford.

Sexton (2007) PhD Research Model is presented in the following two Figures 2&3:

Figure 2: PhD Research Model (2007-1)

The following Figure 3 below represents the second half of the Model:

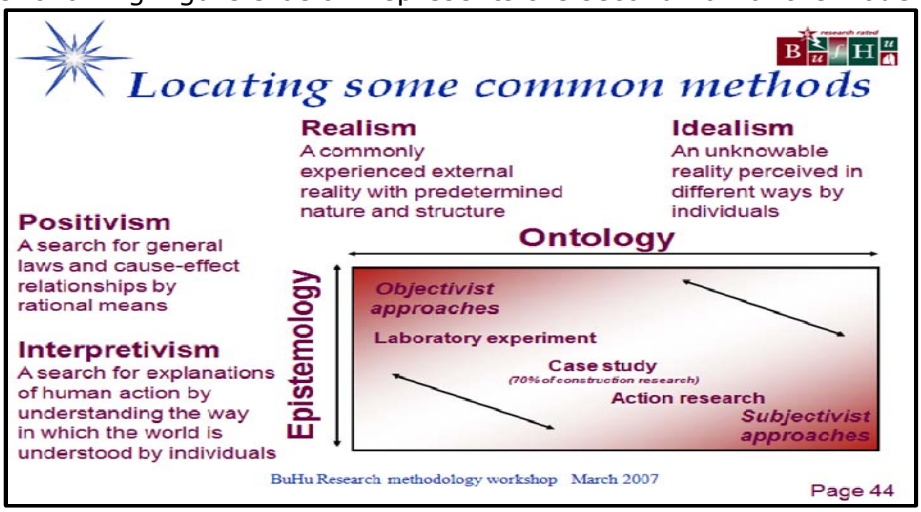


Figure 2: PhD Research Model (2007-2)

Sexton (2004) Model is too confusing especially for researchers who are not native speakers of English. The interpretation and understanding of the Model requires months to comprehend and understand. Any amount of time is considered precious for any PhD researcher especially, the overseas ones. Scholars and writers should understand that the majority of PhD researchers are from overseas and therefore should present their work in a very simple manner. A PhD on its own is a mammoth task. Normally, a PhD needs many years to complete and with this compulsory aspect of a research (understanding and identifying Research Methodology) it makes it even harder to finish. In fact, the way the PhD Research Model was

present may discourage researchers from using it as a guide and perhaps even looking at it.
The criticism of Sexton (2007) PhD Research Model is as follows:

1. There is a great contradiction between Saunders (2003) and Sexton (2004); Saunders (2003), in the outside layer consider Positivism, Interpretivism and Realism as Research Philosophies/Epistemologies, whereas Sexton (2007) consider only Positivism and Interpretivism and Realism as a branch of Ontology which are two different philosophies.

2. The research finds that Ontology has two aspects namely Subjectivism and Objectivism; whereas Sexton (2007) argue that Ontology is Realism and Idealism.

3. Sexton (2007) Model argues that Subjectivism and Objectivism as approaches where as Saunders (2003-2006) Models classifies Approaches as Inductive and Deductive.

4. There is no reference to Research Strategies in the Model.

5. The Model did not identify and define the domain of term Philosophy.

If a researcher studies Saunders and Sexton Research Models, definitely s/he will be significantly confused, misled, frustrated, etc. because of all the contradiction between the two Models. For example: what is approach in one model means different term or notion in another, what is strategy in one strategy in one model also means another and what is Axiology, Epistemology and Ontology in one model refers to different philosophies in another.

## 11. New Proposed Research Methodology Model

The New Research Model will be called "Research Methodology Life Cycle". This Model is believed to be easier, simpler and more comprehensive. The following Research Model in Figure 5 is proposed and believed to help better researchers in their researching process. The New Model based upon the above discussions and arguments:

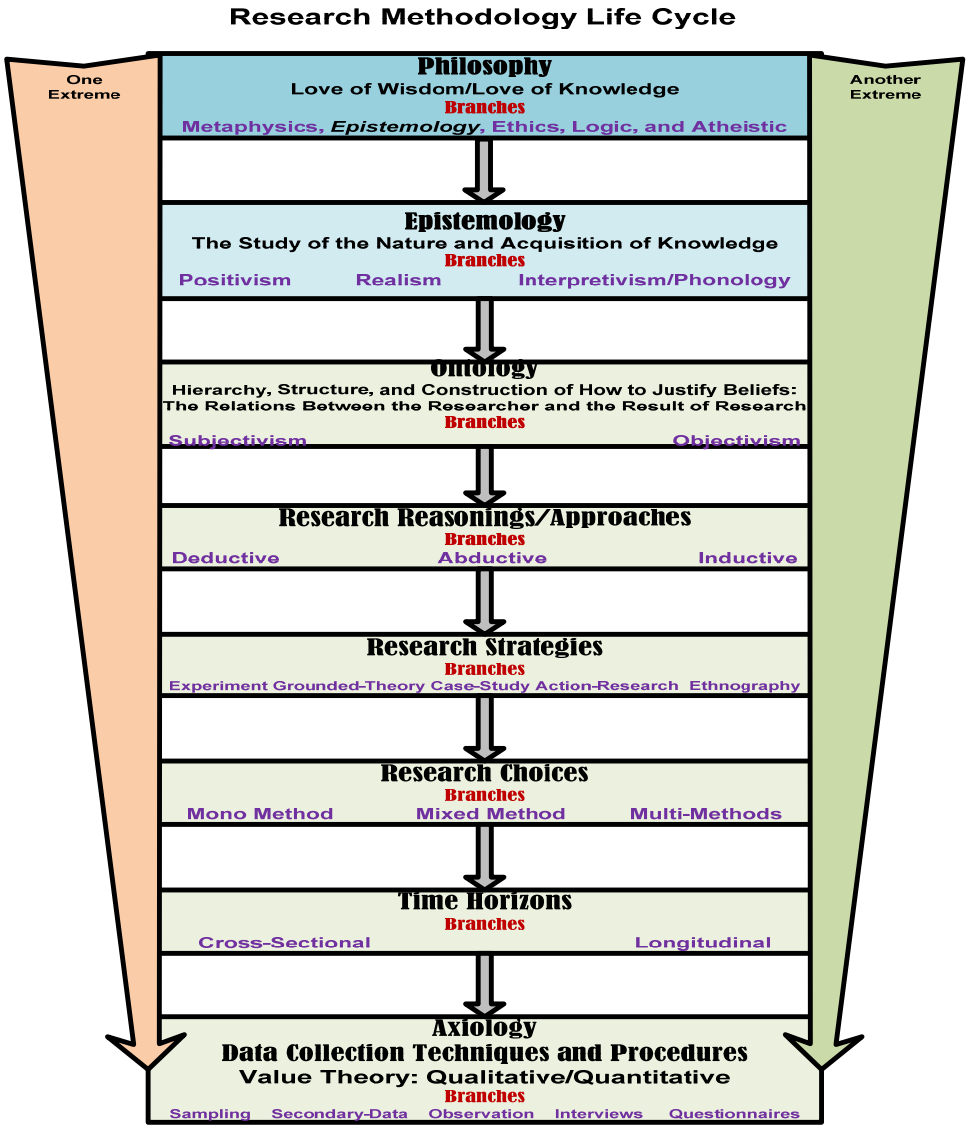


Figure 5: Research Methodology Life Cycle (Dawood and Underwood, 2010)

The New Model in Figure 5 is based on the concepts, notions and terms of Saunders (2003-2006) Models because the models are clearer, easier and more comprehensive than Sexton (2007) Model.
Considering the New Model, a researcher realises that a holistic picture is drawn regarding research methodology and include regular notions and phenomena. The structure of the New Model starts with defining the branches of the term philosophy. It also defines the domains of the illusive terms Epistemology and Ontology respectively. It presents the types of Research Approaches available. The aspects of strategies are presented. Research Choices and Time Horizons are introduced. Finally, Axiology is investigated and linked to data collection techniques and procedures.

## 6. Conclusion

This research criticised and justified the lack in Saunders (2003, 2006) Research Process "Onion" Models and Sexton (2007) Model. Saunders Models displays and presents a reasonably good model may be used by researchers to justify their

research, however, it lack the identifications and differentiations among Philosophy, Epistemology, Ontology, Axiology, etc. On the contrary, Sexton Model is totally misleading because there is a massive use of misconception of the terms and notions such as Epistemology, Ontology, Axiology, etc. There is no reference to Philosophy and its branches. Moreover, Sexton Model explained in more than one Figure/Diagram, therefore, researchers find it too difficult to comprehend and follow, especially, researchers from overseas where English is not their first language.

The New Research Methodology Model leans slightly to Saunders (2003-2006) Models because it is easier and better than Sexton Model. The New Research Methodology Model presents a holistic picture of a research starting from Philosophy and ending with Axiology. The New Model is more comprehensive because it clarifies and classifies all the terms and notions related to research life cycle. A research will learn, conceptualise and differentiate by observing the Model about what is Philosophy and its branches, the domain of Epistemology and its branches, the concept of Ontology, the types of Research Reasoning and Approaches, research strategies available Axiology and Data Collection Techniques and Procedures, etc. this holistic picture is partially presented by Saunders Models and partially and chaotically by Sexton Model. Time is crucial for a researcher; therefore, a researcher does not appreciate learning about research methodology the way it is partially or perhaps incompletely presented by Saunders Model. Moreover, Sexton Model may lead the researcher to be frustration, anxiety, loss of confidence because the model is greatly misleading. These issues will take more time from it was expected and put the researcher under greater pressure.

It is anticipated that the New Research Methodology Model will help researcher conducting and progressing better in their research and reduces the time working on research philosophy rather the research itself.

Finally, because all disciplines: Social Sciences, Humanities, Pure sciences, etc, are closely interrelated and overlapping; therefore, this research paper is definitely related and concerned to Construction and other areas of research.

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# First five years of conducting the Management in Civil Engineering group of courses within the Professional Study Programme and the Polytechnic Graduate Professional Study Programme in the Polytechnic of Zagreb

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## Abstract
The Polytechnic of Zagreb organised two study programmes, a 3-year Professional Study Programme and 2-year Polytechnic Graduate Professional Study Programme, and within those study programmes it embedded a group of courses about Management in Civil Engineering.
With this paper we will try to review some of the basic success indicators of that group of courses, e.g. enlisted students, finished students, average grades, etc.
We will also try to review the results of the survey conducted among the students of both study programmes who took the fore mentioned group of courses. The survey regarded the student opinion on education conduction and their general grades of the study as a whole.
The results will show the students general opinion about these groups of courses, and it will show that the basic success indicators point to a well balanced and concerted group of courses about Management in Civil Engineering within both study programmes.

## Keywords
Study programme, student survey, success indicators

## 1. Short history and introduction to Polytechnic of Zagreb

The Civil Engineering Department of the Polytechnic of Zagreb has had over forty years of experience in the organization and development of professional study programmes. Since its foundation till 2004/05, when it was separated from the Faculty of Civil Engineering, and entered in to the official Register of scientific institutions, the Polytechnic has been carrying out 3-year professional study programmes. Since Croatia has decided to adopt two-cycle study programmes in both academic and professional study programmes, The Polytechnic of Zagreb organised two study programmes, a 3-year Professional Study Programme and 2-year Polytechnic Graduate Professional Study Programme, and within those study programmes it embedded a group of courses about Management in Civil Engineering.

## 2. Professional Study Programme in Civil Engineering

The main objective of professional civil engineering studies is to educate civil engineering experts that will be able to meet ever-growing demands of the present day construction industry. The curriculum has been composed in such a way to provide expert knowledge related to civil engineering projects, technology of their realization, and organization of construction work. In addition to an optimally proportioned theoretical background, a particular attention is paid to the practical part of the curriculum consisting of practical sessions, autonomous but tutored solving of assignments, field work and also practical work which is related to the final examination. Upon completion of their studies, our graduates have proven to be capable of meeting all challenges encountered in the realization of construction projects, mainly because they have acquired, in the course of their studies, highly-specialized skills and knowledge on construction projects, as well as the knowledge and skills relating to construction technologies, site organization, quality control and quality assurance, control of expenditures, construction regulations, environmental protection, etc.

After the initial three semesters during which all students are involved in the same courses of study, the next three-semester programme has been traditionally offering two groups of courses: Building Construction and Civil Engineering (Water and traffic infrastructure). After an extensive analysis of needs in the construction industry, and following various student opinion surveys conducted in recent years, the Polytechnic of Zagreb has decided to offer an additional group of courses - Management in Civil Engineering.

The need for a programme focusing on development of an entrepreneurial and managerial spirit is increasingly felt in construction practice as a result of rapid development of this industry. According to the surveys, one third of our students would opt for Management in Civil Engineering because they know that, due to the rapid development of private entrepreneurship, they may expect to find employment in that sector or develop their own business as soon as they complete their studies.

A first cycle Professional Study Programme in Civil Engineering is carried out in six semesters. After the completion of the first three semesters, four groups of courses are offered in this programme; Building Construction; Water and traffic infrastructure in Civil Engineering; Civil and Environmental Engineering; **Management in Civil Engineering**. The total acquired number of ECTS credits is 180, and after the completion of their studies, the students acquire the title of Bachelor of Civil Engineering and are qualified for work in many fields of the Civil Engineering industry.

In the following tables curriculum for Management in Civil Engineering will be presented. Table 1 shows common courses for all four groups of courses which are offered in this study programme, and are especially related to organization, management and technology. Table 2 presents the group of courses offered only in the Management in Civil Engineering group of courses.

| Course | Semester | Exams | Number of ECTS Credits | Hours of Lectures | Hours of Excercises | Hours of Individual Work |
|---|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| **CONSTRUCTION MACHINERY** | IV | 1 | 4 | 30 | 15 | 75 |
| **FIELD PRACTICE** | IV | | 2 | | 30 | 30 |
| **CONSTRUCTION MANAGEMENT I** | V | 1 | 5 | 30 | 30 | 90 |
| **CONSTRUCTION MANAGEMENT II** | VI | 1 | 5 | 30 | 30 | 90 |
| **CONSTRUCTION TECHNOLOGY** | V | 1 | 5 | 30 | 30 | 90 |
| **FINAL WORK WITH FIELD PRACTICE** | VI | | 20 | 15 | 195 | 390 |

**Table 1**: Common courses for all four groups of courses which are offered in this study programme and are especially related to organization, management and technology

| Course | Semester | Exams | Number of ECTS Credits | Hours of Lectures | Hours of Excercises | Hours of Individual Work |
|---|---|---|---|---|---|---|
| **PLANNING METHODS** | VI | 1 | 5 | 30 | 30 | 90 |
| **ORGANIZATION OF CONSTRUCTION SITE** | V | 1 | 6 | 30 | 30 | 120 |
| **METHODOLOGY AND MANAGEMENT IN CIVIL ENGINEERING** | V | 1 | 2 | 15 | 15 | 30 |
| **CONDUCT OF COMPANY BUSINESS OPERATIONS** | V | 1 | 5 | 30 | 30 | 90 |
| **MARKET AND BUSINESS ENVIRONMENT** | IV | 1 | 5 | 30 | 15 | 105 |
| **PROJECT MANAGEMENT AND LEGISLATION** | V | 1 | 5 | 30 | 15 | 105 |

**Table 2**: Group of courses offered only in the Management in Civil Engineering group of courses

After the completion of the Management in Civil Engineering group of courses within the Professional Study Programme, the students will obtain knowledge, skills and qualifications for all activities relating to construction management. They will learn to participate in the design and development of technological processes during construction of various structures, and to act independently in individual phases of work and in finishing trades. They will also learn to independently make price analysis and check compliance of completed work, prepare working design documentation for site preparation and to organize operation of construction machinery, installations, and equipment during the realization of construction work.

## 3. Polytechnic Graduate Professional Study Programme in Civil Engineering

In order to give the successful graduates of our first cycle Professional Study Programme the opportunity to proceed with their studies, and to meet the economy needs at the same time, we have decided to establish a second cycle Professional Study Programme, a two-year specialist study programme for all students (providing they fulfil the admission requirements). The study programme was named Polytechnic Graduate Professional Study Programme, and among others offered a Specialization in Civil Engineering. The study programme lasts 4 semesters, awarding 120 ECTS credits, and after the completion of their studies, the students acquire the title of Master of Engineering in Civil Engineering

In addition to the traditional groups of courses, i.e. Building Construction and Civil Engineering (Water and Transport Infrastructure) the Polytechnic of Zagreb has decided to offer the students an additional orientation in the form of a group of courses called Management in Civil Engineering. That group of courses corresponds to courses taught during the first cycle Professional Study Programme at the Polytechnic of Zagreb. New developments in technology and economy were the propulsive force that stimulated and encouraged the Polytechnic of Zagreb to organize the new study programmes, and hence to contribute to the development of education through creation of novel areas and disciplines in high education. The quality of our selection of educational programs is additionally confirmed by the fact that many international and European institutions of high education have been increasingly offering programmes such as Civil and Environmental Engineering and Management in Civil Engineering.

Also in December 2008 the Republic of Croatia issued the Law on Architectural and Engineering Activities and Works in Physical Planning and Construction, thus forming a legal category of Building Construction Managers and recognizing the need for Management in Civil Engineering.

The main objective of the second cycle study programme in the field of Civil Engineering is to educate highly qualified civil engineering experts that will be able to offer their services on the labour market in a fully independent manner, and whose profile is optimally suited to the needs of the present day construction industry. The courses of this study programme are primarily oriented toward acquiring expert knowledge and skills with an optimally balanced proportion of modern theoretical background, so that the students can directly be included in work processes that are related to civil engineering. Upon completion of their studies, students are prepared for independent realization of projects, as in the course of their studies they have acquired highly specialized skills and knowledge of management in construction projects, as well as the knowledge and skills related to construction technologies, site organization, quality control and quality assurance, control of expenditures, construction regulations, etc.

The Polytechnic Graduate Professional Study Programme is organized for the Bachelors of Engineering and for Bachelors of Science with some field work or with working experience. The specialization in Civil Engineering offers the continuation of the studies in form of four groups of courses, based mainly on the group of courses selected during previous studies. After fulfilment of program requirements, our students are fully qualified for independent work in construction practice, design

offices, a variety of administrative and municipal services, and in all other branches of industry and areas relating to their field of expertise (construction management).

Table 3 presents courses related to organization, management and technology on the Polytechnic Graduate Professional Study Programme.

| Course | Semester | Exams | Number of ECTS Credits | Hours of Lectures | Hours of Excercises | Hours of Individual Work |
|---|---|---|---|---|---|---|
| **CONSTRUCTION PROJECT MANAGEMENT** | II | 1 | 6 | 30 | 30 | 120 |
| **MODERN CONSTRUCTION TECHNOLOGIES** | II | 1 | 7 | 30 | 30 | 150 |
| **PROJECT PLANNING AND MONITORING** | III | 1 | 6 | 30 | 30 | 120 |
| **CONSTRUCTION REGULATIONS** | III | 1 | 5 | 30 | 15 | 105 |
| **INVESTMENT POLICIES** | III | 1 | 6 | 30 | 30 | 120 |
| **LEGAL ASPECTS OF CONSTRUCTION PROJECTS** | III | 1 | 5 | 30 | 15 | 105 |
| **BUSINESS MANAGEMENT IN CONSTRUCTION INDUSTRY** | III | 1 | 5 | 30 | 15 | 105 |
| **MANAGEMENT AND MAINTENANCE OF INFRASTRUCTURE FACILITIES AND BUILDINGS** | III | 1 | 6 | 30 | 30 | 120 |
| **GRADUATION THESIS** | IV | | 30 | 15 | 285 | 600 |

**Table 3**: Courses related to organization, management and technology and the group of courses specialized for Management in Civil Engineering

## 4. Basic success indicators of the Management in Civil Engineering group of courses on both study programmes

During the past five year period, between the years 2005 and 2009, five generations of students have entered the Professional Study Programme, and four generations of students have entered the Polytechnic Graduate Professional Study Programme. A portion of the students in each of those generations took the Management in Civil Engineering group of courses.

Between the years 2005 and 2009 a total number of 185 students chose the Management in Civil Engineering group of courses in the fourth semester.

It must be noted that in the first academic year in that period, i.e., 2005/06 there were no students who could chose that or any other group of courses, because this was the first academic year in which the Professional Study Programme was being conducted and there were only students who were attending the first and second semester. It must also be noted that there are four groups of courses and each year 25% of the students ranked by their grades can choose the Management in Civil Engineering group of courses. In the second academic year in that period, i.e., 2006/07, a total number of 14 students chose the group of courses. In the year 2007/08 there were 51 students, in the year 2008/09 there were 50 students and in the last year, i.e. 2009/10 there was a total number of 70 students who chose the group of courses.

After the initial fluctuation in the number of students in the year 07/08 and in the year 08/09 did not vary that much. The last increase in the number of students between the years 08/09 and 09/10 happened because the ratios between the four groups of courses changed and in the last year 33% of the students could choose the Management in Civil Engineering group of courses. The change in the ratios happened because the surveys conducted at the National Employment Office said that all of the students that chose and finished the Management in Civil Engineering group of courses on the Professional Study Programme were employed almost instantly after graduation. The first students finished the Professional Study Programme and the Management in Civil Engineering group of courses in the academic year 2007/08 (16 students), in the next academic year 2008/09 a total number of 29 students finished and it is estimated that in the last academic year, i.e., 2009/10 there will be 35 students that will finish the programme and the group of courses. The students finished with an average grade of 3.645.

Between the years 2006 and 2009 a total number of 145 students were admitted to the Polytechnic Graduate Professional Study Programme in Civil Engineering who chose the Management in Civil Engineering group of courses. The number of students that were admitted to the study programme and who chose the group of courses in each academic year was 45 in the year 2006/07, 40 in the year 2007/08, and 30 in both 2008/09 and 2009/10.

The Polytechnic Graduate Professional Study Programme is organized for the Bachelors of Engineering and for the Bachelors of Science with some working experience, and a majority of those students is employed while studying. Because of that fact, the classes are organized in a slowed-down manner so that the each semester actually lasts one year. For that reason there was a slight decrease in the number of students that were admitted to the study programme in each academic year from the year 06/07 to the year 09/10, and it happened due to the technical issues regarding the conduction of classes, so that the high level of education conduction could be maintained.

In the same period a total of 17 students who chose the Management in Civil Engineering group of courses graduated the study programme with an average grade of 3.786. Such a small number is to be explained with the fact that most of the students are employed full time while studying.

## 5. Survey on the student opinion among the students of the Professional Study Programme

After the students finish every semester they are given a survey about their opinion on education conduction and their general grades of the study as a whole. The survey includes all of the students on the Professional Study Programme, so the results given here are extracted for only the students who chose the Management in Civil Engineering group of courses. The number of students being surveyed varied from 34 to 41.

The students were asked a series of questions about the study in whole and a series of questions about every course separately. From the survey we extracted the following question which asked the students are they generally satisfied with the education conduction and the general state of the study programme. The students were given five different answers between which they could choose one. Figure 1 shows their answers for each academic year separately.

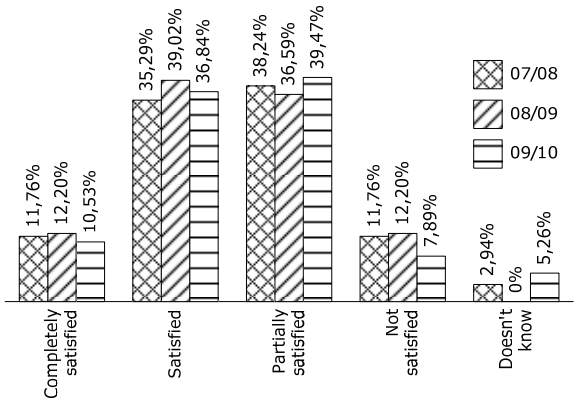


**Figure 1:** Professional Study Programme

## 6. Survey on the student opinion among the students of the Polytechnic Graduate Professional Study Programme

Like the survey among students on the Professional Study Programme, a survey is conducted on the Polytechnic Graduate Professional Study Programme. Also the results given here are extracted for only the students who chose the Management in Civil Engineering group of courses. The number of students being surveyed varied from 16 to 22.

These students were asked the same question as the students on the Professional Study Programme. They were given five different answers between which they could choose one. Figure 2 shows their answers for each academic year separately.

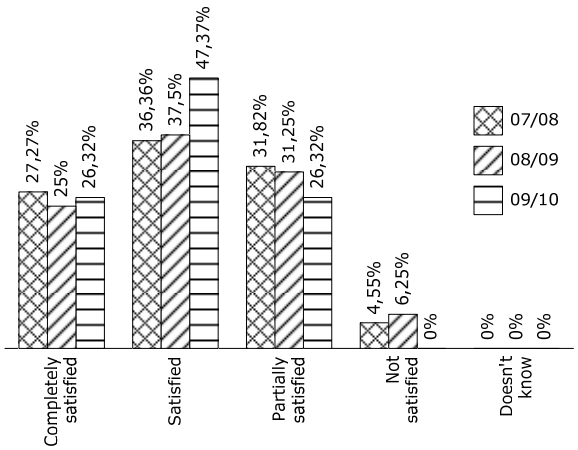


**Figure 2:** Polytechnic Graduate Professional Study Programme

## 7. Conclusion

These new study programmes, harmonized with the Bologna Declaration, both the Professional Study Programme and the Polytechnic Graduate Professional Study Programme, have been started in the academic year 2005/06. During the last five years the Management in Civil Engineering group of courses on the Professional Study Programme and on the Polytechnic Graduate Professional Study Programme, has been established among students as the most popular group of courses. It has achieved that status with the high quality of study programmes, up to date course content, the fact that many professors are experts in their field of work, and that they are transferring their practical professional knowledge to the students.

The specific slowed down manner of studying on the Polytechnic Graduate Professional Study Programme is especially suitable for the students that finished the Professional Study Programme and are employed full time, so it allows them to upgrade their knowledge acquired through their field work experience.

Both the Professional Study Programme and the Polytechnic Graduate Professional Study Programme, especially the Management in Civil Engineering group of courses, have been recognized by the construction business environment also, and the fact is that at this time there are almost no unemployed students who finished the two fore mentioned study programmes.

It must also be mentioned that the Republic of Croatia recognized the knowledge and skills of our students and through the changes made in the legislation gave our students all of the necessary authorizations, which made them equal with all of the students finishing the University Study Programmes.

This model of studying can be applied in other countries which have the similar situation of having a large number of Bachelors of Engineering and Bachelors of Science with some field work or with working experience who want to continue the studies and enhance their existing knowledge in the project management field.

It is our hope that all these positive trends will continue, and that this system of lifelong education of already graduated Bachelors of Civil Engineering is a good assurance for the future.

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*AA093*

# Generation of Rework: An Organisation's Perspective

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## Abstract
Rework can be taken as undesirable outcome in projects. Organisations use different approaches to respond and deal with rework during execution of projects. Some of the organisations might be well-prepared to deal with it as a part of project, whereas, others might be ignorant about it. In fact, the complexity of rework often deludes organisations which are even prepared to handle it. Understanding of the physics of rework is crucial but it needs to be first understood how organisations perceive and tackle it in real life.

This paper intends to present the rework and its source that is understood at the ground level by project team members in an organisation which works with power system projects in the United Arab Emirates. A qualitative approach has been used to explore the understanding of rework in the organization. Semi-structured interviews were taken with the project team members who deal with rework practically and are interested to find proper solutions to mitigate it. The interview data were processed and assembled in terms of a theoretical framework that represents their interpretation of rework. It was found that "failure in quality" and "change from the side of customer" are the two primary sources that are responsible for generating rework in the projects. The understanding is practical but its adequacy is definitely worthwhile to be further investigated.

## Keywords
Rework, understanding of rework, power system projects, qualitative approach, UAE.

## 1. Introduction

Rework is a set of by-product in project that is essentially undesirable. From customer-focused point of view, rework can be taken as something that has to be worked upon again in project, at least for one extra time due to non-conformance to requirements (Love et al., 1999). From process centric view, rework could be defined as the unnecessary effort of re-doing a process that was incorrectly implemented in the first time (Love et al., 2000). From the systems point of view, rework is a form of waste and is a non-value adding activity that add costs directly or indirectly (Love et al. 1999). However it is clearly a set of post-event corrective activity in projects and some authors view it as almost inevitable and acceptable, and define it as "making occasional mistakes" (Sommerville, 2007). At the same time, the costs of rework have been reported to be significant, for example, it would range from 2% to 12% of contract value in construction projects (Burati et

al., 1992; Josephson and Hammarlund, 1999; Love and Li, 2000). Moreover, rework transpires over time necessitating more resource deployment, with possible schedule slippage and reductions in project scope or quality (Love and Edwards, 2004). The adverse consequences of these difficulties include reduced profit, loss of market share and reputation, increased turnover of management and workforce, lower productivity, higher costs and too frequent costly litigation between participants over responsibility for overruns and delays. (Ackermann et al., 1997 and Eden et al. 2000, cited in Love and Edwards, 2004). Probably because of these consequences, organisations which are aware about the existence of rework in their projects are always interested to trace the causes of rework and make attempt for mitigation. This paper presents a set of rework related observation of project team members in a UAE based organisation which works with power system (PS) projects.

## 2. The Studied Organisation

This study looks into the projects in the PS division of the UAE based organisation. The PS division was divided into different local business units (LBU). One of such units was running turn-key projects that run high voltage substation projects as a main contractor of the government public utility authorities. Another unit was working as a sub-contractor for main contractors in running protection and automation systems projects that included protection panels and substation, and control and monitoring systems project. Usually the scope of work for the projects were civil and electrical design, civil works, manufacturing/production, factory test, installation, delivery, test and commissioning of all parts of a high voltage substation. There were altogether 250 employees in the PS division.

According to the project financial controllers' monthly reports which were based on all running projects, there was a huge amount of costs of poor quality (COPQ) which included direct and indirect costs of rework in projects and had considerable effects on the projects' margins. So, the project managers were highly interested in identifying the sources of generation of rework and in finding the proper solutions in order to minimize it.

The respondents for this study were selected among the project functional team members and managers from the organisation. They were a supply chain manager, a design manager, a manufacturing/ production manager, a project manager, a project financial controller and an operation manager. The reason for selection of these people was that they were dealing with rework problem practically in their organization and are interested to find proper solutions to mitigate it. Semi-structured interviews were taken with them to get their understanding about the causes of rework in projects they have been handling.

## 3. Discussion and Analysis

Figure 1 shows the general path of project management activities in the PS division project organization.

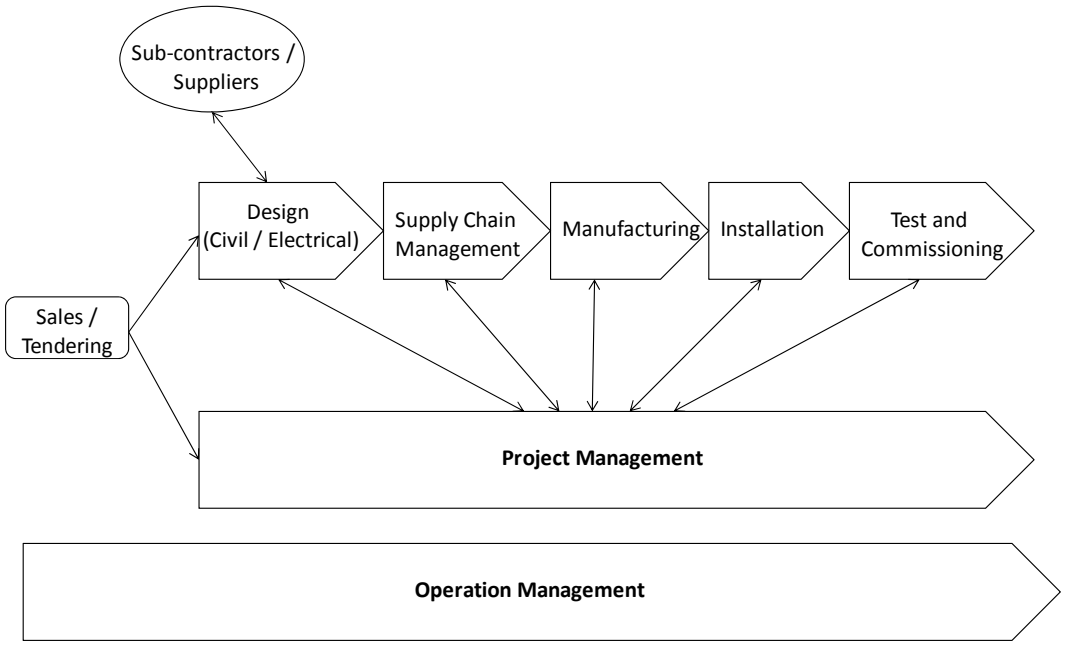


**Fig 1**: General Path of Project Management Activities

The flow in projects generally starts from the sales/tendering stage. An official offer as per the client's technical specifications and contractual scope of work would be prepared. For this task, the first challenge is scope management which is critical to the success of an engineering design project. There is high probability of occurrence of discrepancies between contractual documents (i.e. scope of work and technical specifications) due to poor quality in customer documentations. So, proper scope management could help to figure out these deviations and reduce a huge amount of rework in project in later stages.

Also, poor communication with customer/consultant regarding their requirements can add some problem which would appear as a change order and cause rework in later stages. "I think the most important source of generation of rework in our organization is the lack of proper scope management and close communication with our clients at sales/tendering stage" – this was one of the observations of an operation manager.

The next very important, time consuming and complex phase, especially in power system projects, is the phase of design. Sometimes in order to prepare a simple calculation especially for modification works, there should be lots of information to be provided by the client and even by the end users along with the technical experts. Because of this complexity in the involvement of lots of professionals, and requirements of different software and IT supports, the probability of generation of errors or mistakes is significantly high.

The situation would be worse if there is shortage of dedicated employees. Usually, shortage occurs when there are lots of running projects at the same time, and deployment of more resources may even lead to unintended side effects. On the other hand, engineering productivity can be conveniently measured by work hours which address the need for estimating, resource scheduling and workload distribution in the design team. So, the next important cause of rework in design is poor planning of resources and their workload.

Moreover, the significant amounts of rework that emanate from the design phase are due to lack of ability of design team. A design manager expressed that, "when we hire a new engineer we cannot expect proper output from him/her at least for three to six months, because they should be trained and certified for design and work with products. But usually we do not have that much time due to high workload and they should start to work within weeks. So, obviously organization should expect more mistakes and errors in drawings".

One of the primary outputs of design is bill of quantity (BOQ) which would be taken care of by supply chain management (SCM) team through the project manager. It is clear that if there are any errors on the quantity or specification of the given BOQ, it would create rework for SCM and will add extra costs for project. A supply chain manager explained: ".....we have had a project in which we had to purchase a complete set of 20KV switchgear. We ordered the first one based on agreed drawings and technical specifications. But for the second one we assumed that everything is the same, so in order to save time, we ordered the second set without checking it with the design team. We did not consider that there were some differences in dimensions of 20KV switchgear room. Then when we received the panels, they were not matching with the cable wholes and room. It caused a huge amount of rework for us. It happened only because of lack of double checking of drawings with the design team."

The next step is manufacturing. When all equipment have been purchased and delivered to the factory, there is another requirement for starting the manufacturing activity which is manufacturing drawings (i.e. the second output from engineering). This step is really significant and critical in terms of generation of rework because usually there are some errors in drawings which can repeat in the manufacturing of panels for example. A manufacturing manager mentioned that, "there should be a close communication and coordination among SCM, design, and project manager and manufacturing team in order to minimize the rework". Even, the operation manager approved that "definitely poor communication and coordination in manufacturing stage will cause lots of rework and consequently would affect the project cost and time".

The two last stages after delivery of equipment to sites are installation and test and commissioning which have lots of valid reasons to generate the rework. A project manager expressed that, "we have to repeat our test and commissioning job at site because of poor planning, coordination and shortage of dedicated resources. The most effective cause can be reallocation of resources and sending them to other sites before finishing their current job,.....sometimes unrealistic client demands for earlier completion of projects were a major contributing factor".

A number of poor management practices contributed to the generation of rework and waste in projects. Ineffective use of IT also led to inappropriate and non-timely information transfer between design team members and consequently imposed significant restrictions. The design manager, operation manager and project manager all agreed that ineffective IT system and some managerial problems such as ineffective decision making, lack of proper job separations with defined and agreed job descriptions and roles and responsibilities would increase the probability of occurrence of rework.

## 4. Findings

Based on the collected data from interviews, it can be summarised that rework is generated in the PS division from two major sources: changes and failure in quality.

Usually, the critical changes are external ones due to change orders or variation orders from customer. Lack of experience and knowledge, poor communication with design consultant and poor contract documentation and technical specifications would be the major causes for that.

The second identified cause (i.e. failure in quality), could be attributed to the generated errors and the lack of customer focus approach. Lack of customer focus approach can occur because of ineffective scope management in sales/tendering.

Errors also generate because of poor skills and organisation problems. Poor skills in design team would result in drawings with lots of mistakes and unapproved or rejected stamps on them. Moreover, the project team comes up with inadequate project planning and scheduling, the manufacturing team delivers incorrect assemblies and installations. In addition, the most critical part of poor skills is related to managerial skills which include ineffective decision making, shortage of dedicated resources (due to staff turnover, lack of hiring of dedicated people, lack of proper trainings, poor planning of manpower and reallocation of resources frequently before finishing their jobs).

Organizational problems mostly identified are the ineffective IT system and the organizational structure. Since the organizational structure in the PS division is matrix and functional, poor communications among different functional employees could be a source for generation of rework.

Incorporating all the mentioned factors, a model depicting the generation of rework in the PS division of the company is presented in Figure 2.

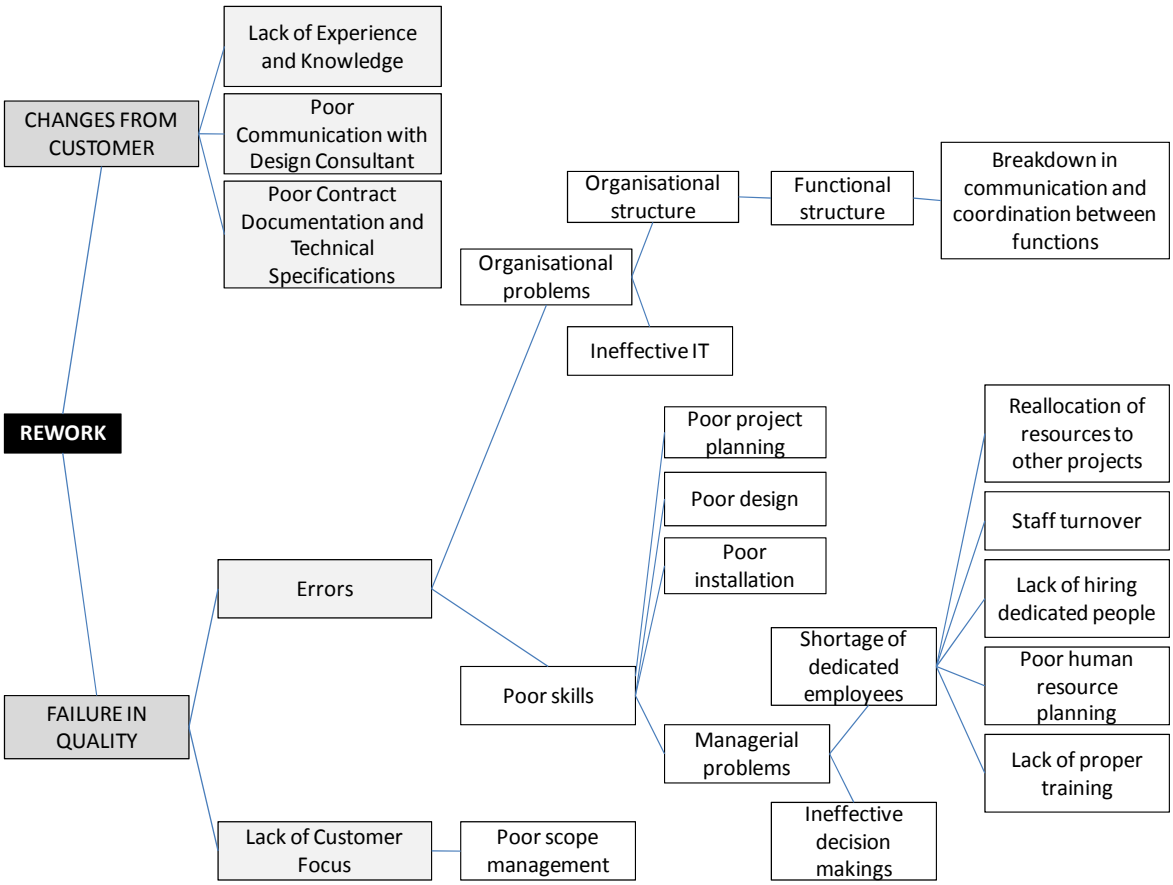


**Fig 2**: Generation of Rework

## 5. Conclusions

In conclusion, it appears that the cause of rework is relatively straightforward and that can be broadly divided into two categories – change from the side of the customer, and failure in quality. The causes were derived from the interview data that is the interpretive understanding of the managers in the company. In fact, the managers were struggling to reduce the amount of rework, and this research has made an attempt to capture their mental model. Their interpretations have been assembled and presented as a cause-and-effect model. However, a closer examination into the rework events reveal that an intricately "complex" and interwoven array of factors contribute to their occurrence. In fact, it was very difficult to identify some specific causes for rework because of the interdependency of work arrangements and dynamic interactions between project participants. Therefore, the attempt of this paper can be taken as a stepping stone to understand the dynamics of rework in projects – which will be a part of further research in this line.

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*AA010*

# A computer-aided conceptual cost estimating system for prestressed concrete road bridges

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## Abstract
The need for an environmentally friendly design of modern motorways increases the construction of bridges, which has exhibited substantial overruns above estimated costs. Therefore, easy to use, inexpensive and accurate methods for conceptual cost estimating are needed. Conceptual cost estimates are made before the project's detailed plans and specifications are known and rely on the conceptual design of the project. Even though they present the lowest expected accuracy, they are used by all the key people involved in the construction process.

This paper presents a computer-aided cost estimating system for prestressed concrete road bridges, which provides estimates of the material quantities and cost of all bridge elements. It relies on a database incorporating actual data collected from recently constructed bridges and exploits material estimating models already developed for bridge superstructure and foundations. The respective models for bridge piers are presented in this paper.

Different configurations are devised from short to long-span bridges, accounting for the major deck construction methods and foundation systems. The system can be easily used to provide different cost estimates to the owner, designer and contractor during the project's early stages, since all the required input data consists of basic design parameters that are known during the preliminary study of each particular bridge. By allowing reliable cost estimates in a short time, the proposed computer-aided system represents a useful decision making tool.

## Keywords
Construction cost, Bridges, Estimation.

## 1. Introduction

Preliminary cost estimates are prepared before the completion of the project's design and are based on the conceptual design of the project at the stage when only its basic technologies are known (Hendrickson 1998). Early cost estimates for engineering projects are extremely important to all the major parties involved in the construction process, such as the projects' owners, designers, contractors and sponsoring organizations. They are vital for business unit decisions involving determination of the project's feasibility and commercial viability, potential project

screening through the comparison and financial evaluation of alternative projects, establishment of initial budgets and asset allocation. Even though conceptual cost estimates present the lowest expected accuracy, due to the limited available information, inaccurate cost estimates may lead to lost opportunities, wasted development effort and lower than expected returns (Oberlender and Trost 2001).

Bridge construction has substantially increased over the last decade. The need to improve transport infrastructure in order to facilitate the mobility of persons and goods, improve the territorial cohesion of the European Union, thus increasing competitiveness and employment, has been identified as a major goal by the European Commission. In the same time, rising ecological awareness requires an environmentally friendly design for motorways that overcome difficult geological terrains and by-pass city centres and archaeological sites. Since bridge construction has traditionally exhibited substantial overruns above estimated costs (Skamris and Flyvbjerg 1997), easy to use, inexpensive and reasonably accurate methods for preliminary cost estimating are necessary.

This paper addresses the need for reliable cost estimates for concrete road bridges during the early stages of the project and presents a computer-aided cost estimating system that relies on information known before the detailed plans and specifications are identified. The system uses material estimating models developed with regression analysis on actual data collected from recently constructed bridges and provides estimates of the material quantities and cost of all bridge elements.

## 2. Previous relevant cost studies and research

Cost estimating systems for motorway bridges are very limited, due to the difficulty of acquiring actual cost and structural information for completed projects. Most research efforts address the lack of actual data with computer-intensive theoretical resolutions that optimize the final design through a trial and error process. They concentrate mostly on the bridge superstructure and optimize its design conforming to specific specifications and using standard shapes and cross sections.

Aparicio et al. (1996) proposed a computer-aided design system for prestressed concrete highway bridges. The software starts from few geometrical data and provides the geometry of all bridge elements taking into account specific live load models, material properties and safety factors, as well as serviceability and resistance requirements. A review of expert systems pertaining to conceptual bridge design was presented by Miles and Moore (1991).

Several research studies address the design optimization of prestressed concrete road bridges' superstructures. Efforts by Sirca and Adeli (2005), Cohn and Lounis (1995) and Lounis and Cohn (1993) rely on theoretical resolutions in order to minimize the construction cost of the bridge superstructure. Sarma and Adeli (1998) presented a review of articles addressing cost optimization of concrete bridges.

On the other hand, Menn (1990) collected actual data from a sample of 19 motorway bridges built in Switzerland between 1958 and 1985. He developed a breakdown of the bridge construction cost into mobilization, accessories, substructure and superstructure and calculated the average values. Menn also presented material estimating models for bridge superstructures, which, combined with the proposed total cost breakdown, can lead to cost estimates for the bridge.

Based on a sample of 119 concrete bridges and overpasses constructed in Greece between 1999 and 2003 as part of the Egnatia Motorway, Fragkakis and Lambropoulos (2004) presented a breakdown of the actual bridge construction cost into earthworks, foundation, substructure, superstructure and accessories and proposed the average cost values for four major deck construction methods.

Cost estimates derived from theoretical design optimization models do not express actual construction and design experience and fail to address the changes that occur during the project's construction. These changes can absorb a significant amount of the available capital, thus leading to substantial cost overruns, especially for long-span bridges crossing difficult ground morphologies. To overcome this problem, it is crucial for the decision makers to have an early estimate of the final cost based on previous experience.

## 3. Concrete bridges of the Egnatia Motorway

Egnatia Motorway, a 680 km-long modern motorway, constitutes part of the Trans-European Network for Transport. Its bridges were mostly constructed between 1996 and 2008. The largest overall bridge length exceeds 1000 m. and the largest single span reaches 235 m. The design of bridges was conducted by Greek or international structural design offices according to the German DIN standards. Concerning the earthquake loading, the Greek Seismic Regulation for Design of Bridges (E39/99) combined with the Greek Standard for Design of Earthquake Resistant Structures (EAK 2000) was utilized.

## 4. Proposed method for pre-design cost estimates

The proposed computer-aided cost estimating system for prestressed concrete road bridges involves two stages: the estimation of the material quantities of all major bridge elements and the calculation of the relevant construction costs. The first stage is based on material estimating models derived from the statistical analysis of the collected actual data. The second stage derives the construction costs by multiplying the estimated quantities with the unit prices for materials. The system also uses the average cost values proposed by Fragkakis and Lambropoulos (2004).

### 4.1 Material estimating models

#### 4.1.1 Bridge foundation and superstructure

The proposed cost estimating system uses different material estimating models for the superstructure, the piers and the foundations. Concerning the bridge foundation, the material estimating models and the rule-based expert system for the selection of the foundation type presented by Fragkakis et al. (2009) are used. The material estimating models for the superstructure proposed by Fragkakis and Lambropoulos as part of an ongoing research are also embedded in the cost estimating system.

#### 4.1.2 Bridge piers

The design of a bridge pier is generally affected by the seismic design parameters, the pier height ($h$), the length of the deck supported by the piers ($l_s$) and the deck width ($b$). Since the majority of the construction projects (85 % of the data

sample) has been designed with similar seismic parameters, the authors decided to exclude this parameter from the analysis and consider only the aforementioned three independent variables. The length of the deck supported by each pier was calculated as the average of the length of the two spans adjacent to the pier. The volume of concrete ($V_c$) and the weight of reinforcing steel ($B_s$) represent the two dependent variables.

A linear model was considered for regression modeling in this study. The analysis approach includes a statistical hypothesis test to determine the significance of each independent variable coupled with the check of the rationality of the cause and effect relationships and the theoretical accuracy of the regression coefficients.

The database includes complete data for 322 bridge piers. The Pearson product-moment correlation coefficients for the independent variables, as well as the variance inflation factors and the tolerance, are given in Table 1. They reveal that even though the length of the deck presents correlation with the height of the pier, the variance inflation factor does not indicate a problem due to multicollinearity.

| | b | $l_s$ | h | Tolerance | VIF |
|---|---|---|---|---|---|
| b | 1.000 | | | 0.859 | 1.164 |
| $l_s$ | -0.045 | 1.000 | | 0.590 | 1.694 |
| h | -0.214 | 0.582 | 1.000 | 0.619 | 1.617 |

**Table 1.** Correlation coefficients, tolerance and Variance Inflation factor for piers.

The correlation coefficients also indicated that the deck width presents a minor impact on the material quantities for both cases. As a result, in order to simplify the regression analysis, the adjusted length of deck was defined as following:

$$l_{sadj} = l_s \times \left( \frac{b}{b_{med}} \right) \quad (1)$$

where $l_{sadj}$ is the adjusted length of deck, $l_s$ is the length of deck supported by the piers, $b$ is the deck width and $b_{med}$ the median value of the deck width that equals 13.00 m. The examined regression model was in the following form:

$$Y = a + \beta_0 \times h + \beta_1 \times l_{sadj} \quad (2)$$

where $Y$ represents the dependent variable ($V_c$, $B_s$ ).

Regression statistics, including the adjusted coefficient of determination ($R^2$), the significance and value of the F-test and the p-values for the independent variables are presented in Table 2. They highlight the goodness of fit and the statistical significance of both the regression model and the independent variables at a 1 % significance level. The following equations provide predesign material estimates for the volume of concrete and the weight of reinforcing steel for piers of concrete bridges:

$$V_c = -119.038 + 9.779 \times h + 2.611 \times l_{sadj} \quad (3)$$

$$B_s = -39706.679 + 1863.910 \times h + 880.240 \times l_{sadj} \quad (4)$$

The above material estimating models are valid for values of pier height between 9.18 m. and 87.83 m. and adjusted length of deck between 26.00 m. and 220.40 m.

| | $V_c$ | $B_s$ |
|---|---|---|
| $l_{sadj}$ | 1.7E-19 | 2.7E-57 |
| h | 4.8E-46 | 2.1E-56 |
| $R^2$ | 0.723 | 0.849 |
| F-Value | 419.540 | 903.411 |
| F-Significance | 4.9E-90 | 4.1E-132 |

**Table 2**. P-values, $R^2$ and values for F-test for bridge piers

The $R^2$ values range from 72 % to 85 %, indicating that the proposed models provide a satisfactory fit to the data. The estimated p and F values also verify that the independent variables and the selected regression models are statistically significant, while the regression coefficients present theoretical correctness.

The correct application of the linear regression methodology requires the error term of the model to be normally distributed, have a mean value of zero and a constant variance (Gujarati 1999). The pattern of the residual plots indicated the sufficiency of the regression models. The assumption of normality was also tested with the use of the Shapiro-Wilks test (Analyse-it Software Ltd. 2009). The p-values were calculated for each sample of residuals and verified the normality assumption of the error terms at a 5 % level of significance. Furthermore, the mean value of the residuals approached the value of zero.

Despite the presence of heteroscedasticity in both samples indicated by White's test (White 1980), the ordinary least squares estimators remain unbiased, consistent and linear (Gujarati 1999) and the computed regression coefficients retain their validity. On the other hand, the estimates of the variances are biased, thus invalidating the tests of significance. White's corrected standard errors were chosen to adjust for heteroskedasticity. The "HC3" corrected standard errors according to Long and Ervin's (2000) recommendation and the relevant p-values were calculated for both cases and verified the statistical significance of the independent variables.

## 5. Proposed cost estimating system

### 5.1 System characteristics and assumptions

The proposed system offers the following alternatives for deck superstructures and construction methods:

- precast prestressed simply-supported concrete beams placed by launching beam or crane and composite reinforced concrete slab;
- single and multispan cast-in-situ box girders;
- box girders with variable cross section depth constructed with the cast-in-situ balanced cantilever method.

The system uses reinforced concrete piers and offers the following alternatives for pier foundations:

- Shallow reinforced concrete spread footings;

- Deep foundations consisting of cast-in-situ piles connected with a reinforced concrete pile cap;
- Deep foundation consisting of reinforced concrete sockets.

## 5.2 Data input

The user has to enter the following data for each bridge:

- General information, such as name, id, location, highway, section and kilometer position;
- Basic design data, such as length, width and number of spans;
- Length of each span and deck construction method;
- Height for each pier;
- Specific foundation type for each pier or provide the ground type and reply to selection criteria in order to use the automated rule-based expert system for the selection of the foundation type;
- Unit prices for materials.

All the required input data consists of basic parameters that are known during the pre-design stages of the project. Based on contour maps and the alignment and specifications of the motorway under evaluation, the user calculates the length and width of the bridge and the length of the spans.

## 5.3 Results

The system produces the following results:

- Material quantities for the bridge deck, the piers and their foundations, both individually for each element and cumulatively, and relevant parametric ranges.
- Cost estimates for the bridge foundations, substructure, superstructure and accessories and relevant parametric ranges.

## 5.4 Case example

The case example involves a prestressed concrete motorway bridge with a total length of 200.00 m., 5 spans of equal length and deck width 13.00 m. The bridge deck includes precast prestressed simply-supported concrete beams placed by launching beam and composite reinforced concrete slab. Data input involves three stages:

- The user first enters the general information for the bridge.
- He is then directed to complete the length and construction method for each span.
- The final stage requires information for each pier. The user enters the pier height and can either designate the foundation system or define the ground type and reply to selection criteria in order to use the automated rule-based expert system for the selection of the foundation system.

Figure 1 displays the data for the piers of the case example. For example, pier 1 has a height of 12.58 m. and ground type categorized as $IB_1$. Since its foundation lies in a steep slope, the system automatically proposes the use of socket foundation. For pier 3, the existence of the river bed leads to the use of piles.

After completing the data input, the system displays the material quantities cumulatively for each foundation type, the substructure and the superstructure of the bridge as presented in figure 2. The user can also examine the material quantities for each bridge element separately and the relevant parametric ranges.

The system also produces cost estimates for the bridge and prompts the user to enter the unit prices for the materials. It displays the breakdown of the total cost in foundations, substructure, superstructure and accessories and offers the option to present the cost estimates analytically for each element and the parametric ranges.

## 6. Conclusions

The proposed computer-aided cost estimating system allows in a short time reliable conceptual cost estimates for prestressed concrete road bridges. It offers alternatives for major foundation types, deck types and construction methods and can be easily used during the early stages of the project. The system represents a useful decision making tool for the project's design engineer, owner and contractor by allowing easy comparative studies from both technical and economical viewpoints among different alternatives.

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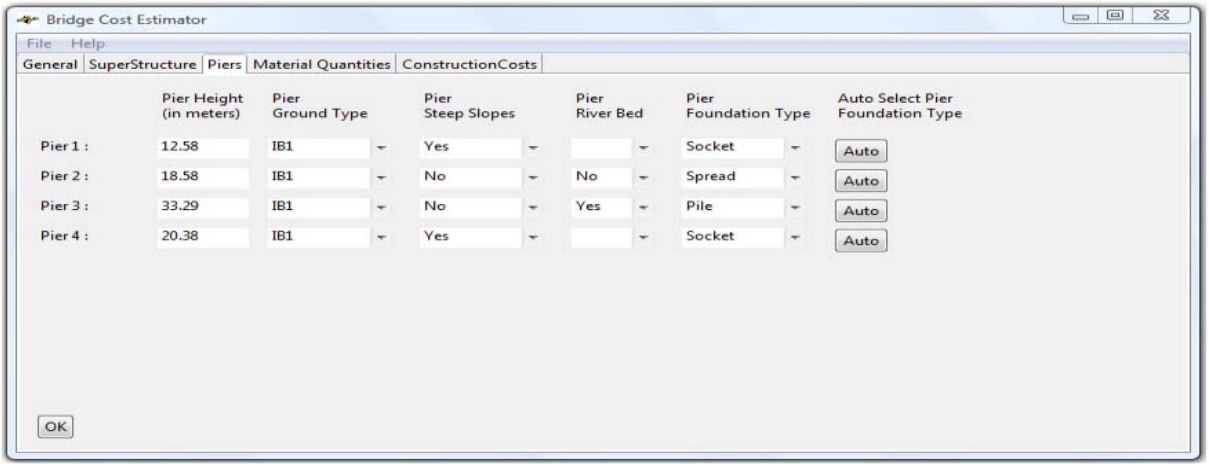


**Fig 1**: Data input for the piers of case example

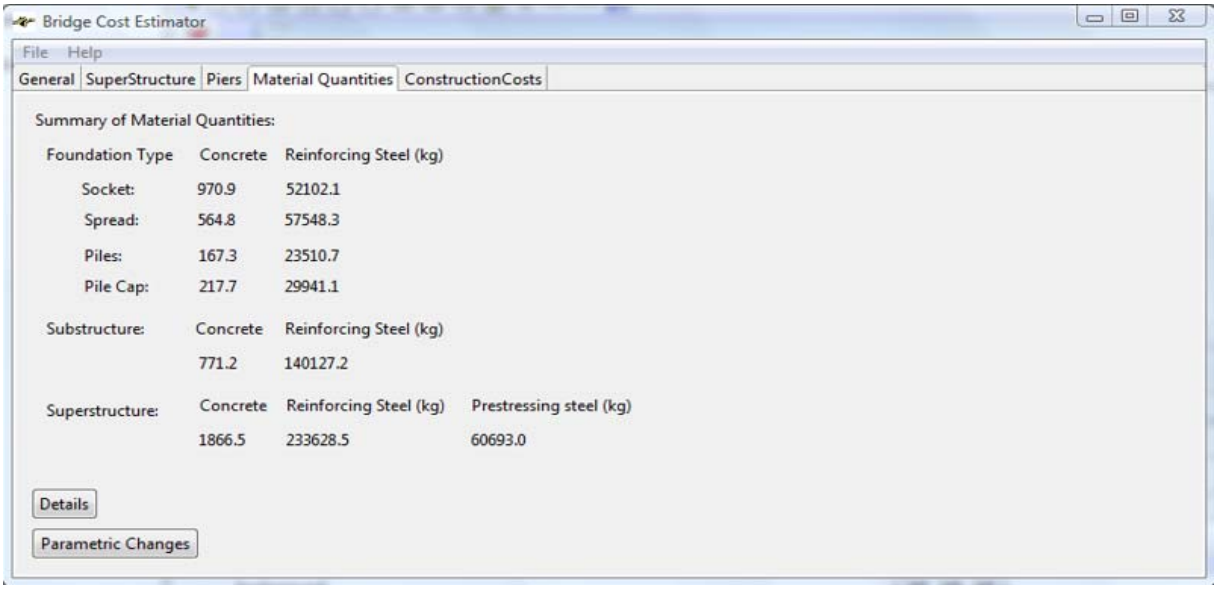


**Fig 2**: Material quantities of case example

*AA074*

# Implementation Of The Entropy Concept on Construction Projects Under Financial Constraints

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## Abstract
The paper investigates the relationship between entropy (disorder) and financially-constrained projects, through a case-study project (a highway project in Cyprus). The work builds on previous and ongoing research at the University of Cyprus and at the Democritus University of Thrace. A number of mathematical models describing the aforementioned relationship are developed, with an emphasis on the effect of financial disorder on the progress of a project. The purpose of this endeavour is to optimize the allocation of the monetary resources to the project activities in such manner that will produce a lower measure of financial entropy and a higher profit. Modelling and evaluation of the proposed method is performed by use of commercially available software. The entropy-based approach results in an optimal solution that satisfies the initially stated purpose of simultaneously reducing the level of entropy and increasing the profitability of the project.

## Keywords
Unbalanced bidding, Entropy, Resource - constrained scheduling

## 1. Introduction

The increase in the number, size and complexity of construction projects has stimulated heightened interest in construction technology and management techniques for the proper development of construction projects. Consequently, construction companies are in a continuous endeavor to deal with the problems that arise due to the lack of organisation and coordination. Therefore, the invention of innovative solutions that will contribute to the optimization of projects and the improvement in their management, the observance of time schedules, the improvement of cashflow and the achievement of high standard production are really important.

The main problem during the construction of a project appears to be the constraint in available resources (human, equipment, financial, etc.). Particularly, indicative problems that may arise in a project under financial constraints are the delay in payments, insufficient financing, negative cashflow and a difficulty in the allocation of monetary resources to all the activities scheduled. The above can create consecutive difficulties and affect the total progress of works. It is for this reason, among others, that project schedules need to include not only time assignments

(activity durations) but also resource assignments (including cost) for all project activities, including the corresponding resource constraints.

Generally, resource-constrained scheduling problems (RCSP) give rise to many related difficulties, that increase significantly with the increase of the number in a project's activities. Several methologies for solving RCSP have been developed to-date. Most of them use a combination of implicit enumeration [Brucker and Knust (2003), Mingozzi *et al*. (1998), Crawford (1996), Garey *et al*. (1976)] and heuristic techniques [Brucker *et al*. (1998), Primavera Systems (2001), Microsoft Corporation (2000)], intelligent branching and evaluation techniques such as mathematical programming, dynamic programming (Carruthers and Battersby, 1966), zero-one programming (Patterson, 1984), artificial agent techniques such as genetic algorithms (Hegazy, 1999) and ACO algorithms [Christodoulou (2005), Christodoulou (2007)].

The aim of this paper is to provide an optimization method for the allocation of monetary resources to each activity in order to reduce the disorder and the possible risk that exists during planning and constructing, and to increase the profitability of a project by use of an alternative method. The utilized method makes use of the entropy concept, for which the term of Monetary Entropy ($H_M$) is introduced, in conjunction with the unbalanced bid method in order to meet the aforementioned goal. The method builds on work by Christodoulou et al. (2008a,b; 2009a,b,c). An entropy reduction of at least 5% with a related minimum increase in net present value (NPV) of at least 1% is also set as a goal (maximize NPV ∩ Limit Entropy).

## 1.1 Monetary entropy

Entropy $H_x$ is considered to be a metric of a system's order and stability and has been applied in recent years to a wide range of sciences. It can be mathematically evaluated as the product of the probability distribution ($p_x$) of a variable x, times the natural logarithm of the inverse of that probability distribution:

$$H_X = p_X * \ln (1/p_X) \text{ ή } H_X = -p_X * \ln(p_X) \quad (1)$$

The definition of the entropy metric in the field of construction management is derived from its classical formula, and the monetary entropy $H_{Mx,r}$ can be defined and calculated through the following equation:

$$H_{Mx,r} = p_r * \ln (1/p_r) \quad (2)$$

where $p_r$ is the bid markup of an activity (=1.0 + profit percentage). The higher the value of entropy is, the more chaotic an activity is expected to be. The produced system disorder may be described as:

- Negative project cashflow that can lead to delay in payments affecting the time schedule, the quality and the productivity of the project or its self-financing
- Uncertainty for the estimated bare cost of the activities (it can be increased due to external factors such as material reevaluation, equipment failure)
- Difficulty in administrating big amounts of money and assigning them to each activity properly

- Reduced possibilities for a contractor to undertake the project because of the deviation from the implementation of classical methods (balanced bid etc.)

## 1.2 Unbalanced Bid Method

In their effort to reduce the negative consequences of delay in payments, self-financing and financial constraints, construction companies often apply the unbalanced bid method in order to secure a positive cashflow. In fact, bid-unbalancing can be thought of as a means to maximize the NPV of the project payments by varying the bid prices of the individual bid items (within acceptable limits). According to its classical definition, bid-unbalancing is a process by which the overall project actual cost and the project profit are intelligently distributed among the project without affecting its total bid price. The method of unbalanced bid can be explained by the following equation:

$$\text{Max}\{NPV_P=\Sigma[(V_x)(P/F,\ i\%,\ t)]\} \quad (3)$$

with $NPV_P$ being the net present value of the project; $V_x$ the value (actual cost plus overhead and profit) of activity x; $(P/F,\ i\%,\ t)$ the single payment factor for the present value (P) of a future payment (F) made at time t, assuming an interest rate i%.

## 1.3 Monetary Entropy-based Bid-unbalancing

A project planner should not only examine the financial assignments that maximize the activity or the project profitability but also the assignments that minimize the system's tendency to fall into disorder.Therefore, a revision of the bid-unbalancing problem in terms of entropy would be the examination of the percentage of the overall bid amount that should be assigned to an activity so as to maximize the project's NPV while minimizing the project's monetary entropy (subject to a specified financial limitation). Thus, the optimization given by the equation (3) can be formed as followed:

$$\text{Min}\{\ H_{Mx,r} = \Sigma(H_{Mx,r}) = \Sigma[p_{x,r} \ln (1/p_{x,r})]=\} \quad (4.1)$$

$$\text{Max}\{\ NPV_P = \Sigma\ [(V_x)(P/F,\ i\%,\ t)]\} \quad (4.2)$$

subject to: $\Sigma\ (V_x) \le B_P \quad \& \quad V_x,\ B_P > 0$ (4.3)

$$a.r_p \le b_x \le \beta.\ r_p \quad (4.4)$$

$$H_{Mx,r} \ge 0 \quad (4.5)$$

with $H_{Mx,r}$ being the monetary entropy of activity x caused by a bid markup of value r; $NPV_P$ being the net present value of the project; $V_x$ the value (actual cost plus overhead and profit) of activity x; $(P/F,\ i\%,\ t)$ the single payment factor for the present value (P) of a future payment (F) made at time t, assuming an interest rate i%; $r_p$ and $r_x$ the project and activity markup respectively; $B_p$ the total bid price for the project; $a.r_p$ and $\beta.\ r_p$ the lower and upper limits from which an activity markup can be selected with respect to the total bid markup.

## 2. Methodology

The methodology presented in this paper combines the concept of monetary entropy with the unbalanced bid method, in a single-criterion methodology under constraints and includes the following steps:

- Develop and solve the project network (Critical Path Method), calculating the early start/finish and late start/finish dates of every project activity (in Primavera Project Planner or Microsoft Excel)
- Evaluate the cost for each activity ($C_x$) and the total bare cost of the project ($C_p$),
- Introduce the balanced-bid project markup ($r_p$) as the ratio of bid price ($B_p$) over total bare cost ($C_P$),
- Define the economical parameters of the project: The total bid price ($B_p$) and the financing interest rate ($i\%$)
- Establish the upper and lower limits in which the activity markup can range (this should be based on the constraint that the combined effects of the unbalanced-bid activity markup must not exceed the original project bid price, $B_p$),
- Assume a probability distribution for the assigned activity bid mark-ups. Typically, this can be a normal distribution with mean equal to the balanced-bid project markup (eg. 1.20, assuming a 20% profit) and a related standard deviation (eg. equal to 10% of the mean),
- State the monetary entropy equations ($H_{Mx,r}$) for each activity $x$ (in Microsoft Excel)
- Use commercially available simulation software (Crystal Ball, Crystal Ball's Optquest) to simulate the behavior of the network under resource and entropy constraints to obtain the following results:
    - the resulting activity monetary values ($V_x = r_x * C_x$)
    - the probability value for the examined activity bid markup
    - the activity monetary entropy ($H_{Mx,r}$)
    - the project monetary entropy ($H_M$)
    - the project cashflow and the N.P.V (Net Present Value) in different time periods
- Identify the simulation with the lower total monetary entropy of the project along with the combination of activity bid markups that produce the lower entropy. Furthermore, identify the combination that produces the maximum NPV and the desirable conjunction of both reduced entropy metric and increased NPV.

Primavera Project Planner (P3) and Crystal Ball (v7.2) are both commercially available softwares. P3 addresses resource-constrained scheduling by means of resource leveling and schedules an activity only when the activity's resource demands can be met. Crystal Ball is a forecasting and risk analysis software which works in the MS Excel environment processing data with connected relationships through a simulation process. Solution of the aforementioned entropy optimization problem required the execution of a large number of simulations (using different parameters each time).

## 2.1 Notes and Assumptions

The assumptions used in this paper consider mainly economic parameters. The parameters considered are:

- The contractor's profit is designated to 20%. Of course it will undergo changes through the implementation of the unbalanced bid method. Therefore, the initial bid markup will be equal to 1.20.
- The standard deviation during the simulations (normal, triangular distribution) is 0.12.
- The interest rate is i=12% and it is assumed that the contractor will get paid at the end of each month
- Every activity is paid one month after its completion
- In the monetary entropy equation (1) $p_x$ defines the bid markup which is the price of actual cost plus the profit divided with the actual cost.

## 3. Case Study

The project studied in this paper refers to the construction of 4km highway in Cyrpus with 2+2 lanes. The project schedule consisted of 502 activities with a minimum project duration of 335 working days. The total cost of the project runs into 4.117.664€ which leads to a total bid price of 4.941.197€ (profit set at 20%). Furthermore, the original-schedule NPV for the total bid price is 4.495.818€ (according to the aforementioned assumptions) and the project monetary entropy equals $H_M$=109.83.

The simulations executed, referred to the separate implementation of decision variables, normal distribution and triangular distribution on the values of the bid markup with different objective each time (maximum NPV or minimum $H_M$).

## 3.1 Decision Variables

Initially, a number of 110,000 trials were executed in order to optimize the bid markup value and to minimize the disorder produced during the project. The objective as shown in Fig. 1 was to minimize the total project entropy whilst satisfying the constraint of not exceeding the total bid price. The value of the decision variable (bid markup) can range from 0.9 to 1.3. The minimum obtained entropy is $H_M$= 90.64 which is quite lower than the initial number (109.83). The obtained NPV for the particular simulation is 4.458.870€ giving a reduced profitabilty of 36.948€.

| Select | Name | Forecast Statistic | Lower Bound | Upper Bound | Units | WorkBook | WorkSheet | Cell |
|---|---|---|---|---|---|---|---|---|
| Requirement | Bid Price | Mean | 4900000 | 4941197 | Euro | bidmarkupdecisionvar-minimize entropy.xls | SUCCESSORS | $AE$504 |
| Minimize Objective | TotalProfitEntropy | Mean | | | Entropy | bidmarkupdecisionvar-minimize entropy.xls | SUCCESSORS | $AF$504 |
| No | NetPresentValue | Mean | | | Euro € | bidmarkupdecisionvar-minimize entropy.xls | SUCCESSORS | $AG$504 |

Fig. 1. Case study entropy-minimization objective

The subsequent simulation of 110,000 trials aims to maximize the project's NPV as shown in Fig. 2. It is also subject to the constraint of not exceeding the total bid price.The combination of bid markups produce a value of NPV equal to 4.506.728€ which is 10.909€ (1.87%) higher than the original. The observed measure of

entropy is 136.50 which indicates a relatively high degree of disorder in the construction process.

| | Select | Name | Forecast Statistic | Lower Bound | Upper Bound | Units | WorkBook | WorkSheet | Cell |
|---|---|---|---|---|---|---|---|---|---|
| | Requirement | bid price | Mean | 4900000 | 4941197 | euro | bidmarkdecision4-max NPV.xls | SUCCESSORS | $AE$50 |
| | No | TotalProjectEntropy | Mean | | | Entropy | bidmarkdecision4-max NPV.xls | SUCCESSORS | $AF$50 |
| ▶ | Maximize Objective | NPV | Mean | | | EURO | bidmarkdecision4-max NPV.xls | SUCCESSORS | $AG$50 |

Fig. 2. Case study NPV-maximization objective

The final simulation set, utilizing decision variables, includes 60,000 trials and intends to maximize the NPV while simultaneously reducing the monetary entropy $H_M$. In this case, the monetary entropy value cannot be lower than 90 while the NPV-related objective remains the maximization of NPV. The best result recorded satisfies the desired target giving a NPV value equal to 4.501.090€ and an entropy value equal to 103.19. In terms of percentage, a profit increase of 1.17% is obtained together with a decrease in entropy of 6.44%.

| | Select | Name | Forecast Statistic | Lower Bound | Upper Bound | Units | WorkBook | WorkSheet | Cell |
|---|---|---|---|---|---|---|---|---|---|
| ▶ | Maximize Objective | NetPresentValue | Mean | | | Euro € | decvar_4.xls | SUCCESSORS | $AG$504 |
| | Requirement | Bid Price | Mean | 4900000 | 4941197 | Euro | decvar_4.xls | SUCCESSORS | $AE$504 |
| | Requirement | TotalProfitEntropy | Mean | 90 | 105,5 | Entropy | decvar_4.xls | SUCCESSORS | $AF$504 |

Fig. 3. Case study entropy and NPV joint objectives

### 3.3 Normal Distribution of bid markup value

For the particular simulation a number of 30,000 trials is performed using the bid markup value assumed to be normally distributed and equal to 1.20 (20% profit) and its standard deviation being equal to 10%. The maximum NPV value achieved is 4.500.456€ while the monetary entropy value is $H_M$=116.17. On the other hand, the minimum value of monetary entropy recorded through normal distribution is $H_M$=103.81 with the value of NPV=4.474.224€. The obtained increase in the number of maximized NPV is 1.03% compared to the balanced bid method, whilst in the value of total project entropy there is an increase of 5.77%. With regards to the minimum value of monetary entropy, it is decreased by 5.85%, whereas the projects profit depicts a 4.83% meiosis.

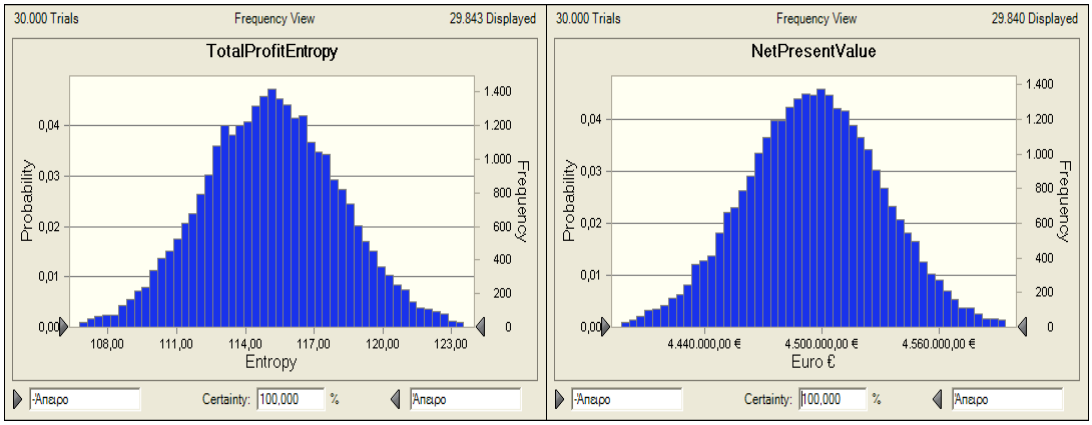


Fig. 4. Case study monetary entropy and NPV distributions

## 3.4 Triangular Distribution of bid markup value

Simulations based on triangularly distributed bid-markups were also executed. For the specific scenario a number of 30,000 trials is performed using a bid markup value of 1.20 (20% profit) with the standard deviation being equal to 10%. The maximum NPV value achieved is 4.497.676€, while the monetary entropy value is $H_M$=108.45. On the other hand, the minimum value of monetary entropy recorded through normal distribution is $H_M$=104.90 with the value of NPV=4.479.361€. The obtained increase in the value of maximized NPV is 0.32% compared to the balanced bid method, whilst in the value of total project entropy there is a decrease of 1.27%. With regard to the minimum value of monetary entropy, it is decreased by 4.70% whereas the project's profit depicts a 3.67% meiosis.

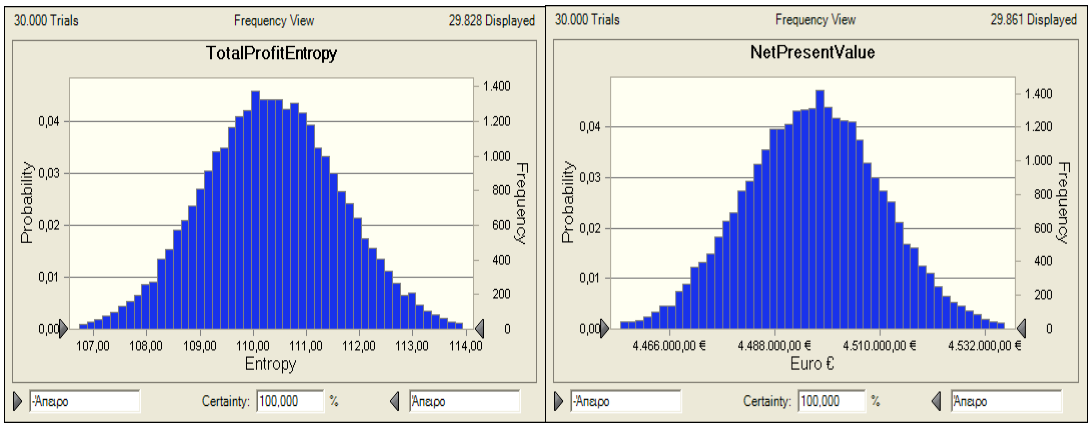


Fig. 5. Case study monetary entropy and NPV distributions

The results of all scenarios are summarized in Table 1.

Table 1. Summary of simulation results

| | NPV | Entropy | Bidprice |
|---|---|---|---|
| **Decision Variables (max NPV)** | 4.506.728 € | 136,50 | 4.941.197 € |
| **Decision Variables (min Entropy)** | 4.458.870 € | 90,64 | 4.900.839 € |
| **Decision Variables (max NPV ∩ Limit Entropy)** | 4.501.090 € | 103,19 | 4.941.196 € |
| **Normal Distribution (max NPV)** | 4.500.456 € | 116,17 | 4.941.189 € |
| **Normal Distribution (min Entropy)** | 4.474.224 € | 103,81 | 4.919.572 € |
| **Triangular distribution (max NPV)** | 4.497.676 € | 108,45 | 4.941.150 € |
| **Triangular distribution (min Entropy)** | 4.479.361 € | 104,90 | 4.908.443 € |
| **Balanced Bid** | 4.495.819 € | 109,83 | 4.941.197 € |

## 4. Conclusions

The methodology presented in this paper considers the effects of financial disorder that arise due to the uncertainty of the project monetary resource allocation and

the cashflow. Furthermore, the unbalanced-bid method is a complex problem that demands complex optimization calculations. In the particular case study an important decrease in the metric of entropy (6,44%) was achieved with the use of decision variables compared to the classical method of balanced bid. This optimized solution provided also an increased profitability for the project(1,17%). The above may be interpreted as minimized monetary disorder and optimized cashflow that enhance the sequence of work in the project and the final result.

The innovative element of this paper stems from the fact that it manages to combine decreased financial risk with increased profitability during a project. The advantages of this methodology will be more visible when applied in projects with longer duration for completion. Finally, a future correlation of this methodology with the human-resource allocation entropy is proposed.

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*INV3*

# Designing Project & Programme Organizations

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## Projects & Programmes: Agenda

- **Processes, Projects, Programmes**
- Project Management
- Project Organization
- Programme Definition & Case Study
- Programme Management
- Programme Organization

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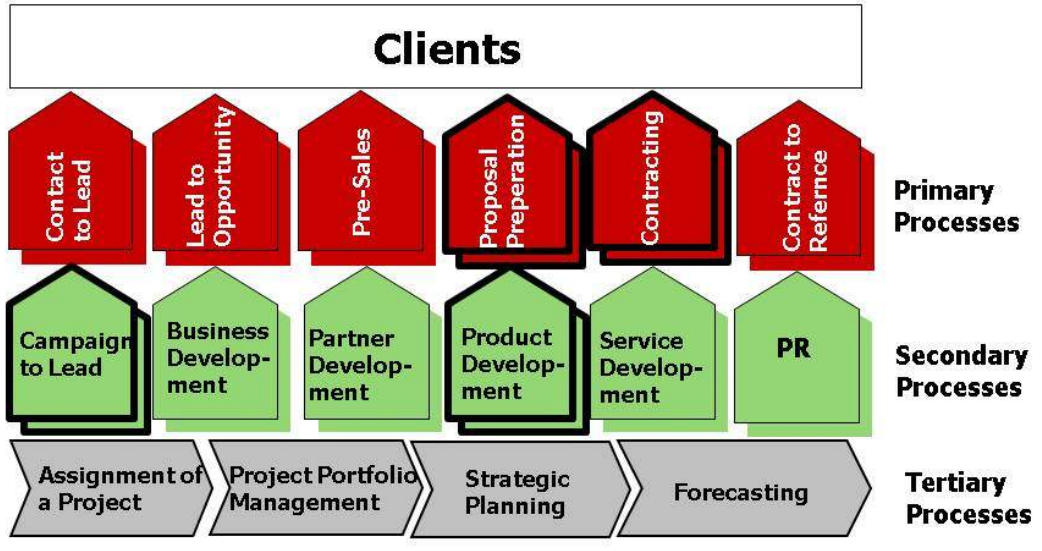
## IT Company: Map of Processes

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## Organizations for the Performance of Processes

| Characteristics of Processes | Scale | | |
|---|---|---|---|
| Frequency | continuously | uniquely | uniquely |
| Duration | short term | short-, medium term | medium-, long term |
| Importance | low | medium – high | high |
| Scope | small | medium – large | large |
| Resource demand | low | medium | high |
| Costs | low – medium | medium – high | high |
| Companies involved | few | several - many | many |
| ↓ | ↓ | ↓ | ↓ |
| Organisation form | Permanent organisation | Project | Programme |
| ↓ | ↓ | ↓ | ↓ |
| Management approach | Process management | Project management | Programme management |

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## Example: Project Definition of an IT Company

| Criterion | Line Organization | Small Project | Project | Programme |
|---|---|---|---|---|
| Strategic Importance | Small: NPV<€ 50.000 | Small/middle NPV>€ 50.000 | Middle/high NPV>€ 100.000 | High: NPV>€250.000 |
| Scope of work of external projects | Small: e.g. IT consulting service | Small/middle: e.g. SW development | Middle/high: e.g. SW development & implementation (one site) | High: SW development & implementation (several sites) |
| Duration | < 10 weeks | > 2 months | > 4 months | > 12 months |
| Organizational units | < 4 | 4 or more | > 7 | > 10 |
| Resources | > 100 person days | > 100 person days | > 200 person days | > 500 person days |

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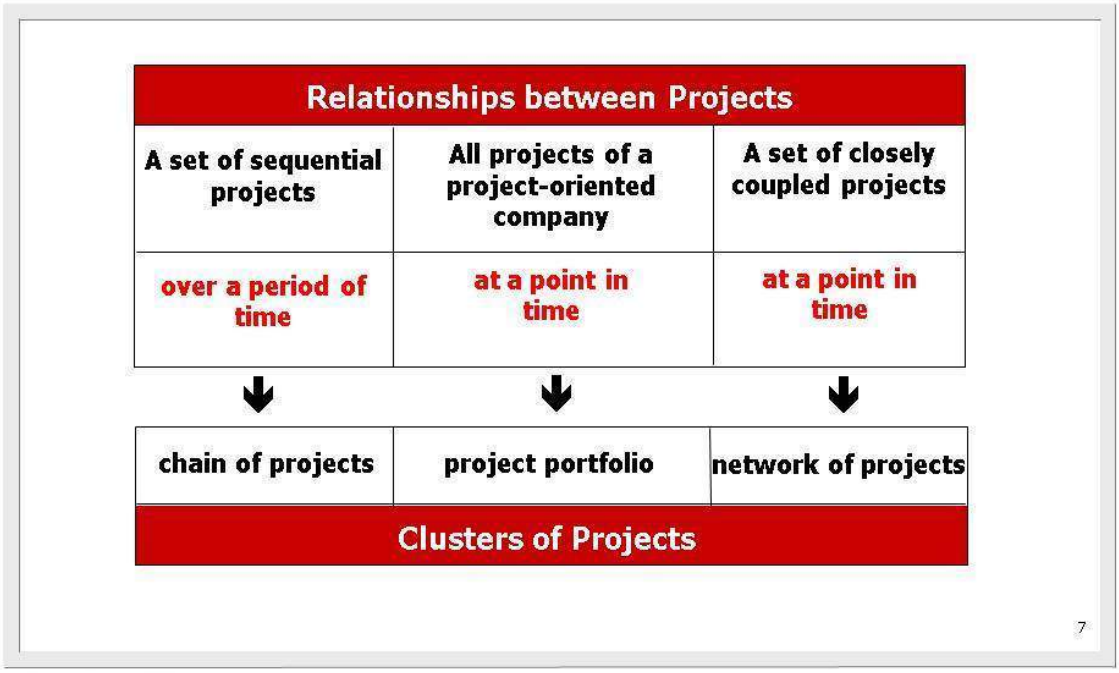
## Clusters of Projects

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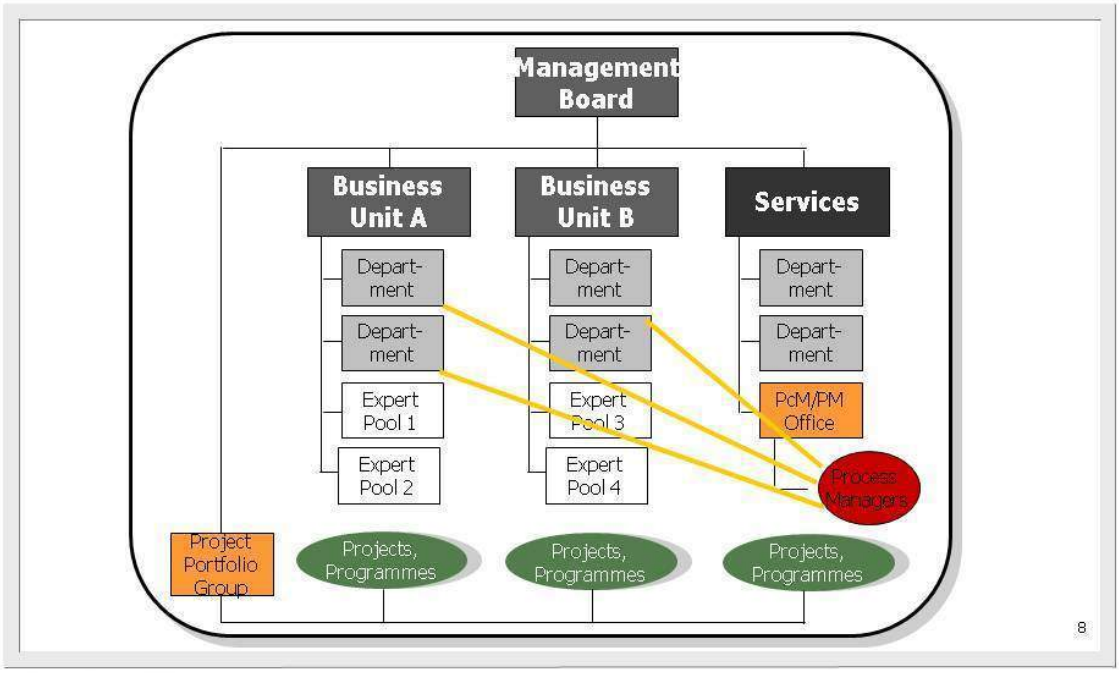
## Project-oriented Company

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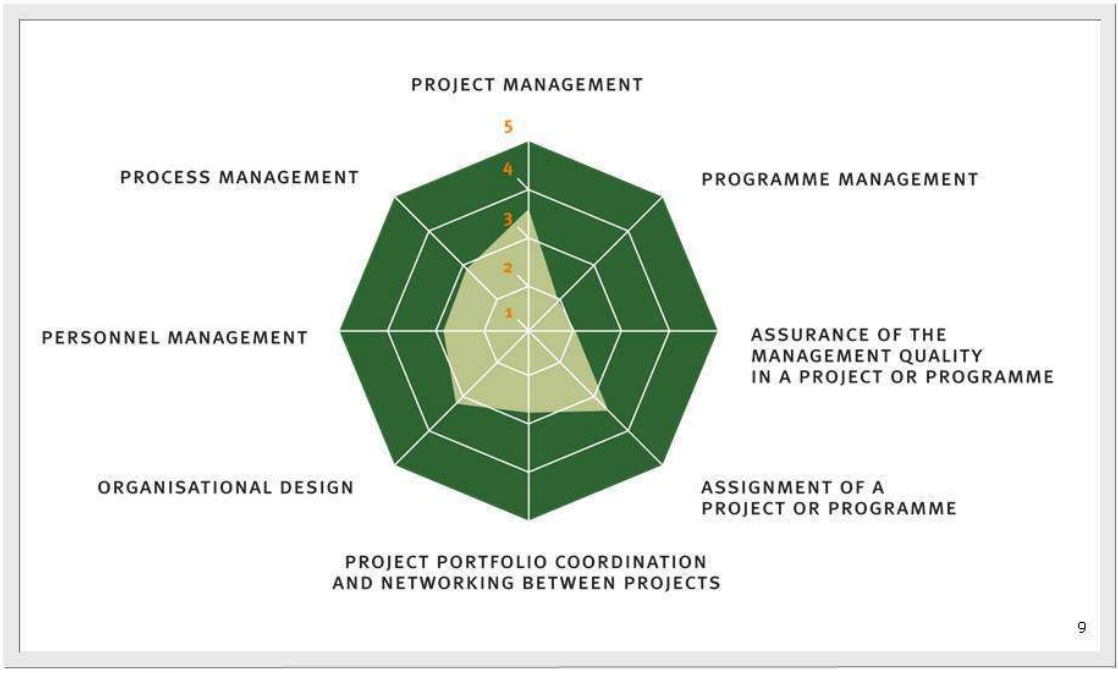
## company *mature*

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## Projects & Programmes: Agenda

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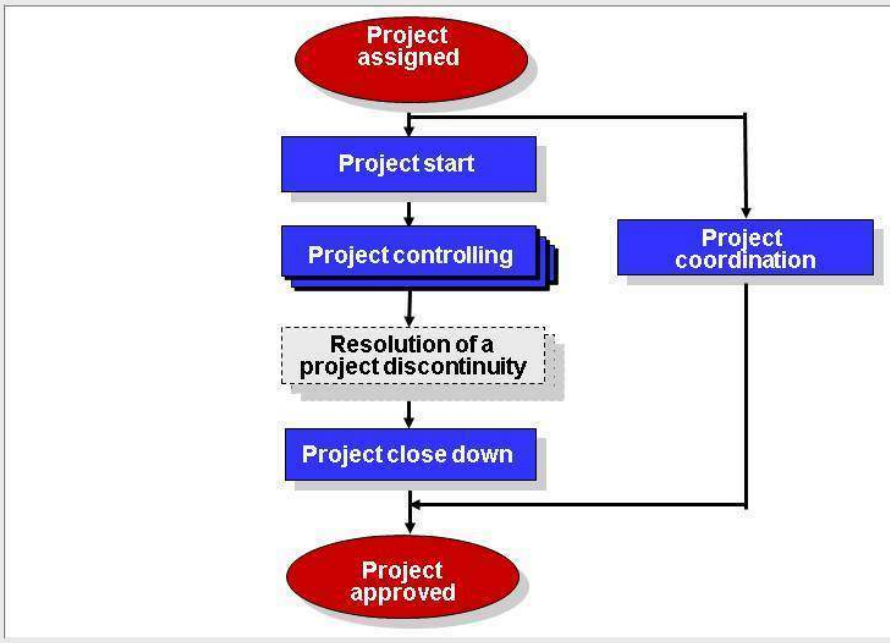
## Project Management Process

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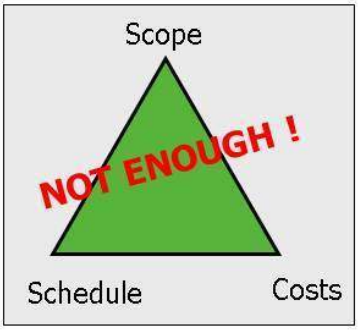
## Project and Programme Management: Objects of Consideration




- Scope, schedule, costs, and ...
- Objectives, resources, income, risks
- Organization, culture, personnel, infrastructure
- Context: Pre-, post-project phase, relevant environments, other projects, company strategies, business case

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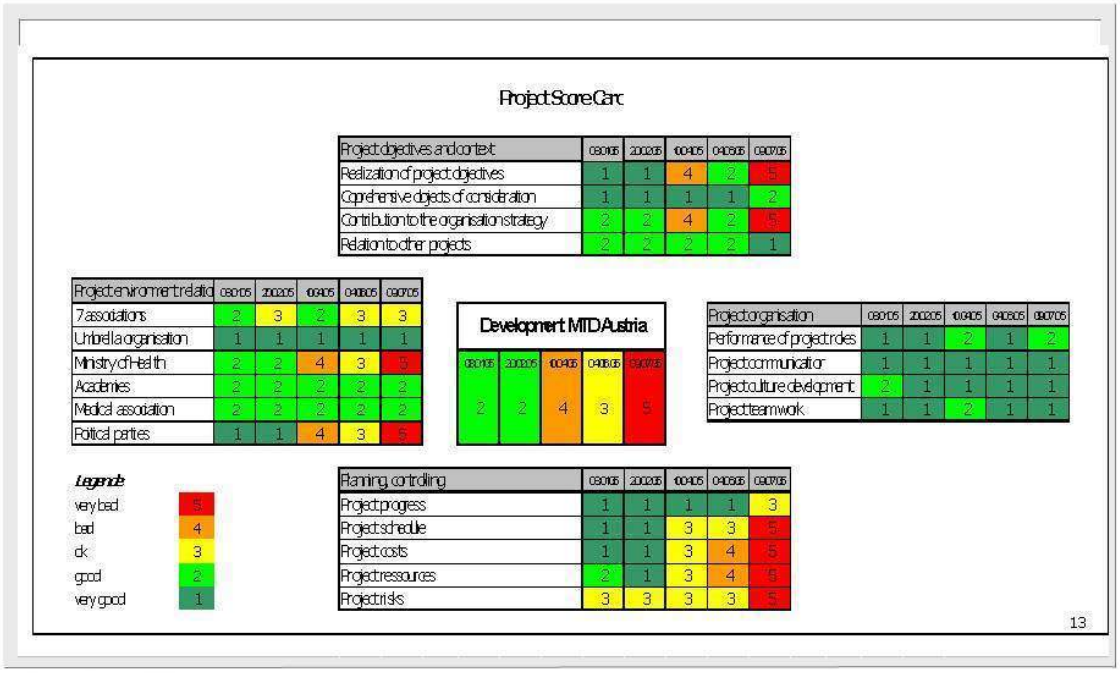
## Example: Project Score Card

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## Application of Project Management Methods

| Application of methods in the project start process | Small Project | Project |
|---|---|---|
| **Planning Methods** | | |
| Project objectives plan | must | must |
| Objects of consideration plan | can | must |
| Project work breakdown structure | must | must |
| Project work package specification | can | must |
| Project bar chart | must | must |
| Project finance plan | can | can |
| Project cost plan | must | must |
| Business case analysis | can | must |

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## Multi-Methods Approach

- Different methods to cope with the project complexity, to assure project management quality
- Differentiated application of project management methods
  - number of methods, „must" and „can"-methods
  - different levels of detail
- Assurance of project management quality by relating methods to each other
- Compatible structures allow to integrate the results of different project management methods (e.g. WBS)

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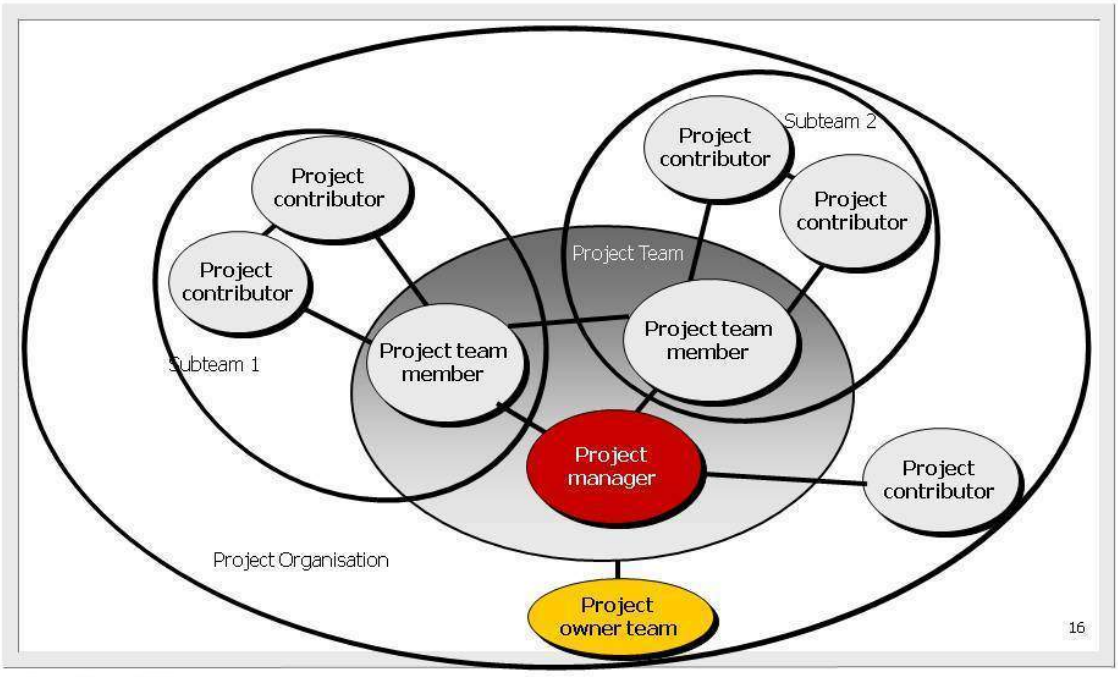
## Project Organization Chart

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## Role: Project Manager

**Objectives**

- Realizing the project objectives and the business case objectives
- Directing the project team and the project contributors
- Representing the project to relevant project environments
- Preparing and adapting of the project management documentation

**Organizational position**

- Reporting to the project owner team
- Member of the project team

**Tasks**

**Tasks in the project start process**

- Performing the project start process: Know-how transfer from the pre-project phase in the project, together with project team members and the project owner team
- ....

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## Role: Project Owner Team

**Objectives**

- Coordinating of project and company interests
- Assigning and supporting the project team
- Directing the project manager

**Organizational position**

- Member of the project organisation
- Project manager reports to the project owner team

**Tasks**

**Tasks in the project start process**

- Selecting the project manager and some project team members
- Agreeing about the project objectives with the project team
- Contributing to the construction of the project context
- .....

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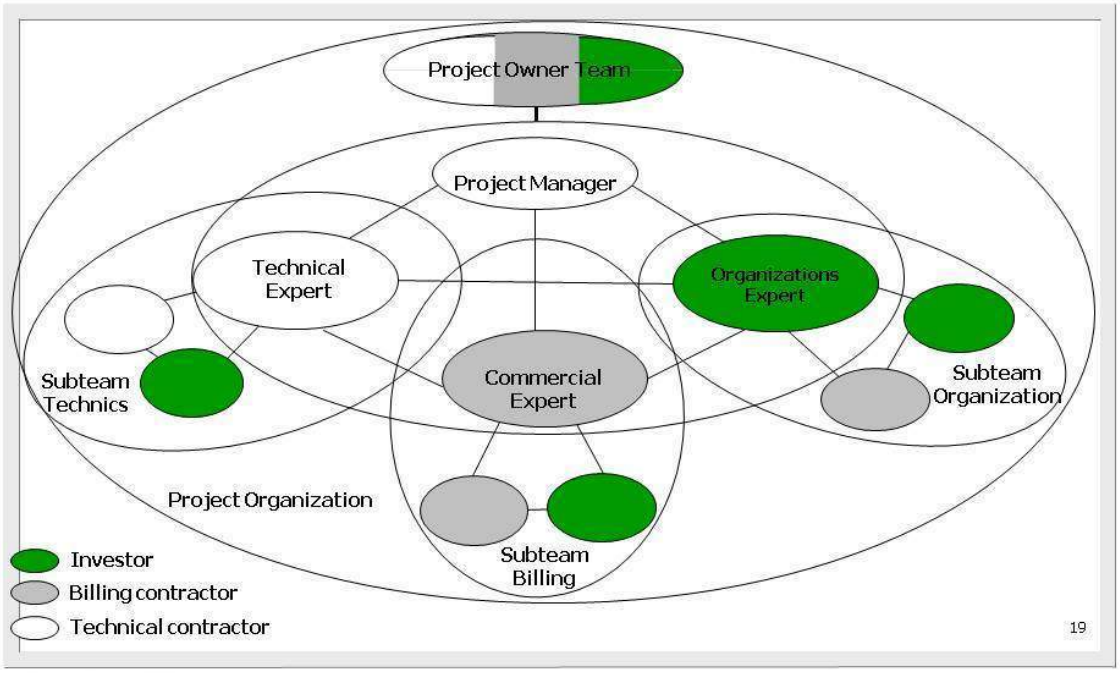
## Integrated Project Organization

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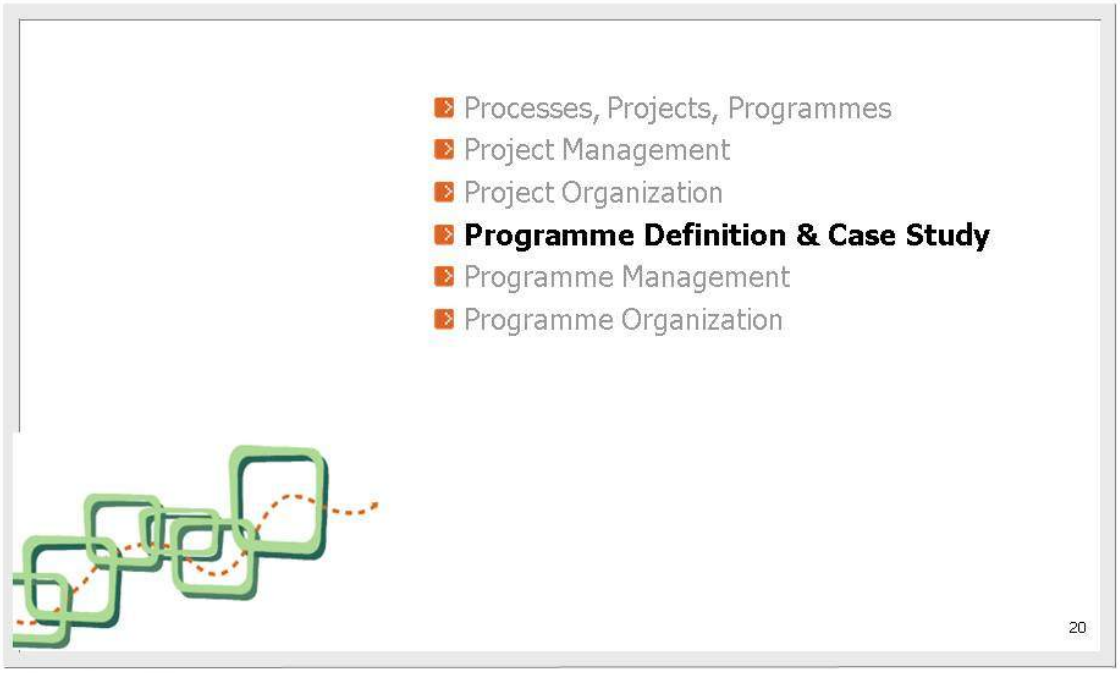
## Projects & Programmes: Agenda

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## Programme: Definition and Characteristics

- Programme definition
  - A temporary organization for the performance of a relatively unique process of large scope
- Characteristics
  - Set of projects and work packages
  - Closely coupled by overall objectives, strategies, rules, ...
  - Mid to long term, but time limited
  - Relatively open, detailed objectives to be defined within the programme

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## Examples of Programmes

| Programme Name | Programme Objective | Company |
|---|---|---|
| Railway Stations Initiative | Revitalising of 40 austrian railway stations | Österreichische Bundesbahnen |
| LKS 2000 | Reorganisation der Landeskliniken Salzburg | Landeskliniken Salzburg |
| Statoil SAP | Implementation of SAP at Statoil | Statoil |
| programm I austria | The austrian Project Managment-Initiative | PMG und PROJEKT MANAGEMENT AUSTRIA |
| STAR 2000 | Migration of SW -Systems of Lufthansa and AUA | Austrian Airlines |
| eBanking & eBrokerage | Establisment of eBanking and eBrokerage-Companies | ABN AMRO |
| Symphonie | Merger of Bawag and PSK | Bawag/PSK |

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## Programme Types

- Product development programme
  - e.g. development of product family
- Marketing programme
  - e.g. re-branding of a company
- Organizational change programme
  - e.g. merger of two companies
- Construction programme
  - e.g. modernization of several facilities
- IT programme
  - e.g. implementing and ERP system
- etc.

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## Criteria for Defining a Programme

- Large scope, high complexity
- High management attention required
- Application of common standards required
- Potentials for synergies
- Several relatively independent objects of consideration (loosely coupled)
- Overall, common objectives regarding these objects

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## Programme Management Case Study: Railway Stations Initiative

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## Programme Railway Stations Initiative: Objectives

- Revitalizing 40 large railway stations in Austria
- Optimizing the use of the properties of the Austrian Railway Company
- Reorganization of the management of the railway stations
- Assurance of financial requirements

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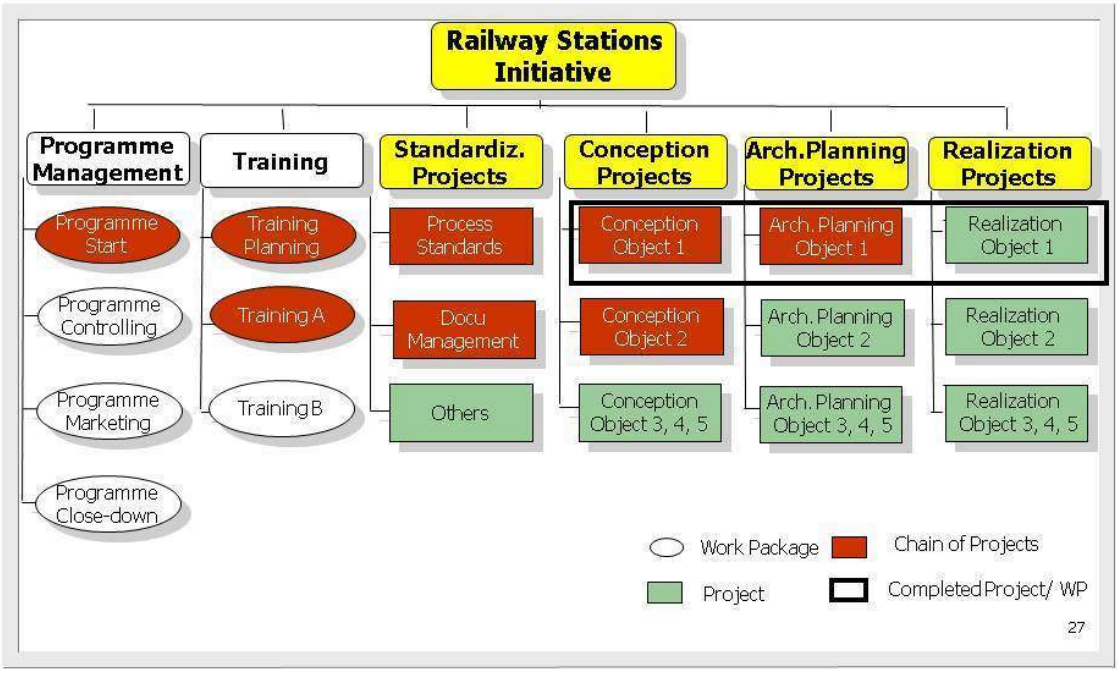
## Programme Breakdown Structure

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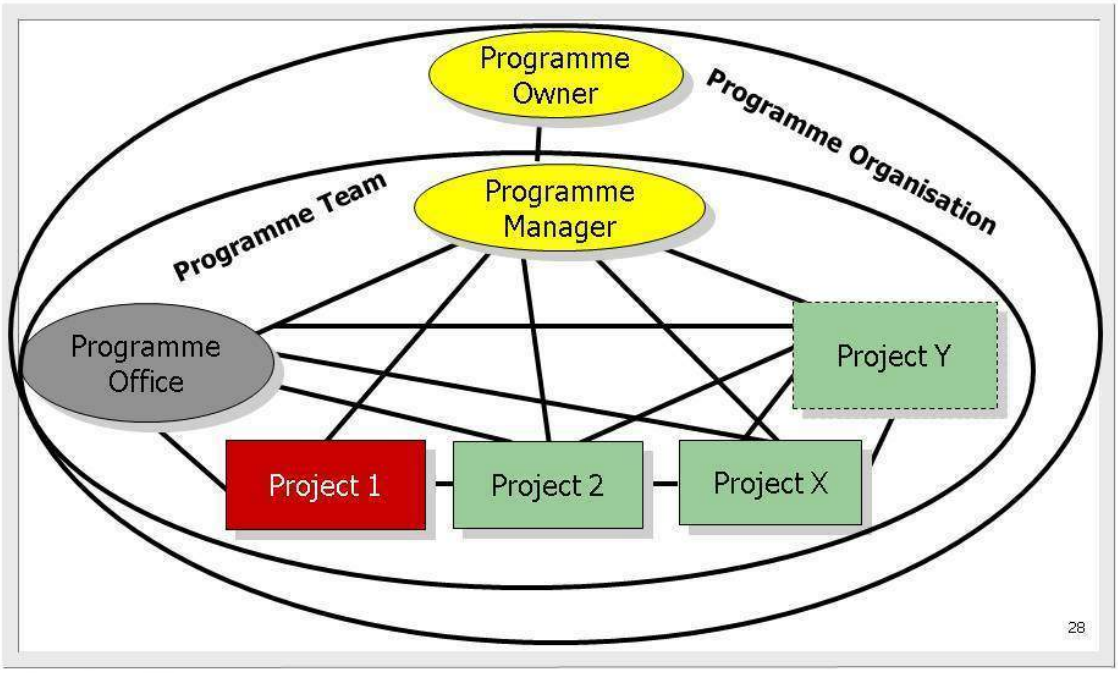
## Programme Organization

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## Projects & Programmes: Agenda

- Processes, Projects, Programmes
- Project Management, Project Organization
- Programme Definition & Case Study
- **Programme Management**
- Programme Organization
- Features of Programme Management

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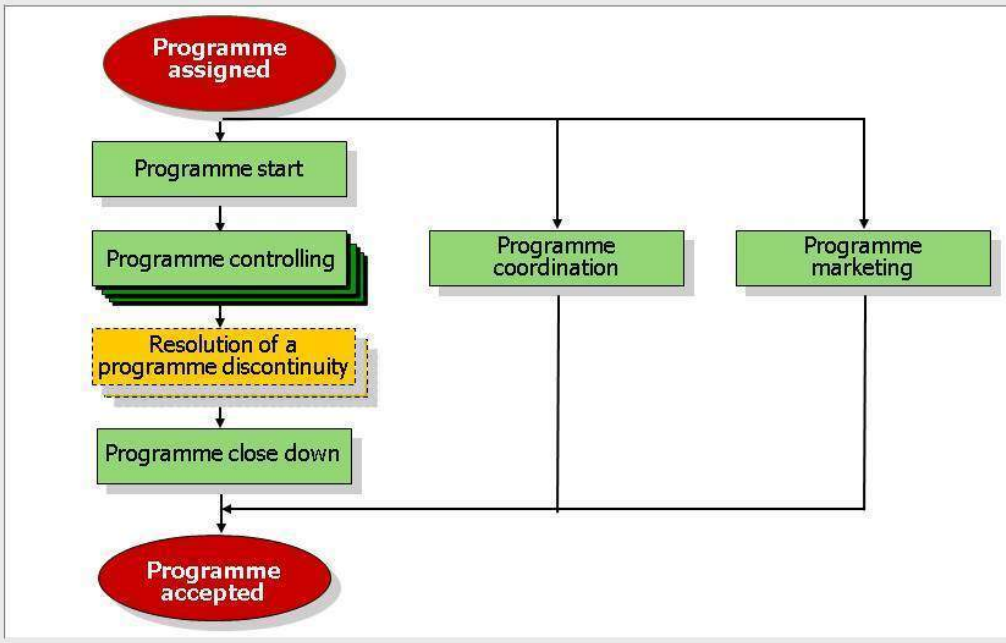
## Programme Management Process

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## Programme Management Methods

| Use of methods at programme start | Programme |
|---|---|
| Methods for planning the programme objectives, programme deliverables, programme schedule, programme resources and programme costs | |
| Programme deliverables planning | |
| • Programme objective plan | Must |
| • Programme objects of consideration plan | Must |
| • Work breakdown structure | Must |
| • Work package specifications (for essential work packages) | Must |
| Programme schedule planning | |
| • Programme milestone plan | Must |
| • Programme bar chart | Must |
| • Programme network plan | |
| Programme resource and programme cost planning | |
| • programme resource plan | |
| • programme cost plan | Must |
| • Programme finance plan | Must |
| Methods for forming the programme context relationships | |
| • Programme environment analysis | Must |
| • Cost-use analysis | Must |
| • Analysis: relationships to other programmes and projects | Must |
| • Analysis: pre- and post-programme phase | Must |
| • Presentations, -vernissage, -publications | Must |
| Methods for designing the programme organisation | |
| • programme assignment | Must |
| • Programme organisational diagram | Must |

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## Programme Score Card

| Programme objectives and context | 10.06. | 10.10. | 15.11. |
|---|---|---|---|
| Programme objectives | 1 | 1 | |
| Objects of consideration | 1 | 1 | |
| Contribution to strategies of cooperation partners | 2 | 2 | |
| Relations to other programmes/projects | 3 | 3 | |

| Programme ratios | 10.06. | 10.10. | 15.11. |
|---|---|---|---|
| Programme progress | 2 | 3 | |
| Programme schedule | 2 | 3 | |
| Programme costs | 2 | 2 | |
| Programme income | 3 | 3 | |
| Programme resources | 2 | 2 | |
| Programme risks | 3 | 2 | |

**Programme status per 10.10.2005**

| Programme organisation | 10.06. | 10.10. | 15.11. |
|---|---|---|---|
| Programme roles | 2 | 3 | |
| Programme communication | 3 | 3 | |
| Programme team work | 2 | 3 | |
| Programme culture | 2 | 2 | |

| Programme environments | 10.06. | 10.10. | 15.11. |
|---|---|---|---|
| PROJEKTMANAGEMENT GROUP | 1 | 1 | |
| National cooperation partners | 2 | 2 | |
| Sponsors | 3 | 3 | |
| Publishers | 2 | 2 | |
| Media | 3 | 3 | |
| Event organisors | 2 | 2 | |

| Status of projects | 10.06. | 10.10. | 15.11. |
|---|---|---|---|
| *project orientation [austria II]* | 1 | 3 | |
| *project orientation [croatia]* | 2 | 3 | |
| *project orientation [finland]* | 1 | 1 | |
| *project orientation [norway]* | 2 | 2 | |
| *project orientation [poland]* | 2 | 3 | |
| *project orientation [romania]* | 2 | 2 | |
| *project orientation [slovakia]* | 2 | 1 | |
| *project orientation [south africa]* | 1 | 1 | |

***Legend***
Very bad
Bad
Ok
Good
Very good

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## Programme Management: Characteristics

- Programme management process and methods similar to project management
- Specific roles: Programme owner, programme manager, programme team
- Specific programme culture: Name, slogans, ...
- Explicit programme marketing

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## Projects & Programmes: Agenda

- Processes, Projects, Programmes
- Project Management, Project Organization
- Programme Definition
- Case Studies
- Programme Management
- **Programme Organization**
- Features of Programme Management

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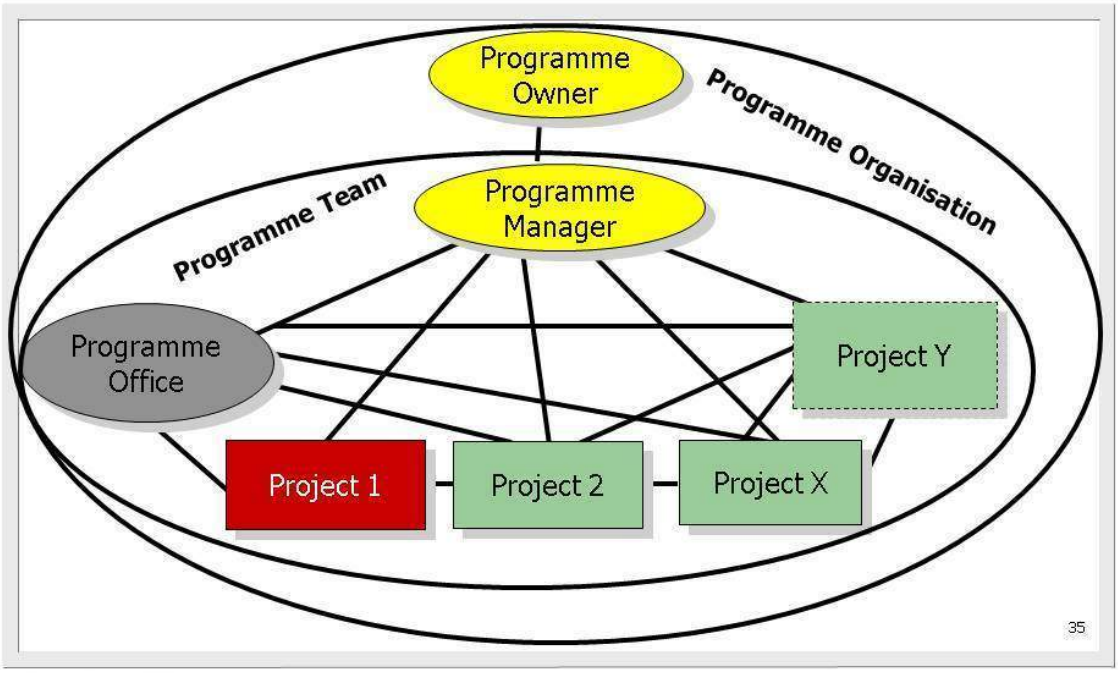
## Programme Organization

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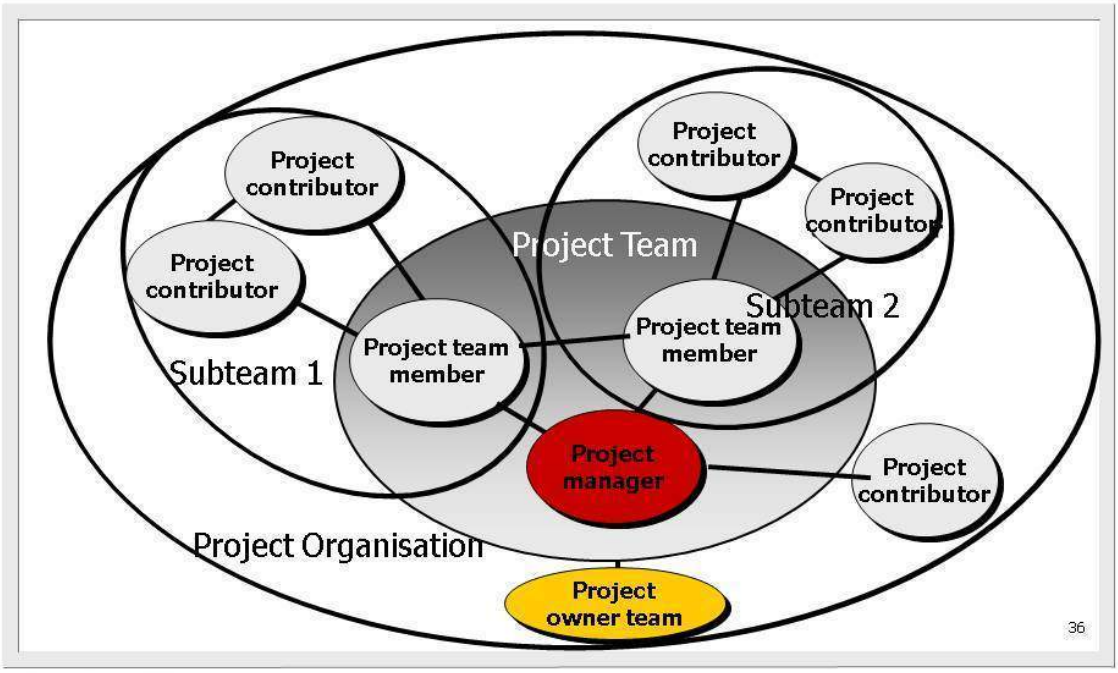
## Project Organization Chart

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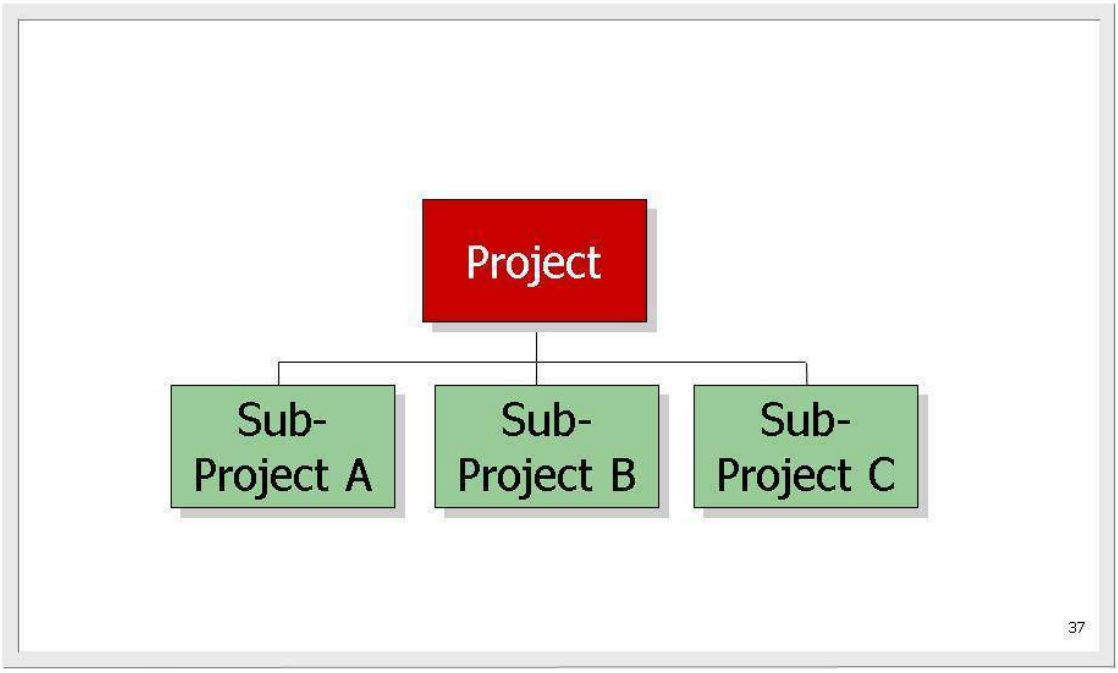
## Project and Subprojects

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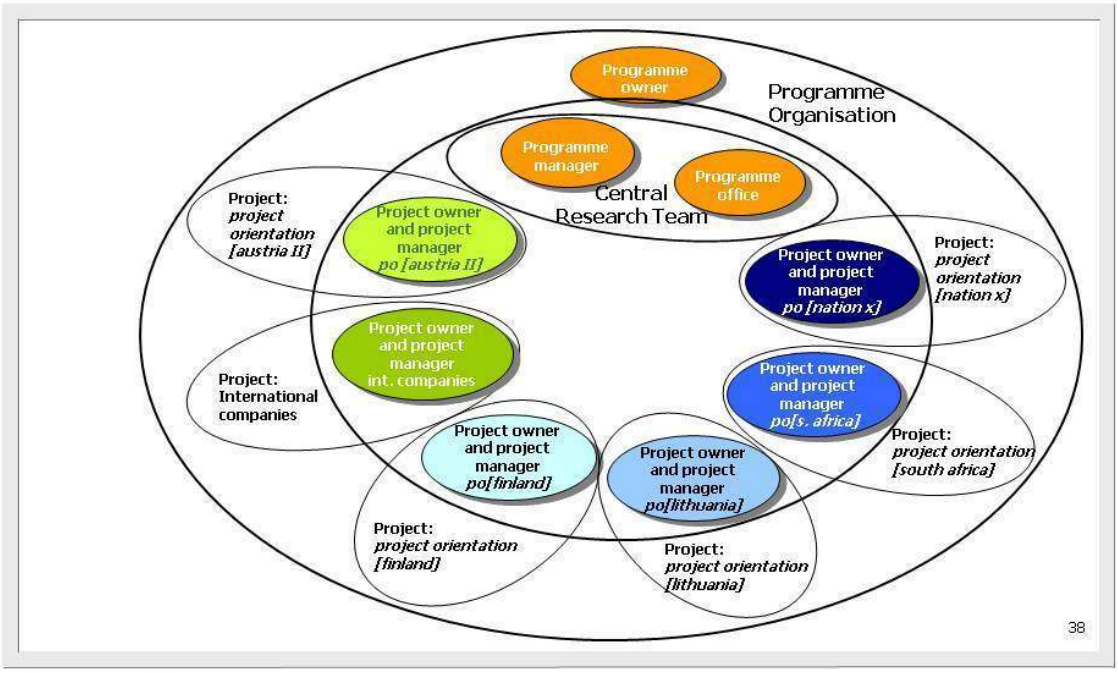
## Programme Organisation Chart

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## Programme Management: Organizational Potentials

- Programme and projects instead of a project and subprojects
- Less hierarchial than project and sub-projects
- Potentials for differentations
  - Programme owner is not project owner
  - Different project owners for different projects
- Potentials for integration
  - Assignments of roles: Project owner and member of programme owner team can be combined
- Clear terminology, appropriate culture allows for clear structures

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## Role: Programme Manager

| **Role: Programme Manager** |
|---|
| **Objectives** |
| • Ensures the realisation of the programme and the business case objectives |
| • Leads the programme team |
| • Represents the programme to relevant environments |
| **Position in the organisation** |
| • Is a member of the programme team |
| • Reports to the programme owner (team) |
| • Is given organisational support by the programme office |
| • Is the contact person for the project owners (teams) and the project managers |
| **Tasks** |
| *Tasks at the programme start* |
| • Plans the programme start process together with the programme team |
| • Holds programme team meetings |
| • Creates adequate programme plans and programme organisation together with the programme team |
| • Plans activities for risk management and the development of a specific programme culture together with the programme team |
| • Plans the formation of the programme context relationships and perform programme marketing |
| • Creates the programme start documentation with support from the programme office |

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## Decisions in Projects & Programme

- Decisions at programme level
  - Definition of standards
  - Selection of projects to start
  - Assigning scarce resources, i.e. to set priorities between projects
  - Definition of scope, budget, standards for each project
- Decisions at project level
  - Procurement decisions
  - Personnel decisions, …
  - Autonomy for project within the defined scope, budget, standards

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## Programme Risk Management

- Management of the programme risk by considering the relationships between the project risks
- Positive correlations between risks of single projects increase the programme risk
  - E.g. same contractor for different projects of the programme
- Objective: Minimization of positive correlations

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## Programme Marketing

- Basis: Development of a programme culture
  - Name, logo, office, language, slogans, mission, …
- Events
  - E.g. Event „Ouverture" of the programme „Symphonie" of Bawag/PSK
- Programme folder, newsletters, vernissages

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## Conclusion: Programme Management

- Programme management adds value: Better quality, shorter time, less costs, less risks,
  - … because of an appropriate organization
- Organizational relevance
  - Different organizational alternatives
  - Different definitions, procedures, roles
- Personnel management relevance
  - Different qualifications required, salaries, development plans, career paths
  - Establishment of entry barriers

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*W02*

# The Use of the Construction Registers to Measure the Competitiveness of Small, Medium, & Micro Enterprise Contractors

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Professor Winston Shakantu
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Professor John Smallwood
*(Head of Construction Management Department, Nelson Mandela Metropolitan University, Port Elizabeth, South Africa)*

## Abstract
This abstract outlines the research focus aimed at demonstrating that the South African construction industry's use of the Construction Register Service (CRS), would assist it to measure the competitiveness of Small, Micro and Medium Enterprises (SMMEs). The CRS was developed by the Construction Industry Development Board (CIDB) with the intent of offering a basis for sustainable development, improved construction delivery, improved performance and empowerment of the construction sector. The research conducted by the authors expands the construction industry's knowledge base in as far as it relates to enhanced performance and the competitiveness of construction SMMEs.

The research limits itself to the levels of contractors registered between grades 2 and 5 with a view to establish a benchmark for contractor competitiveness within those bands. The research's unit of study is at company level drawing from a reflection on the SMMEs active in industry delimited within the geographical area of the Eastern Cape Province of South Africa. The research deals with a real problem in industry and therefore the theoretical underpinnings of an epistemologically objectivist paradigm have been employed in the study.

## Keywords
SMMEs, contractor capability, competitiveness, contractor registers service.

## 1. Introduction

In the South African context, Small, Medium and Micro Enterprises (SMMEs) by and large refer to the full spectrum of businesses other than large corporations and publicly owned enterprises (DTI, 2005). SMME companies include categories known as micro-enterprises, survivalist-enterprises, informal sector enterprises, formal small and medium-sized enterprises and all businesses in all stages of evolution otherwise referred to as start-ups, emerging or expanding enterprises (DTI, 2005). The term also characterises family-owned, black-owned, women-owned or co-operatively owned enterprises (DTI, 2005).

The South African construction industry lays a foundation for economic growth through the provision of economic and social infrastructure (cidb, 2004). The advance of the expansionary fiscal framework in South Africa, realized through a

suite of construction projects within the sectors of rail, road, ports and power valued at R787 billion of infrastructure investment; is set to outstrip formal established contracting capacity (Creamer, 2009). It is expected that as the order books of the established construction contractors are filled, demand will trickle down to SMMEs. However, the observation within industry is that SMMEs have limited contracting, delivery and employment generating capability. The limited capability of SMMEs is considered a serious obstacle to the achievement of government objectives whose intent it was to invest in public infrastructure to bolster economic growth, employment creation and poverty alleviation. The South African government recognizes the construction sector as a significant contributor to the economy (5.6% contributor to the Gross Domestic Product of SA) and a vehicle for employment creation. The current scenario is that there are 106 247 contractors registered with the Construction Industry Development Board (cidb). Of that number of registered contractors 78% constitutes those generally defined as contracting SMMEs (cidb, 2004).

The main problem identified by the construction industry was that there seems to be more than sufficient capacity (in numbers) whilst the sectoral projects targeted for the infrastructure investment through the national fiscus – are complex and they require a higher level of sophistication and competence and as such matching the numbers (of SMMEs) with the infrastructure investment would not have adequately dealt with the challenge of the availability of capacity. It was therefore evident that there needed to be 'some new measure' that sets the SMMEs apart and as such this need gave impetus to this research. The aim, therefore of this research was to investigate how the construction registers can be used to measure the competitiveness of SMMEs with a view of adding suitable capacity to respond to the sectoral infrastructure projects which the SA government has prioritized. This would be done so as to enhance their capacity to deliver especially on economic infrastructure projects for the sectors that have already been mentioned above. To achieve this aim the study needed to:

i) identify the factors that drive competition in the SMME sector;
ii) through definition, inspire a culture of economic activism that drives entrepreneurship within the SMME sector;
iii) identify the support mechanisms for SMMEs that can substantially accelerate their growth and improve performance.

## 1.1 The Problem

There is a general lack of competitiveness within construction SMMEs. Most construction SMMEs can hardly demonstrate management competencies and resources (or capability) which could enable them to compete in a growing construction economy.

## 1.2 Background

The construction Rregisters service (CRS) was developed by the Construction Industry Development Board (CIDB) in terms of the Construction Industry Development Board (CIDB) Act 38 of 2000. As a tool, it was designed to offer a basis for sustainable construction development, growth, improved delivery,

performance and sustainable empowerment. It was also developed to be used by the construction industry to, *inter alia*, provide statistical data which would enable the construction industry to better understand the contracting capacity in South Africa. The research undertaken through the methodology of grounded theory looked at how the CRS can be used to measure the competitiveness of a targeted group of small contractors.

The competitiveness of construction SMMEs is a field that has not been explored in the South African construction environment and therefore not enough prior research has gone into the expansion of its knowledge and expertise. Most of the research conducted to date has largely covered in great detail the imperatives of growth, transformation and enhanced overall performance of the South African construction industry. As the contractor registration process has stabilized particularly over the past four years (2006-2010), the cidb has advanced with reporting on progress against stated strategic objectives but also looking at overall industry enhancement considerations. This it has done and communicated both to the industry and the government administration through two quarterly publications. The one being the Construction Industry Indicators (CIIs) and the other being the Quarterly Monitor reports. The sole purpose of these reports is to provide industry with a simple method of establishing a performance measurement system within the industry. The benefits of doing this however has neither been qualified nor quantified as yet.

Future studies should explore this gap as it was never the sole purpose of this study to do so, however laying the foundation on what to measure and how to use the CRS tool to measure it, is in itself the intention of this study. At present, the SMME contractors progress up the grading system only on the basis of having had demonstrated improved financial capability and an expansion of the value of work and complexities in projects which they are now able to undertake. If they are not able to demonstrate this growth, their attractiveness to construction clients and their ability to aggressively pursue work (competitiveness) is curtailed or constrained.

## 2. Unit of Study

The unit of study for the purposes of this research is at organization level; drawing from a reflection on who is an active participant in the South African construction industry. The research first conducts an in-depth analysis of the South African construction industry, with a focus on the targeted SMME contractors, and it proceeds to demonstrate how improved business processes within that sector would result in enhanced competitiveness arising out of using the CRS tool to measure that competitiveness. During the research work, the focus has been on the efficacy of the CRS as a tool with which to measure competitiveness and its ability to identify the areas needing targeted development to support SMMEs in being more capable to undertake work to the level of complexity as that espoused by the strategic projects which will be funded through the national fiscus.

The area of research was limited to one provincial geographical area, namely the Eastern Cape Province. Within the first year of rolling out the cidb CRS (2004), there were only 457 contractors registered. Currently, the South African construction industry is comprised of 106 247 registered contractors (cidb, 2009). Of that number, no less than 78% is made up of what the industry would classify as SMME contractors and elucidated in the definition of SMMEs above. Hereunder is a

table which indicates how many of that number (106 247) comes from the Eastern Cape and the respective grades within which they are registered:

**Eastern Cape Contractor statistics**

| Grade | CE | EB | EP | GB | ME | SW | Total Grades |
|---|---|---|---|---|---|---|---|
| 1 | 2,180 | 65 | 122 | 7,625 | 141 | 795 | **10,928** |
| 2 | 121 | 12 | 1 | 179 | 6 | 27 | **346** |
| 3 | 72 | 4 | 2 | 58 | 3 | 3 | **142** |
| 4 | 68 | 9 | 3 | 49 | 1 | 5 | **135** |
| 5 | 38 | 5 | 6 | 26 | | 4 | **79** |
| 6 | 26 | 1 | | 27 | | | **54** |
| 7 | 7 | 1 | | 9 | 1 | | **18** |
| 8 | | | | 2 | | | **2** |
| **Total** | **2,512** | **97** | **134** | **7,975** | **152** | **834** | **11,704** |

**Table 1**: Contractor Statistics within the delimited geographical area

## 3. Justification of Study

Current industry research has focused on construction activity across the country and determining the state of health of the industry and its participants (Dlungwana & Rwelamila, 2003). However none of the work that is currently produced within the country gives a sense of whether the contracting fraternity of South Africa appreciates what it could do for the country if it had a thriving and competitive construction sector of the economy. The sector understands why government is investing as much as it is in infrastructure, however there is no record of a debate that has taken place amongst the participants within the construction industry arguing for competitiveness as a measure of growth and improved performance for this sector. Moving from a base of R458 billion for the Medium-Term Expenditure Framework (MTEF) period of 2006/7/8 to the R787 billion investment in infrastructure which government has set aside for the MTEF period of 2009/10/11, the absence of such a debate has led to a lack of clarity on where the investment is targeted and who within the sector will benefit and what the material effect of that benefit would be.

There was a great need therefore for a research study that will provide an objective assessment of why the construction sector needs to be interested in the competitiveness of its SMME contractors. This is purely due to the fact that competitive forces continue to drive companies to seek new areas of growth, with either portfolio expansion or penetration into new markets (OECD, 2008). Although the forces that weigh heavily on a company are recognised, their influence in determining a company's action in choosing a particular strategy is not as yet well understood by most of the contractors that fall within the band that is the focus of this research. The thesis recognised that this could be averted by appreciating the natural progression of contractor capability as they move up the value chain of grading through the cidb registers. The importance of this study is in that its outcomes would present the SMME contractors with a proper understanding on the practice of how their competitiveness is assessed or measured in the South African

construction sector to enable the industry as a whole to measure not only contractors' individual competitiveness but also their subsequent contribution towards the economic growth objectives espoused by government. Being in a position to measure this would in itself lead to the achievement of sustainable development and growth of the South African economy.

## 4. Defining Contractor Competitiveness

South Africa is regarded as one of the more sophisticated and promising emerging markets in the world, offering a unique combination of highly developed first world economic infrastructure with a vibrant market economy. It is also considered to be one of the most advanced and productive economies in Africa. One of the aspects that are considered to be incentives for doing business in South Africa can largely be attributed to its competitiveness when engaging the global economy (SA Tourism, 2007).

There is both the global definition of competitiveness as well as a local definition. Competitiveness is a measure of a country's advantage or disadvantage in selling its products in international markets. Competitiveness can be defined by country, region, industry, company or product. The global definition of competitiveness is that it is:

> Competitiveness is an aggressive willingness to compete. It is the quality of being bold and enterprising. It is also defined as the degree to which an enterprise can, under free and fair market conditions, produce goods and services which meet the test of international markets, while simultaneously maintaining and expanding real incomes over the long term (OECD, 2006, p. 459).

There is an argument to be made for the competitiveness of organizations and what is required to achieve that within their businesses. Fellows *et al.* (2002) define strategic thinking as key in creating the competitive advantage for construction firms. Within this assertion they explicitly single out three key areas within strategic thinking which they claim create this competitiveness advantage and they list them as follows:

- Strategic management;
- Managing people;
- Managing money, and
- Decision-making techniques.

Contractor competitiveness therefore defines something more than just contractor competence (as this pertains to the value range of each tender that contractors are able to handle and their track record based on the individual grades allocated through the CRS). Competitiveness speaks to entrepreneurial innovation under five group categories: contractor's organisation, financial considerations, management resource, experience used as an envisioning tool, and past performance (Flanagan *et al*, 2007).

## 5. Methodology

The study used non-probabilistic sampling which meant the research would be purposive. The focus of its subjects - those SMME contractors who had worked on projects which afforded them the opportunity to grow and demonstrate competitiveness – were informative for the purposes of the research as it followed the grounded theory approach. It was not necessary to have a cap on the number of SMME contractors to be interviewed as the research's basis was 'grounded theory' which entailed conducting interviews regarding informative subjects and only ceasing when a point of saturation had been reached and there can be no further outcome of interest to be extracted. In total a group of 60 SMME companies were interview at the time of producing this paper. Outcomes of the structured interviews will be presented at the Conference.

## 6. Discussion

In considering the key enablers of competitiveness for this study it became quite critical that the approach needing to be followed to analyse what ought to be done to solve the problem statement, be contextualised in the following questions:

- What are the phenomena that give rise to the perceived lack of competitiveness which plagues the lower end of entry into the construction sector?
- How are the gaps of development identified and plugged so that SMMEs' understanding of the competitive environment improves and with this a further improvement of their competencies, performance output and productivity are achieved?
- What would it take to enhance the attractiveness of SMMEs to clients?
- What could be used to empower SMMEs to approach work opportunities in a bold and enterprising manner so as to guarantee their continuous attainment of work?
- How could the competitiveness of SMMEs be assessed with a view to create new models or procedures with which to enhance that competitiveness?

## 7. Findings

As mentioned through the abstract the study is at a stage where the synthesis of outcomes from the interviews is being undertaken and therefore there are no conclusive findings that have as yet been finalized. However the early indications of outcomes are hereunder listed:

- Examining existing or current research on contractor development assisted the study to consider where and how competitiveness would be crucial in enhancing growth and sustained participation of construction SMMEs in the mainstream economy;
- Assessing the contracting 'capacity' and capability within a geographic area was possible;

- Using the CRS to measure the competitiveness of selected SMME contractors within a geographical area was possible and was beginning to pronounce qualitative benefits;
- Identifying gaps on the understanding of SMMEs of the competitive environment and attempting to close these, improves contractor competencies, their performance output and productivity.

## 8. Conclusion

Superimposing the focus areas of this research forms a basis for a singular approach towards a definition of competitiveness and its measurement system. This goes a long way in assisting with outlining an integrated construction SMME development strategy that would inform the industry on a holistic model that can yield both quantitative and qualitative outcomes. Both the South African government and the country's construction industry are continuously engaged in a process of encouraging industrial growth and performance which in turn will support the country's social and economic transformation. The ultimate objective is sustainable growth, stability, employment, enhanced delivery, improved industry performance and competitiveness, value for money and empowerment (cidb, 2004). In selecting contractors to perform work activities, decision makers must be assured that the contractor selected has the capabilities to apply the best innovative technologies in an enterprising manner towards their work. It is that entrepreneurial flair and boldness; it is that ability to enterprise; which summarises the kind of contractor competiveness that clients are looking for.

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*AA048*

# A review of spatial considerations in project scheduling

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## Abstract
Project scheduling is considered as a study of the relations between activities and time, it is well known, however, that for certain types of projects spatial considerations (e.g. site layout, facility planning, site congestion etc) should also be taken into account. In this paper a literature investigation is performed with the purpose of indentifying all methodologies and techniques that take into account "space" as an entity in producing construction schedules and the practical implications of this approach are discussed. It is argued that it is mainly a lack of perception and not a scarcity of tools that by and large lead to spatial considerations not being taken into account in most project time schedules.

## Keywords
Space management, Construction planning, Construction scheduling

## 1. Introduction

The definition of space in the construction domain is hardly evident or explored (Mallasi and Dawood 2002); throughout this paper is assumed that construction space consists of: Workspace (the location where activities are executed), Product Space (the space that occupy the components of the construction; i.e. walls), Resource Space (materials', equipment's space), Storage Space (contains temporary/permanent storage areas; e.g. staging areas) and Path Space (contains the loading/unloading path for materials delivery and possibly equipment path; e.g. crane rail) (Georgiou 2009).

Construction space management is a challenging task, as space is complex and changes dynamically throughout the construction process, namely workspaces are generated when a floor is built; while workspaces are limited when walls are built. It is argued that effective space management has significant impact on construction cost, productivity, safety and leads to schedule compression and space conflicts avoidance (El-Rayes and Said 2009). Yet in construction, relatively little formal attention is paid to the allocation of tasks to spaces and no standard tools, comparable to those available for the sequencing of tasks provided by critical path analysis and its derivatives, have gained acceptance among construction. The

availability of space is typically based on intuition and rarely formalized beyond the most basic rules of thumb.
This paper focuses on introducing all different approaches which have been developed to automate the consideration of space requirements during planning and scheduling. Current state of knowledge of space management is summarized by a literature investigation to indentify all methodologies, tools and techniques that take into account space as an entity in producing construction schedules and the practical implications of this approach are also discussed.

## 2. Space Considerations in Construction Management Research

The primary aspects of research in space management are grouped into four categories: (1) Path planning; (2) Site layout; (3) Space scheduling and (4) Location based scheduling (Akinci et al. 2000; Akinci and Fischer 1998). The aforementioned categories, their field of application and their limitations are analysed in the following sections and the inputs and outputs of each approach are shown in Fig 1.

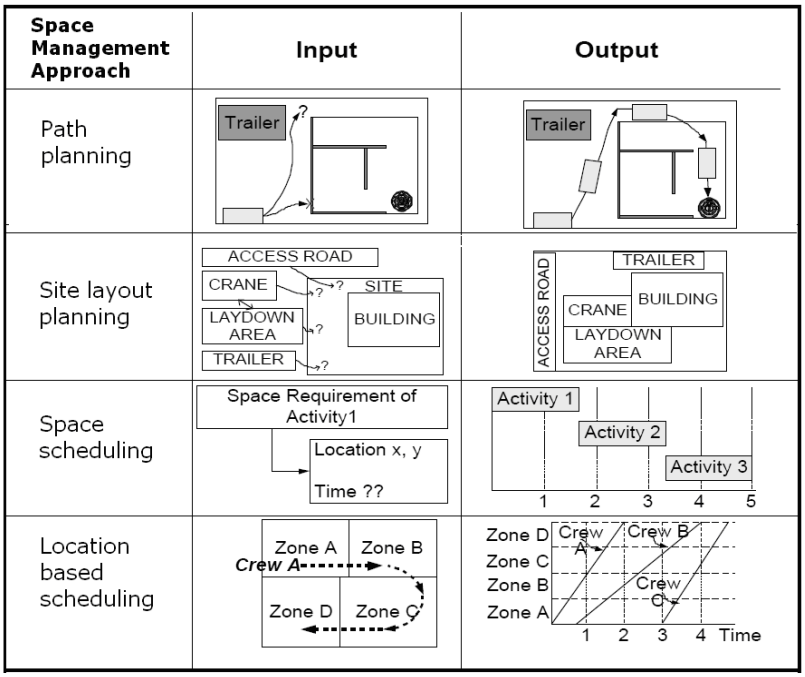


**Fig 1**: Different approaches for space management (Akinci et al. 2000)

## 2.1 Path planning

In Path planning routes for construction equipment and operations are generated and the shortest, collision-free path is identified according to work requirements and the starting and destination points of the route. Typical applications include routing large vehicles or heavy-lift operations on the construction site and various algorithms have been developed. Varghese and O'Connor (1995) attempted to model process of path planning through a set of predetermined rules and to provide data display capabilities, by applying two computer technologies: GIS and expert systems. Lin and Haas (1996) proposed a planning environment that uses computer-aided drafting tools and a set of computerized planning primitives to facilitate a very visual planning process, while Tserng et al. (1996) developed a

computer-integrated operations planning system that simulates the site and automatically generates path plans.
However, path planning studies focus on equipment and, in general, workers and material storage are not included. In addition, space availability is considered fixed within a specific time period, as path planning is viable when modelling a path around fixed obstacles. When a facility changes continuously over time and multiple paths and mobile objects need to be considered for each change, the path planning approach becomes very complex; thus, path planning approach is most frequently used to model the paths required by critical operations (Akinci et al. 2002a).

## 2.2 Site layout planning

Site layout planning includes the identification of the temporary facilities needed to support construction operations (i.e. offices, tool trailers, warehouses, fabrication yards), the determination of their size and shape and their positioning within the site boundaries. In general, the objective of site layout is to position temporary facilities in the best layout according to the shortest travel distance or minimum travel cost between them. Regarding to the manner temporary facilities are assigned on site, two distinct field of approaches are commonly encountered: (1) facility to location assignment, which assigns a set of predefined facilities to a set of predefined locations on site and (2) facility to site assignment, a more generic approach, in which temporary facilities are assigned to any unoccupied space available on site (Osman et al., 2003). Under these fields, site layout models are grouped into two main categories: static and dynamic site layout planning.

A variety of methodologies and tools have been utilized for the production of static site layout models such as computer-aided design (CAD) (Sadeghpour et al. 2004), goal programming (Osman and Georgy 2005), computer simulation (Retik and Shapira 1999; Dawood and Marasini 2002), Geographic information systems (GIS) (Cheng and O'Connor 1996), knowledge-based systems (Tam et al. 2002; Chau and Anson 2002; Sadeghpour et al. 2006), hybrid systems (Zhang et al. 2002) and genetic algorithms (Hegazy and Elbeltagi 1999; Mawdesley et al. 2002; Zouein et al. 2002; Cheung et al. 2002; Tam et al. 2001; Osman et al. 2003b; Khalafallah and El-Rayes 2005, 2006). A single site layout that identifies static locations for all temporary facilities in the project is produced and cannot be changed during the construction progress. The dynamic changes in space needs and availabilities on construction sites, as the schedule evolves, are not taken into consideration in static models.

Dynamic site layout models, on the other hand, provide possible space reuse to accommodate different resources at different times, relocation of resources and consider the changing space needs of resources over time. This is accomplished by subdividing the project's schedule in periods and by identifying the available and needed space of temporary facilities for each period. Many site layouts are generated and optimized and the site layout plan is re-organized at frequent intervals during the project. Recent studies focusing on solving dynamic site layout problems adopt techniques and tools such as 4D CAD (Wang et al. 2004; Ma et Al 2005), genetic algorithms (Elbetagi et al. 2004), ant colony optimization (ACO) algorithms (Ning et al. 2010), even a combination of artificial intelligence tools: knowledge-based systems, fuzzy logic and genetic algorithms (Elbetagi et al. 2001). The latter model provides direct integration with a scheduling tool to determine the schedule-dependent site needs. Furthermore, through the development of an approximate dynamic programming model that considers future

implications of layout decisions made in early stages, the identification of global optimal dynamic site layout plans is possible (El-Rayes and Said 2009).

## 2.3 Space scheduling

In both static and dynamic site layout models the schedule is considered to be given. In addition, activity scheduling and site layout are tackled as independent problems. The combined problem is addressed by space scheduling approaches, which focus on modelling the different types of work spaces required by construction activities.

Space scheduling includes the planning of task execution spaces. In this approach space is considered as a resource, which varies with time and all working elements (workers, equipment, material, path and temporary facilities) are subjected to the variations of time frames or schedules. The algorithms developed in space scheduling mainly focus on creating a schedule to eliminate or minimize space conflicts. Recent studies use fully automated approaches to assess space availability and needs during scheduling activities and focus on space needs of activities either inside buildings (Thabet and Beliveau 1994; Riley and Sanvido 1997; Zouein and Tommelein 1999) or on the whole site, by producing dynamic layouts with schedule adjustment (Zouein and Tommelein 2001; Guo 2002; Winch and North 2006). Tools and techniques such as 4D CAD (Akinci et al. 2002 a,b) and 4D simulations (Mallasi 2005) are adopted to create dynamic representations of activities' execution workspaces.

## 2.4 Location based scheduling

Kenley and Seppänen (2009) classify the methodologies for scheduling construction work into activity-based scheduling and location-based scheduling. Activity-based scheduling includes techniques such as the Critical Path Method (CPM), introduced in the late 1950s and Gantt charts, the universal graphical representation of schedules, which was introduced by Gantt and Taylor in the early 1900. Work is treated as a series of packages which have (only) a time-based relationship to each other. Each work package is considered discrete and there is no relationship between locations and activities. In activity-based scheduling the physical location of an activity and its relationship to surrounding locations are not taken into consideration (Kenley and Seppänen 2009).

Space is, on the other hand, taken into account in location-based scheduling. Research and development regarding the location-based scheduling methods has been carried out since the 1940s and a variety of techniques appears in literature (Jongeling and Olofsson 2007; Kenley and Seppänen 2009) under different names such as 'Line-of-Balance', 'Flowline', 'Construction Planning Technique', 'Vertical Production Method', 'Time–Location Matrix Model', 'Time–Space Scheduling Method', 'Horizontal and Vertical Logic Scheduling Logic for Multi-Story Projects' and 'Repetitive Scheduling Method'. In location-based scheduling techniques location is an intrinsic component of the planning system and emphasis is given to relate the location of work to the work to be done. Projects are divided into zones so that each crew moves from one zone to another undisrupted and the schedule is generated across two axes: time and zone-axis (Kenley and Seppänen 2009; Akinci et al. 2002a).

However, both activity and location-based methodologies do not explicitly address the spatial configuration of activities, for example users have to look at 2D drawings to identify and understand what building components are related to each activity. The locations generated in location-based methods provide some spatial information, but are only abstract representations of the real world; spatial configuration of a project is often much more complex than the hierarchical location structure depicted in a two-axis diagram. This is achieved through the use of technologies of Geographic Information Systems (Poku and Arditi 2006; Bansal and Pal 2007; Georgiou 2008) and 4D CAD (Jongeling and Olofsson 2007; Coyne 2008), which enhance the abovementioned scheduling techniques by integrating the schedule with its spatial components. A spatial insight of the project is provided through the linkage of the schedule activities with their associate building elements and a clear 4D understanding of the project is facilitated.

Furthermore, new location-based management systems, which use location as the unit of analysis that drives the schedule planning and the progress control, have recently been developed. Seppänen and Aalto (2005) developed a comprehensive line of balance-based planning, scheduling and control system, supported by the commercial software package DynaProject™, which constitutes the prevailing planning methodology among the main contractors in Finland. Kenley and Seppänen (2009) introduced the "Location-based management system", which combines activity and location-based logic: locations are used as the unit of analysis for scheduling and activities as the unit of control. The system refers to a set of planning and scheduling functions such as a risk simulation module based on the Monte Carlo technique, a bill of quantities collecting the building materials that are distributed among the activities, a procurement module for the supply of building material and a national database with building productivity data. The various functions of this planning, scheduling and control system are integrated in VicoControl™ software, developed to implement the system.

## 3. Conclusion and future research

The present paper succinctly reviews recent progress in space considerations in project scheduling discipline. The literature identified a variety of methodologies, tools and techniques that can be applied to all four categories of "space management problem": path planning, site layout, space scheduling and location based scheduling. The number of the relevant literature cited indicates the significance of efficient space planning and it is argued that it is mainly a lack of perception; the major focus of planning is set on activities and not on the objects which are engaged in the activities, and not a scarcity of tools that by and large lead to spatial considerations not being taken into account in most project time schedules. The aforementioned categories are interdependent, but require rather different approaches. Comparison between them could be possible by determining a set of criteria, which would form the basis of comparison; however this goes beyond the scope of the paper and could be the objective of future work based on this review.

Space is suggested to be used as an intrinsic component, which will derive the schedule planning process from the estimating system. When space is used as a unit of analysis of the scheduling process; namely when the construction project is broken down into its locations and not into its activities, then more precise estimation of not only the quantities of the components, but also of the cost and duration of the project is enabled. Both researchers and practitioners have already

turned their interest towards this direction and new commercial software such as VicoControl™ is being developed.

As an increasing trend of applying new advancing technologies, such as Virtual Reality and Radio-frequency identification (RFID) in the building science and construction management discipline is observed, it is believed that space management will as well profit from them. Thus, future research is suggested to focus on the above technologies, which are strongly expected to serve as platforms for the development of new planning and controlling tools and will possibly put forward new directions to space management problem, namely to address space as a whole entity, by creating a virtual environment and exploring virtual scenes throughout the construction site, in which all aspects of space (workspace, resources, path, storage and product space) will effectively be planned and managed during construction process.

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*AA022*

# Visualising Time: a GIS Approach

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## Abstract
This paper presents a methodology for visualizing in 3D the scheduling time data associated with the construction of a linear/ repetitive project. The Repetitive Scheduling Method (RSM) algorithm is used to provide the time data which then are visualized in a Geographical Information Systems (GIS) environment. A three storey building is modeled with this methodology to illustrate the applicability of the concept and to underline the benefits of the spatial and time data integration. This visual understanding of the project allows efficient schedule communication among the interested parties, although the methodology has still opportunities for improvement mainly in the field of software package integration on a single platform.

## Keywords
3D Visualisation, Repetitive Scheduling Method, Geographic Information System, Data integration

## 1. Introduction

Most scheduling techniques relate project activities with time; representing a logical process and enabling the calculation of start and finish dates of the activities while representing their inter-relationship.

Visualizing the construction sequence during the planning phase can assist project planners and detect mistakes and potential problems at an early stage. During the construction phase, visualizing the action and interaction of project activities establishes potential space conflicts (Jeljeli et.al 2003). The importance of the location/space of activity implementation in construction management is thus straightforward.

It is beyond the scope of this paper to discuss the scheduling method used to obtain the time data. The problem posed by projects with repeating activities and technical precedence constrains has been discussed for many years and has led to several methodologies that meet specific objectives. This study uses the Repetitive Scheduling Method (RSM) introduced by Harris and Ioannou (1998), a simple and

easily applied scheduling methodology that follows from the concepts found in CPM precedence networks.

The primary objective of this paper is to demonstrate how to link the time and spatial data of a project in a single computer environment, namely that of ArcInfoGIS®. Once this linkage is successfully completed, the user can fully utilize the capabilities of the GIS environment and perform simple or complex queries to obtain answers to specific questions. ArcInfoGIS® was chosen because it is a commercial, complete GIS out of the box, with a user friendly interface.

A Case Study of a building is used to aid the presentation of the methodology under discussion. The original technical drawings of the building, available in the form of AutoCAD® were slightly modified to obtain the level of detail required. Again, AutoCAD® was preferred to other commercial software because it is used widely for drafting purposes in the technical industry.

## 2. Methodology for Visualizing the Schedule

A three storey building is used as a case study to implement the methodology discussed in this paper. The building consists of prefabricated metallic columns and slabs connected through joints in situ. The structural skeleton that results as the aforementioned structural elements' assembly includes channels where pipework installation is performed before the floor concrete pouring. The completion of the construction is performed by concrete casting and walls and frames placement. The floors are identical and the project is classified into the category of repetitive projects.

The steps performed to integrate the textual and spatial information of the project in GIS, the attachment of different information to the corresponding components of the building and the information retrieval mechanism (queries) are fully described with the aid of the case study.

**Step 1: Generation of time data**

Activity durations and precedence relationships of one unit, namely one floor of the repetitive project examined are defined and presented in Table 1.

| Task | Activity | Duration | Predecessor | Lag |
|---|---|---|---|---|
| 1 | Foundation | 2 | - | 0 |
| 2 | Assembling | 1 | 1 | 0 |
| 3 | Pipework | 1 | 1 | 1 |
| 4 | Stair Units | 1 | 1 | 1 |
| 5 | Concrete casting | 1 | 2,3 | 0 |
| 6 | Walls | 3 | 5 | 2 |
| 7 | Frames | 1 | 6 | 0 |

**Table 1**: Activity Information for one unit

The planned start and completion dates of each Activity in every unit were calculated using the Repetitive Scheduling Method, taking into account that Task 1

is only executed in unit 1 (ground floor) and Task 4 is not executed in unit 3 (top floor). The actual start and finish dates were assumed for exploratory purposes. The required time data of all activities in all floors are assembled in the Schedule table, the fields of which are presented in Table 2.

| **Fields of Schedule Table** | |
|---|---|
| **FIELD** | **DESCRIPTION** |
| Task_ID | Two-digit Number, combines units and activities.<br>Task_ID 32 represents the Activity Pipework executed in the second floor (Task 3/ unit 2). |
| PS | Planned Start Date |
| PF | Planned Finish Date |
| AS | Actual Start Date |
| AF | Actual Finish Date |

**Table 2**: Fields of Schedule Table

**Step 2: Generation and transfer of building components.**

Only one 2D drawing of a single floor was prepared in AutoCAD®, since all floors are identical in a repetitive project. Having this technical drawing, the 3D view of the entire building can be prepared by multiplying and editing this layer in ArcInfoGIS® To express the spatial dimension of each activity, meaning to relate each activity to the corresponding components of the building, the 2D drawing is further divided into its building components, which are grouped in 4 layers and transferred into the ArcInfoGIS® namely slab, column, wall and frame layer (Fig.1). Stairs and pipework were excluded from this case study to simplify the process.

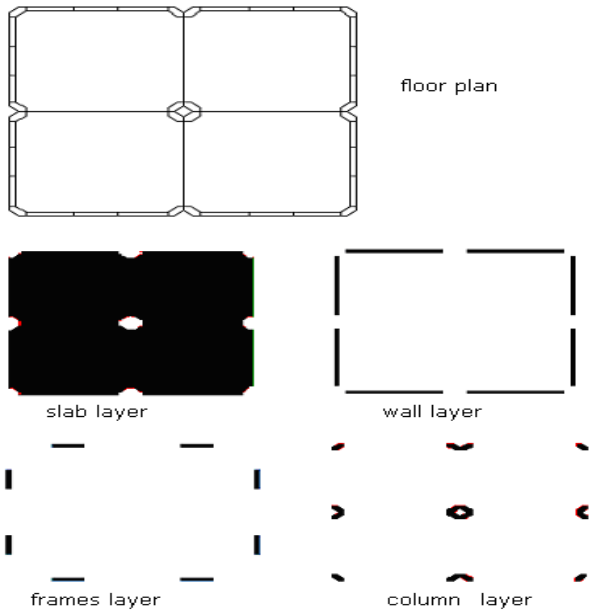


**Fig 1**: The architectural design divided into 4 layers

**Step 3: Generation of the entire building in ArcInfoGIS®.**

ArcInfoGIS® can import AutoCAD® layers, but in order to manage their containing information, some manipulations have to performed. This is because in an ArcInfoGIS® shapefile (layer), all features need to share the same geometry type, which is not the case with AutoCAD® layers. Shapefiles are a simple, nontopological format for storing the geometric location and attribute information of geographic features. Thus after transferring the 4 layers into ArcInfoGIS®, all features are converted to polygons and the layers to shapefiles. The Append functionality of ArcInfoGIS® is then used to create the other two identical storeys of the case study building.

**Step 4: Adjusting the Attribute Table.**

In Shapefiles there is always a linkage between the spatial and attribute data. For each feature transferred to ArcInfoGIS® its own attribute table is automatically generated that define the non spatial parameters of the features. There is really no limit to what the tables can contain and different columns can be inserted, sorted and selected according to the user's need. The Attribute Table created in this study consists of the fields shown and described in Table 3.

| **Fields of Attribute Table** | | |
|---|---|---|
| **FIELD** | **DESCRIPTION** | **TYPE OF DATA** |
| **FID** | Feature ID | Numeric, Numbering done by GIS |
| **BASE** | Lower Height of a Feature | Numeric |
| **HEIGHT** | Upper Height of a Feature | Numeric |

**Table 3**: Fields of Attribute Table

**Step 5: Generation of a 3D View in ArcInfoGIS®.**

To display a 3D perspective view, the features of a 2D layer generated in AutoCAD® were assigned a base height and feature height from the fields of their own attribute table. The base height is the elevation value for the features of a layer in 3D space. The extrusion tool in ArcScene® of ArcInfoGIS® was used to change the polygons into 3D blocks. Different colors were assigned to layers to differentiate them and give a better view of the project.

**Step 6: Linking the 3D model with the construction schedule.**

To construct the spatial data of each activity in every floor a field named Task_ID was added to the Attribute Table of each component. The field Task_ID is common between the Attribute and Schedule tables and is used to establish the connection between each component and the corresponding activity in the schedule, according to the principles of any database. The attribute required to associate the components with the corresponding activities in the schedule are the entries in the field Task_ID. The linkage of the 3D model with construction schedule is shown in Fig 2.

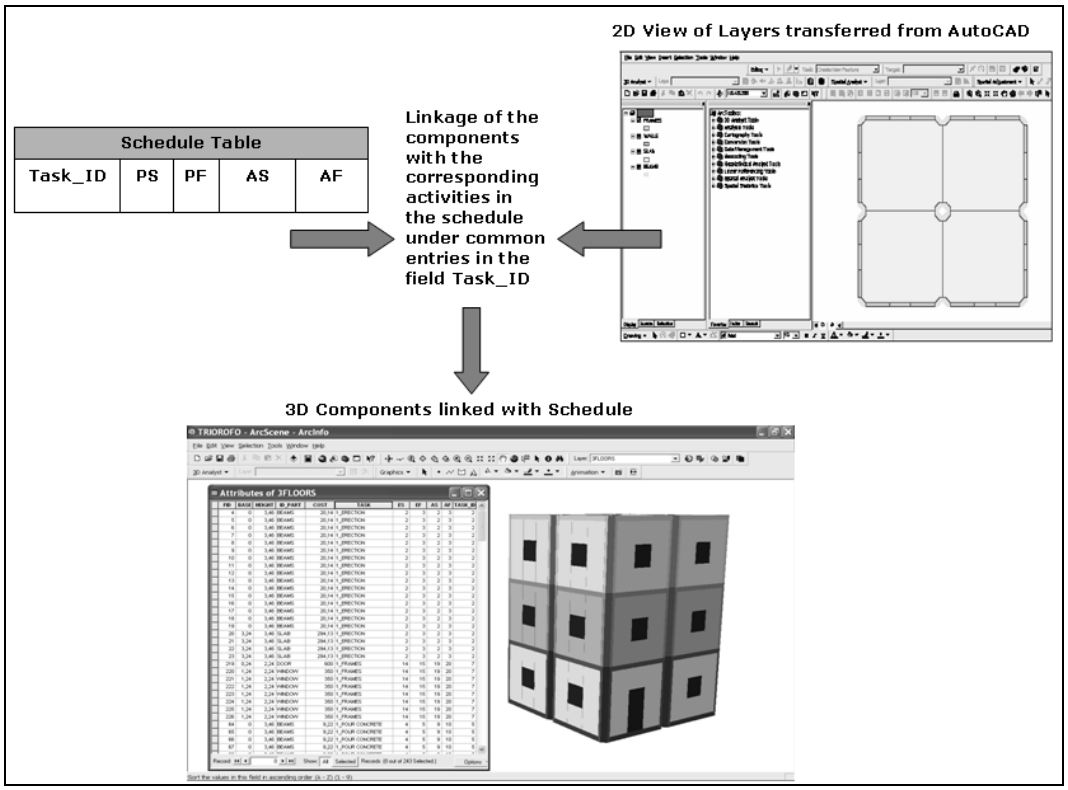


**Fig 2**: Linking the 3D model with construction schedule

**Step 7: Retrieving Information in a 3D View.**

Since space and time data are incorporated in a single GIS environment and a visual overview of the project can be created and used to reflect the situation. Features can be selected by their location or by their attributes, while more complex searches can be performed by combining queries. Progress information for an individual activity as well as for a set of activities can also be viewed. Fig 3 shows a 3D View of construction progress in a control date.

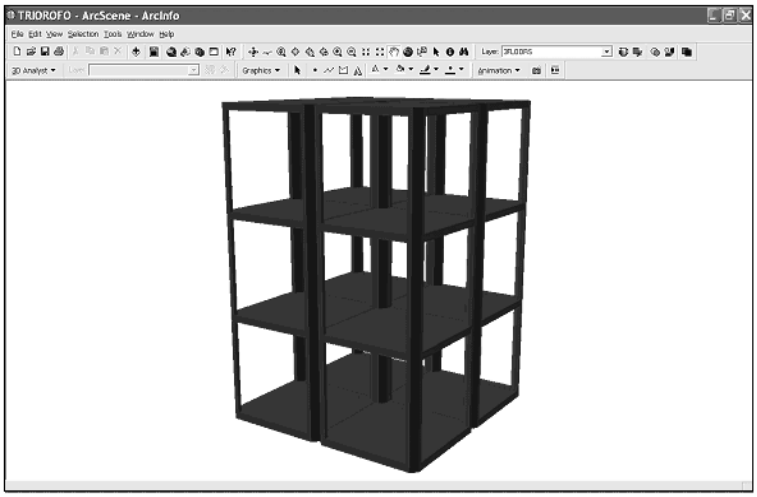


**Fig 3**: 3D View of the constructed components in a control date

## 3. Benefits and Limitations of the System

Scheduling techniques, such as RSM, do not provide any information about the spatial aspects of the activities of a construction project. To identify the building components, which are related to each activity or to interpret progress information, namely what is built at a particular time, users normally look at 2D drawings and conceptually gain spatial configuration of the project. This results to inconsistent interpretations and usually makes effective communication among the interested parties of the project difficult. With the proposed methodology, the spatial characteristics and relevant time data of the project can be displayed in GIS in order to obtain a better understanding of the project. This "visual" check of the schedule enables the user to avoid space conflicts and omission of activities, since all components are related to activities. Furthermore, the visual observation and understanding of the progress of the project helps the parties involved to communicate better.

The collection and management of various types of information efficiently and on demand is seen as the key for successful management of construction projects (Poku and Arditi 2006) and the capabilities of GIS to store huge data can be utilized towards this direction. The resulting GIS-based methodology maintains the project's spatial and time data in one digital database, which can be easily accessed and updated during the construction of the project. In the present study the required data were manually transferred into GIS, however work is underway to automate the process. The existing database could also be enriched by adding all sorts of information associated with the project (e.g. percent complete, material, cost, safety and quality control recommendation) in the attribute table.

It should be noted that this study was about time/space data integration and visualization rather than software integration into a single platform. This is an important limitation when it comes to case studies with a large amount of data.
Another limitation derived from the previous sentence is that data exchange between the two software packages (AutoCAD® and ArcInfoGIS®) is not automatic, as explained in detail in the previous paragraph. A dynamic exchange of data between any two software packages requires several rules and criteria regarding the format of the data.

Overall, the future challenge in this field of research is to create a single platform, on which construction scheduling tools are dynamically linked with the visualization tools. Data integration and transfer without interruption and user interference can deliver timely and accurate information to the interested parties.

## 4. Conclusions

The present paper acknowledges the advantages resulting from the visualisation of the project activities during the design or the construction phase and outlines a methodology for linking time with spatial data of a repetitive construction project.

A case study is used to illustrate the steps of the procedure which is straightforward. Practical considerations refer to the data interchange between the "spatial" software used and the data manipulation to obtain the desired attributes. This is however common in the computer technology and was expected. The benefits on the other hand from this application refer mainly to the common interpretation of the project schedule and the visualisation of space conflicts and

activity omissions. Concluding overall, "a frame in time" is always advancement in project management.

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*AA041*

# Conceptual Modeling of Cause and Effect Relationships among Crisis Elements in Projects Using Fuzzy Cognitive Maps

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## Abstract

During the project lifecycle, special treatment is required for crises, which may be prompted by the sudden trigger of internal or external perturbations, or they may be generated and become self-enforcing over time until a certain threshold-limit is reached. Crisis management, therefore, emerges as an essential systematic process, inherent in project management, which involves attempts to predict or identify potential crises that an organization may encounter, take precautions to prevent them, or minimize their effects. The variety of crisis types inhibits the generation of a unified treatment of crises; instead, it is more appropriate to isolate and group the most common crisis situations and their characteristics and aim to depict the relationships between crisis causes and effects.

In this work, we not only identify and verify these relationships but we also solicit the negative / positive effects between them and we assign a weight in it. To achieve this, we use the theory of Cognitive Maps (CMs) (based on qualitative reasoning) and its extension to Fuzzy Cognitive Maps (FCMs). Generally, the basic elements of a CM are simple, the concepts used are represented as nodes, and the causal relationships between these concepts are represented as directed arrows. Each arrow is characterized by a weight, a real value that indicates the effect of the causal relationship between nodes. The inputs and outputs of our model concern the basic characteristics of crisis and the ways of managing them.

The main deliverable of our work is the representation, using FCMs, of the relationships between crisis triggers and impacts, and the provision of a model of cross-correlations and interactions that can forecast the crisis outcomes depending on various confrontation strategies. We deepen our modeling by analyzing all the phases in the crisis "lifecycle" and, namely, pre-crisis, main crisis, re-establishment and learning, and model their inherent relationships. The resulting model provides an explanatory overview of the project crisis management mechanisms, useful for both the theorist and the practitioner.

## Keywords

Crises, Crisis Management techniques, Cognitive Maps, Fuzzy Cognitive Maps

## 1. Introduction

Enterprises are often threatened by crises, some of which could have been prevented or their impact lessened if knowledge of causal and influencing factors were known and better managed (Wang & Belardo (2005)). A critical situation may be caused by nature or may be man-made. The latter may result from the loss of technological control or from identifiable human errors, they may point to

deliberate attempts to reshape the social and political fabric, or they may follow from a constellation, if not sheer coincidence, of unfortunate factors. Crises can have international, domestic, local, or organizational dimensions, or a mixture of these. Crisis analysts have been trying to impose order on this variety by developing typologies of crisis events (Rosenthal & Kouzmin (1997)).

In this work, we use the theory of Cognitive Maps (CMs) (based on qualitative reasoning) and its extension to Fuzzy Cognitive Maps (FCMs) to model the relationships among internal and external elements (causes and effects) of crises. Generally, the basic elements of a CM are simple, the concepts used are represented as nodes, and the causal relationships between these concepts are represented as directed arrows. Each arrow is characterized by a weight, a real value that indicates the effect of the causal relationship between nodes. Their graph structure allows systematic causal propagation, in particular forward and backward chaining, and it allows knowledge bases to be grown by connecting different FCMs. FCMs are especially applicable in soft knowledge domains, where both the system concepts/ relationships and the meta-system language are fundamentally fuzzy, (Kosko (1986)). The inputs and outputs of our model concern the basic characteristics of crisis and the ways of managing them.

The paper is organized as follows: Section 2 provides the theoretical background on which the model is based, while Section 3 briefly describes the formulation and development of a FCM. Section 4 presents the CMs and FCMs for describing relationships between crisis characteristics and ways of crisis management. Finally our conclusions are presented in Section 5.

## 2. Background theory

Several definitions have been presented to describe what a crisis is. Some of these are included in the work of Hwang & Lichtenthal (1999) and are provided herein. According to Hermann, *a crisis may be defined as a situation with high threat level and short decision time that surprises the members of the decision-making unit*. Proposing a reformulated framework for crisis, Billings et al. suggested that *the extent of crisis depends on perceived value of possible loss, perceived probability of loss, and perceived time pressure*. Borrowing from definition-based research, Clark attempted to develop a tentative definition for crises. It consists of three elements: *threat to goals; reduced ability to control or direct the environment; and perceived time pressure*. Organizational crises are highly ambiguous situations where causes and effects are unknown, have a low probability of occurring but, nevertheless, pose a major threat to the survival of an organization and to organizational stakeholders, offer little time to respond, sometimes surprise organizational members and present a dilemma in need of decision or judgment that will result in change for better or worse (Pearson & Clair (1998)).

Although it is difficult for crises to be categorised, some researchers managed to group the crises depending on their common characteristics, the ways of management, as well as the results that they can have. The type of a business crisis can be determined by evaluating its degree of similarity to each of five major natural and man-made disasters, Earthquakes, Floods, Hurricanes, Nuclear Accidents, and Oil Spills. Such an evaluation is done by examining eight crisis characteristics, Exposure, Destructive Potential, Scope of Impact, Duration, Predictability, Controllability, Speed of Onset, and Length of Forewarning, of the crisis (Wang & Belardo (2005)).

Crisis can occur within any company, irrespective of the size. Also crises can occur when things are going extremely well. It has been noticed that companies that have been overwhelmingly successful for a long time tend to become complacent even though the initial assumptions and environment conditions have changed. Under these conditions, crises are more likely to occur (Kerzner (2005)).

Crisis management is defined as a systematic process by which an organization attempts to predict or identify potential crises that an organization may encounter, take precautions to prevent the crises, or minimize the effects of the crises (Preble (1997)). Organizational crisis management is a systematic attempt by members of the organization and external stakeholders to avert crises or to effectively manage those that do occur. Organizational crisis management effectiveness is evidenced when potential crises are averted or when key stakeholders believe that the success outcomes of short and long range impacts of crises outweigh the failure outcomes (Pearson & Clair (1998)). Crisis management efforts are effective when operations are sustained or resumed, organizational and external stakeholder losses are minimized, and learning occurs so that lessons are transferred to future incidents**.**

According to the above we can say that crisis is a situation with low probabilities of appearance and because of that can surprise the involved members who may face it subjectively, while it is certain that it can threaten organization's objectives or even its viability and for this reason it requires the direct reaction of all involved. Some of these characteristics, as also some of the basic crisis management techniques are used as concepts in our model in order to find out a general interaction between them.

## 3. Cognitive & Fuzzy Cognitive Maps

As far as Cognitive and Fuzzy cognitive maps are concerned, Cognitive Maps (CMs) firstly introduced in the 1970s by political scientist Robert Axelrod for representing social scientific knowledge. Axelrod's CMs are signed digraphs based on qualitative reasoning and can be used to cope with knowledge that generally involves many interacting concepts. Generally, the basic elements of a CM are simple: The concepts used by an individual decision-maker are represented as nodes, and the causal relationships between these concepts are represented as directed arrows. A positive edge from node A to node B means A casually increases B, while, a negative edge from A to B means casually decreases B. Cognitive Maps facilitate documentary coding, constructing symbolic representation of expert documents (Kosko (1986)). Kosko extended the graphs of Axelrod to the fuzzy mode thus creating Fuzzy Cognitive Maps (FCMs), which were originally proposed as a means of explaining political decision-making processes. Each arrow is now characterized by a weight, a real value that indicates the effect of the causal relationship between nodes. Carson and Fuller include a number of reports that describe such cases of FCM implementation modelling specific environments like decision-making and policymaking (Andreou *et. al*. (2004)).
The advantage of this representation is that it offers a global view of the various links between causal relationships and concepts in the model. Three different types of causal relationships between two nodes p and q (p→q) are represented in the map indicating the effects as follows:
- Positive (+) causality, in cases in which p promotes, enhances, or is a benefit to q. An increase in the cause variable will bring about an increase in the effect

variable, or a decrease in the cause concept will result to a decrease in the effect concept.
- Negative (-) causality, in cases in which p retards, prevents, or is harmful to q. In such cases an increase in the cause variable will end up with a decrease of the effect variable and vice-versa.
- No effect (0), when p has no effect on, or does not matter for q.

The introduction of fuzzy logic contributed to enhancing the potential of the CMs, indicating both the type of representation of the causal relationships between concepts (i.e., positive, negative, zero) and the degree or strength of this relationship. Fuzzy Cognitive Maps (FCMs) are soft computing tools, which combine elements of fuzzy logic and neural networks. FCM theory was developed recently as an extension of cognitive maps used for planning and decision-making in the fields of international relations, social systems modelling and the study of political developments in the context of such systems. Strictly speaking, a FCM is a figure composed of nodes and edges, the former introducing the qualitative concepts of the analysis while the latter indicate the various causal relationships. Each concept node possesses a numeric state, which denotes the qualitative measure of its presence in the conceptual domain. Thus, a high numerical value indicates that the concept is strongly present in the analysis while a negative or zero value indicates that the concept is not currently active or relevant to the conceptual domain.

An FCM works in discrete steps. When a strong positive correlation exists between the current state of a concept and that of another concept in a preceding period, we say that the former positively influences the latter, indicated by a positively weighted arrow directed from the causing to the influenced concept. By contrast, when a strong negative correlation exists, it reveals the existence of a negative causal relationship indicated by an arrow charged with a negative weight. Two conceptual nodes without a direct link are, obviously, independent.

## 4. FCMs for describing relationships between crisis characteristics and ways of crisis management

The methodology of CMs and FCMs is employed herein to develop a general model which uses the basic crisis characteristics and the basic management techniques as qualitative concepts, which are used at the preparation of an organization for a potential crisis, and during a crisis. The causal relationships between these concepts are indicative and accrued from literature. These qualitative concepts are summarized and described in Table 1; concepts C1 to C5 correspond to some crisis management techniques which take place during preparation of the organization for a potential crisis, concepts C6 to C15 correspond to basic and permanent crisis characteristics, while concepts C16 to C24 correspond to some crisis management techniques which take place during the crisis. Concepts C5 "Vulnerability minimization", C12 "Scope of Impact" and C23 "Prevent situation from getting worse/ Control damage", are considered fundamental for our model, and as such they will be further analyzed.

| | | | |
|---|---|---|---|
| C1 | Learning/ Experience acquisition/ Knowledge | C13 | Cognitive restrictions/ Ambiguity of cause, effect and means of resolution |
| C2 | Danger determination/ Forecast/ Evaluation | C14 | Adverse conditions of communication |
| C3 | Action plan/Alternative strategies | C15 | Subjectivity |

| | | | |
|---|---|---|---|
| C4 | Potential danger minimization | C16 | Ascertainment |
| C5 | Vulnerability minimization | C17 | Gather information |
| C6 | Probability | C18 | Risk determination |
| C7 | Predictability | C19 | Action plan determination |
| C8 | Warning signals | C20 | Stakeholders intervention |
| C9 | Speed of onset/ Time pressure | C21 | Bureaucracy expulsion |
| C10 | Controllability | C22 | Transparency |
| C11 | Destructive potential | C23 | Prevent situation from getting worse/ Control damage |
| C12 | Scope of impact | C24 | Stakeholders support/ Restore / Damage identification |

**Table 1:** Description of the concepts

The resulting CM is depicted in figure 1, where concepts are represented as nodes, and the causal relationships between these concepts are represented as directed arrows. The weights descriptions for the cognitive map are given in Table 2.

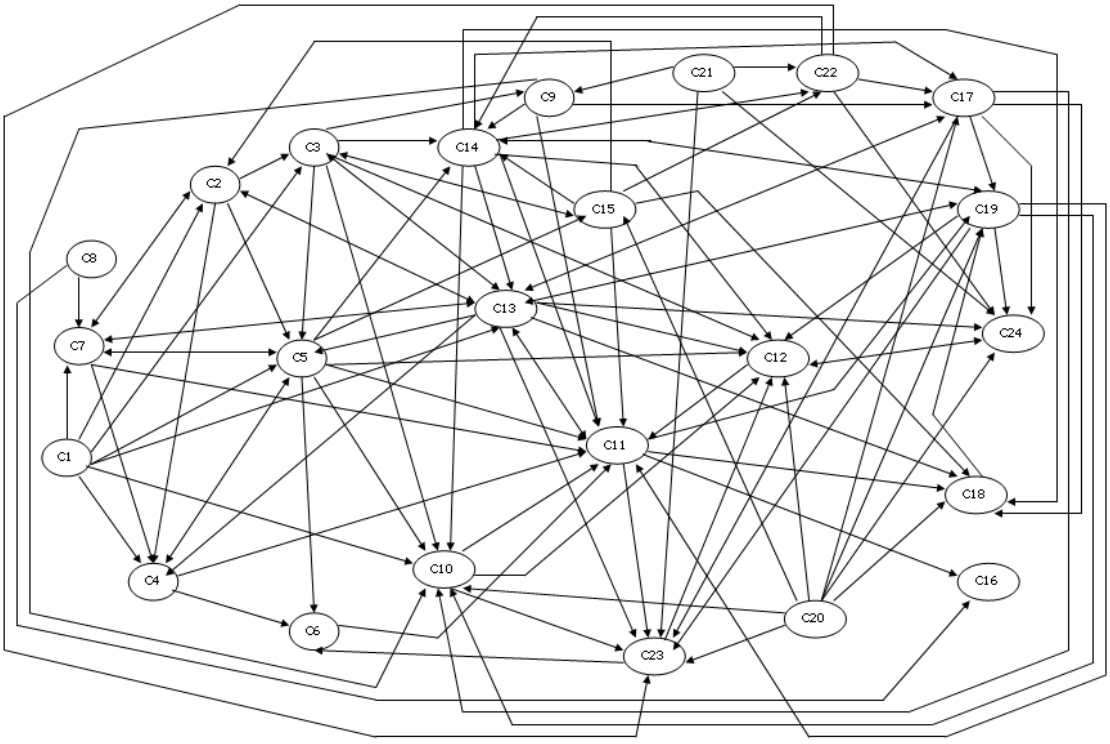


**Fig 1**: Cognitive Map 1, Relationships between Basic Crisis Characteristics and Ways of Management before Crisis occurs as also during the crisis

In Figure 1, we notice that concept C3 ("Action plan/Alternative strategies"), affects concepts C5 ("Vulnerability minimization"), C9 ("Speed of onset/ Time pressure"), C10 ("Controllability"), C12 ("Scope of impact"), C13 ("Cognitive restrictions/ Ambiguity of cause, effect and means of resolution"), C14 ("Adverse conditions of communication") and C15 ("Subjectivity"), while it is affected by concepts C1 ("Learning/ Experience acquisition/ Knowledge"), C2 ("Danger determination/ Forecast/ Evaluation"), C13 ("Cognitive restrictions/ Ambiguity of cause, effect and means of resolution") and C15 ("Subjectivity").

| | | | | | |
|---|---|---|---|---|---|
| W1: C1,C2 | W20: C4, C5 | W39: C9, C11 | W58: C15, C11 | W77: C15, C18 | W96: C20, C17 |
| W2: C1, C3 | W21: C4, C6 | W40: C9, C14 | W59: C15, C14 | W78: C15, C22 | W97: C20, C18 |
| W3: C1, C4 | W22: C4, C11 | W41: C10, C11 | W60: C8, C16 | W79: C17, C10 | W98: C20, C19 |
| W4: C1, C5 | W23: C5, C4 | W42: C10, C12 | W61: C9, C17 | W80: C17, C13 | W99: C20, C23 |
| W5: C1, C7 | W24: C5, C6 | W43: C11, C13 | W62: C10, C23 | W81: C17, C18 | W100: C20, C24 |
| W6: C1, C10 | W25: C5, C7 | W44: C12, C11 | W63: C11, C16 | W82: C17, C19 | W101: C21, C9 |
| W7: C1, C13 | W26: C5, C10 | W45: C13, C2 | W64: C11, C18 | W83: C17, C23 | W102: C21, C22 |
| W8: C2, C3 | W27: C5, C11 | W46: C13, C3 | W65: C11, C19 | W84: C17, C24 | W103: C21, C23 |
| W9: C2, C4 | W28: C5, C12 | W47: C13, C4 | W66: C11, C23 | W85: C18, C19 | W104: C21, C24 |
| W10: C2, C5 | W29: C5, C14 | W48: C13, C5 | W67: C12, C24 | W86: C19, C10 | W105: C22, C14 |
| W11: C2, C7 | W30: C5, C15 | W49: C13, C7 | W68: C13, C17 | W87: C19, C11 | W106: C22, C17 |
| W12: C2, C13 | W31: C6, C11 | W50: C13, C11 | W69: C13, C18 | W88: C19, C12 | W107: C22, C23 |
| W13: C3, C5 | W32: C7, C2 | W51: C13, C12 | W70: C13, C19 | W89: C19, C13 | W108: C22, C24 |
| W14: C3, C9 | W33: C7, C4 | W52: C14, C10 | W71: C13, C23 | W90: C19, C14 | W109: C23, C6 |
| W15: C3, C10 | W34: C7, C5 | W53: C14, C11 | W72: C13, C24 | W91: C19, C23 | W110: C23, C12 |
| W16: C3, C12 | W35: C7, C11 | W54: C14, C12 | W73: C14, C17 | W92: C19, C24 | W111: C24, C12 |
| W17: C3, C13 | W36: C7, C13 | W55: C14, C13 | W74: C14, C18 | W93: C20, C10 | |
| W18: C3, C14 | W37: C8, C7 | W56: C15, C2 | W75: C14, C19 | W94: C20, C12 | |
| W19: C3, C15 | W38: C9, C10 | W57: C15, C3 | W76: C14, C22 | W95: C20, C15 | |

**Table 2**: Description of the Weights for Cognitive Map in Figure 1

The types of causal relationships between the concepts (positive causality (+), negative causality (-) and no effect (0)) are shown in Table 3. We denote as $e_{ij}=e(C_i, C_j)$, the causal edge function value, where, the causality causal concept node $C_i$ impacts to $C_j$. $C_i$ causally increases $C_j$ if $e_{ij}=1$, causally decreases $C_j$ if $e_{ij}=-1$, and impacts no causality if $e_{ij}=0$ (Kosko (1986)). For example, in Table 3, concept $C_i$ = C1 which corresponds to "Learning/ Experience acquisition/ Knowledge" increases $C_j$=C2 which corresponds to "Danger determination/ Forecast/ Evaluation", while at the same time $C_i$=C1 decreases $C_j$=C13 which correspond to "Cognitive restrictions/ Ambiguity of cause, effect and means of resolution". Finally, concept C1 has no impact to concepts C6, C8, C9, C11, C12, C14 and C15 to C24.

In order to transform the CM into an FCM, fuzzy relations between concepts were introduced by assigning indicative weights depending on the amount of effect that we estimated as valid. More specifically, a weight of 0, 0.18, 0.36, 0.54, 0.72, 0.9 and 1 was assigned when the influence between two concepts was evaluated as absent, very weak, weak, medium, strong, very strong, and absolute, respectively. The weight matrix for the FCM is given in Table 4. As an example, a weight W1=0,72 represents a strong influence between concepts C1 "Learning/ Experience acquisition/ Knowledge" and C2 "Danger determination/ Forecast/ Evaluation". This is because earning knowledge and learning from previous critical situations can strongly increase the forecast of a potential critical situation, the evaluation of the potential critical situation, as also can strongly increase the danger determination.

| | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 | C11 | C12 | C13 | C14 | C15 | C16 | C17 | C18 | C19 | C20 | C21 | C22 | C23 | C24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | -1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C2 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | -1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C3 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | -1 | 1 | 0 | -1 | -1 | -1 | -1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C4 | 0 | 0 | 0 | 0 | 1 | -1 | 0 | 0 | 0 | 0 | -1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C5 | 0 | 0 | 0 | 1 | 0 | -1 | 1 | 0 | 0 | 1 | -1 | -1 | 0 | -1 | -1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C7 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | -1 | 0 | -1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C8 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1 | 1 | 0 | 0 | 1 | 0 | 0 | -1 | 0 | 0 | 0 | 0 | 0 | 0 |
| C10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | -1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1 | 0 |
| C11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | -1 | 0 |
| C12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| C13 | 0 | -1 | -1 | -1 | -1 | 0 | -1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | -1 | -1 | -1 | 0 | 0 | -1 | -1 |
| C14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1 | 1 | 1 | 1 | 0 | 0 | 0 | -1 | -1 | -1 | 0 | 0 | -1 | 0 | 0 |
| C15 | 0 | -1 | -1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | -1 | 0 | 0 | 0 | -1 | 0 | 0 |
| C16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | -1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 |
| C18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| C19 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | -1 | -1 | 1 | -1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| C20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | -1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 |
| C21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| C22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| C23 | 0 | 0 | 0 | 0 | 0 | -1 | 0 | 0 | 0 | 0 | 0 | -1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Table 3**: Adjacency-matrix representation for Cognitive Map in Fig 1.

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| W1 | W11 | W21 | W31 | W41 | W51 | W61 | W71 | W81 | W91 | W101 | W111 |
| 0,72 | 0,18 | -0,72 | 0,36 | -0,72 | 0,72 | -0,9 | -0,72 | 0,72 | 0,72 | -0,72 | 0,9 |
| W2 | W12 | W22 | W32 | W42 | W52 | W62 | W72 | W82 | W92 | W102 | |
| 0,9 | -0,72 | -0,54 | 0,72 | -0,18 | -0,72 | 0,72 | -0,72 | 0,72 | 0,72 | 0,72 | |
| W3 | W13 | W23 | W33 | W43 | W53 | W63 | W73 | W83 | W93 | W103 | |
| 0,54 | 0,9 | 0,9 | 0,54 | 0,18 | 0,54 | -0,18 | -0,72 | 0,54 | 0,72 | 0,54 | |
| W4 | W14 | W24 | W34 | W44 | W54 | W64 | W74 | W84 | W94 | W104 | |
| 0,72 | -0,18 | 0,72 | 0,36 | 0,72 | 0,18 | -0,36 | -0,54 | 0,54 | -0,18 | 0,54 | |
| W5 | W15 | W25 | W35 | W45 | W55 | W65 | W75 | W85 | W95 | W105 | |
| 0,54 | 0,72 | 0,72 | -0,18 | -0,9 | 0,54 | -0,36 | -0,54 | 0,72 | 0,54 | -0,72 | |
| W6 | W16 | W26 | W36 | W46 | W56 | W66 | W76 | W86 | W96 | W106 | |
| 0,72 | -0,36 | 0,54 | -0,18 | -0,9 | -0,54 | -0,54 | -0,54 | 0,54 | 0,54 | 0,9 | |
| W7 | W17 | W27 | W37 | W47 | W57 | W67 | W77 | W87 | W97 | W107 | |
| -0,72 | -0,54 | -0,18 | 0,72 | -0,72 | -0,36 | 0,72 | -0,72 | -0,54 | 0,36 | 0,72 | |
| W8 | W18 | W28 | W38 | W48 | W58 | W68 | W78 | W88 | W98 | W108 | |
| 0,9 | -0,54 | -0,54 | -0,54 | -0,9 | 0,36 | -0,9 | -0,18 | -0,54 | 0,36 | 0,54 | |
| W9 | W19 | W29 | W39 | W49 | W59 | W69 | W79 | W89 | W99 | W109 | |
| 0,54 | -0,18 | -0,54 | 0,18 | -0,54 | 0,18 | -0,9 | 0,72 | 0,54 | 0,72 | -0,18 | |
| W10 | W20 | W30 | W40 | W50 | W60 | W70 | W80 | W90 | W100 | W110 | |
| 0,72 | 0,9 | -0,36 | 0,36 | 0,72 | 0,72 | -0,9 | -0,9 | -0,72 | 0,72 | -0,9 | |

**Table 4**: Weight matrix for Fuzzy Cognitive Map, in Fig 1.

In our FCM, weights W23 to W30 represent the degree of direct influence that vulnerability (C5) can have to potential threat minimization (C4), probability for a critical situation to occur (C6), the possible predictability that the critical situation

can have (C7), the controllability (C10), the destructive potential (C11), the possible scope of impact that the critical situation can have (C12), the adverse conditions of communication (C14) and the stakeholders' subjectivity (C15). Other concepts are analyzed in the same manner. The final results concern the interactions that possible changes in concepts' influence can have in the vulnerability, in the scope of impact and in control of damage concepts.

## 5. Conclusions

Following the presentation and construction of a CM and an FCM model, we attempted to analyze the possible relationships and effects between crisis characteristics and basic crisis management techniques. The concepts that we mainly examined are the vulnerability that an organization may have and how it can be influenced by the crisis characteristics as well as by the crisis management techniques and the scope of impact that a critical situation can have in the organisation after its end. We also examined how crisis characteristics and crisis management techniques can affect the control of damage and the prevention of the situation from getting worse during, or after the end of crisis. The model that we introduced can be used as a general matrix for examining certain critical situations and how their characteristics can be influenced by the basic management techniques that we examined and may trigger further investigation on the temporal evolution of crisis elements as a result of changes in crisis causes.

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*AA032*

# Two-Party Risk Assessment and Allocation Model

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## Abstract
Over the past few decades, numerous research efforts have been undertaken concerning the allocation of construction risks. Nevertheless, industry participants remain concerned over the current practice of risk allocation/misallocation within construction contracting. Based on this problem, a research product that would aid contracting parties in determining how each risk can best be identified, assessed, and allocated was developed. The risk allocation model is called the "Single-Party Risk Assessment Worksheet" and is to be used internally to facilitate risk alignment within each party's organization. The results are later compared in the "Two-Party Risk Assessment Worksheet" in order to begin the cooperative assessment and allocation process. This paper presents the risk assessment tools developed and the details of the worksheets.

## Keywords
Project management, Risk analysis, Construction risk

## 1. Introduction

Risk – defined in Webster's dictionary as "The possibility of loss or injury or someone or something that creates or suggests a hazard" – is a reality that every construction company faces on a daily basis. Construction companies often realize risk at an elevated level due to the high risk nature of the business. As a result, allocation of risk in the construction industry is often a controversial process with each party attempting to avoid as much risk as possible by drafting or negotiating favorable, biased contract terms. This aversion mindset often results in risk being misallocated to inappropriate parties. Contractual misallocation of risk is cited as the leading cause of construction disputes in the United States (Megens (1997)); (Smith (1995)).

Some risks are best dealt with through direct contract language, while other risks are best dealt with through project execution and performance. Due to the need for a standardized risk allocation process, this paper aids contracting parties in determining how each risk in a construction contract can be successfully identified, assessed, and allocated.

## 2. Research Methodology

In order to provide owners and contractors with a research product that would serve to identify, assess, and appropriately allocate construction risks, a strict research methodology was undertaken. The research methodology set forth was a

two-fold process: the data collection methodology and the model development methodology. Fig. 1 provides an overview of the overall research methodology. The bolded boxes represent the primary data collection results, while all dashed-line boxes signify outside consultation initiated by the author to finalize data collection results and various model components. It should be noted that this research was conducted under the guidance of the Construction Industry Institute Research Team 2010 (CII).

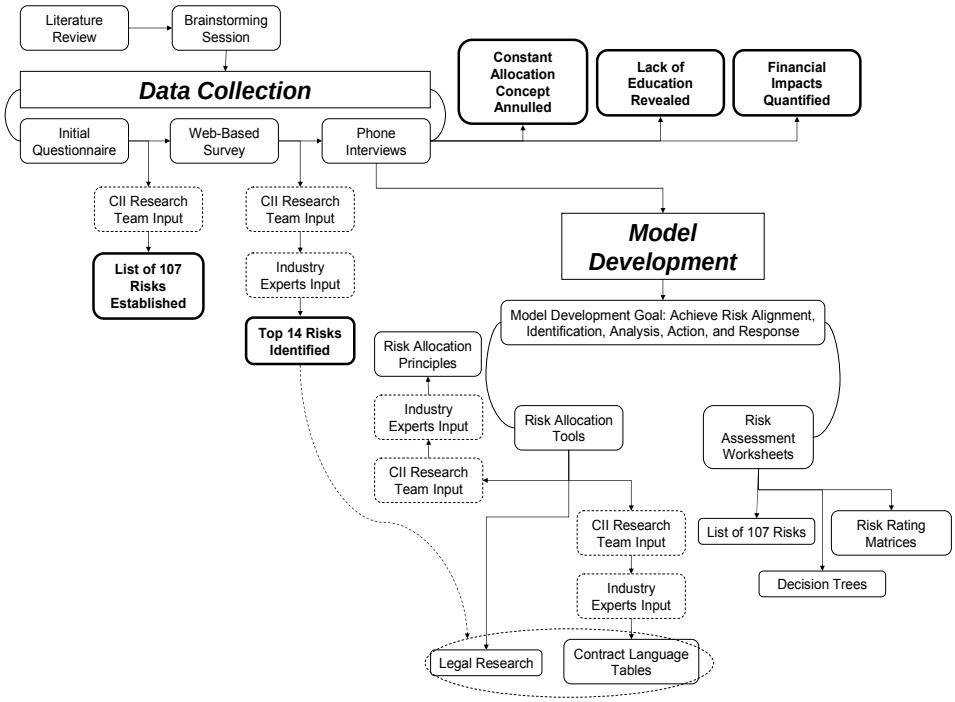



**Fig. 1:** Research Methodology Flow Diagram

## 3. Model Development Methodology

After the multiple phases of data collection were complete, the structure of the risk assessment and allocation model was formed by establishing four phases: risk alignment, risk identification, risk analysis, and risk action. Subsequently, the "Single-Party Risk Assessment Worksheet" was developed to be used internally to facilitate alignment within each party's own organization. After each party has used a single-party worksheet, their individual assessments can be automatically compared in the "Two-Party Risk Assessment Worksheet" to begin the cooperative assessment and allocation process.

## 4. Risk Identification

Risk identification is a two-party process that involves identifying risks that have the potential to be inappropriately allocated and documenting their possible time and cost impacts. This research identifies 107 risk factors along with their definition.

## 5. Risk Analysis

Risk analysis is the single-party and two-party process of assessing each identified risk and determining its specific attributes and characteristics. In this model, risk

analysis is performed by assessing five primary attributes of each identified risk: (1) Likelihood of Risk Realization (L.O.R.R), (2) Relative Impact (R.I), (3) Risk Rating = L.O.R.R x R.I, (4) Risk Rating Disagreement = Party 1 Risk Rating – Party 2 Risk Rating, and (5)Combined Risk Rating = Party 1 Risk Rating x Party 2 Risk Rating.

## 5.1 Likelihood of Risk Realization (L.O.R.R)

The likelihood of risk realization is assigned using a numerical value from zero (0) to five (5). Zero (0) indicates that the risk is not applicable to the project, one (1) indicates that the risk has a very low chance of occurring (<10%) and five (5) indicates that the risk has a very high chance (>90%) of occurring.

## 5.2 Relative Impact (RI)

The RI of a risk is assigned using a numerical value from zero (1) to five (5). Zero (0) indicates that the risk is not applicable to the project, one (1) indicates that the impact would be negligible and five (5) indicates that the risk would have a severe impact on the project.

## 5.3 Risk Rating

The risk rating is the product of the LORR and the RI of the risk. The value of risk rating can range from a minimum of one (1) to a maximum of twenty-five (25). A rating of one (1) indicates a low likelihood of risk realization (LORR) and a low relative impact (RI), while a rating of twenty-five (25) indicates a high likelihood of risk realization and a high relative impact.

The risk rating value helps the single-party user assess which risks have more potential for inappropriate allocation and therefore which risks should be given the highest priority to optimize allocation.

## 5.4 Risk Rating Disagreement

The risk rating disagreement is the absolute difference between the two parties' individual risk ratings for the risk. This different represents the degree to which the two contracting parties disagree on the importance of a risk. A large risk rating disagreement may indicate that one of the contracting parties possesses information that the other contracting party is unaware of.

## 5.5 Combined Risk Rating

The combined risk rating is the product of party 1 and party 2 risk ratings. The purpose of calculating the combined risk rating is to identify the risks that both parties feel are in need of high attention and concern so that they can be brought to the table for balanced discussion and appropriate allocation.

# 6. Risk Action

After risk analysis, risk action needs to take place. Risk action can be defined as a two-party process of developing and recommending actions to enhance probability for project success.

# 7. Single-Party Risk Assessment Worksheet

The single-party risk assessment worksheet is used for internal risk alignment within the contracting party. In this case, single-party means that each party will individually fill out its assigned worksheet, "party 1 risk assessment worksheet" or "party 2 risk assessment worksheet". The contracting party initiating the application of the risk assessment worksheets, typically the buyer entity, should use the "party 1 risk assessment worksheet", thus taking on the title of "party 1". The remaining party will use the "party 2 risk assessment worksheet".

## 7.1 The Six Sections of the Single-Party Risk Assessment Worksheet

The single-party risk assessment worksheets are broken into six different sections: (1) Datasheet, (2) List of Risks, (3) Risk Assessment, (4) Buyer Decision Tree, (5) Seller Decision Tree, and (6) Risk Allocation Principles. The last three are outside the scope of this paper. Each of these six sections has a separate spreadsheet within the single-party risk assessment worksheets.

### 7.1.1. Section One: Datasheet

The datasheet section contains information on the project name, title of party 1, date of assessment, purpose of assessment, estimated project cost and time, and timing of assessment. The "purpose of assessment" will either be for a single-party (internal) assessment or a two-party (cooperative) assessment.

### 7.1.2. Section Two: List of Risks

The "List of Risks" section initially allocates 50 rows so that the user can enter a list of customized risks if so desire. If more rows are required, they can be inserted by "right clicking" and inserting. Some contracting parties may find it more manageable to create a customized "List of Risks" for each project.

### 7.1.3. Section Three: Risk Assessment

The third section of the worksheet is where the single-party internal assessment of risks is accomplished.Fig.shows the initial view of the risk assessment section of the worksheet.

| | A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Party 1 Risk Assessment Worksheet | | | | | | | | | | |
| 2 | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) |
| 3 | List of Risks | Risk Applies? | Contract Risk? | Likelihood of Risk Realization (0-5) | Relative Impact (0-5) | Risk Rating (0-25) | Expected Value of the Risk | Recommended Action | Risk Allocation Recommendation | "1-5" Risk? | Comments |
| 4 | Customized List | | | | | | | | | | |
| 5 | | | | 0 | 0 | 0 | | | | | |
| 6 | | | | 0 | 0 | 0 | | | | | |
| 7 | | | | 0 | 0 | 0 | | | | | |
| 8 | | | | 0 | 0 | 0 | | | | | |
| 9 | | | | 0 | 0 | 0 | | | | | |
| 10 | | | | 0 | 0 | 0 | | | | | |
| 11 | | | | 0 | 0 | 0 | | | | | |
| 12 | | | | 0 | 0 | 0 | | | | | |
| 13 | | | | 0 | 0 | 0 | | | | | |
| 14 | | | | 0 | 0 | 0 | | | | | |
| 15 | | | | 0 | 0 | 0 | | | | | |
| 16 | | | | 0 | 0 | 0 | | | | | |
| 17 | | | | 0 | 0 | 0 | | | | | |
| 18 | | | | 0 | 0 | 0 | | | | | |
| 19 | | | | 0 | 0 | 0 | | | | | |
| 20 | | | | 0 | 0 | 0 | | | | | |
| 21 | | | | 0 | 0 | 0 | | | | | |
| 22 | | | | 0 | 0 | 0 | | | | | |
| 23 | | | | 0 | 0 | 0 | | | | | |
| 24 | | | | 0 | 0 | 0 | | | | | |
| 25 | | | | 0 | 0 | 0 | | | | | |
| 26 | | | | 0 | 0 | 0 | | | | | |
| 27 | | | | 0 | 0 | 0 | | | | | |
| 28 | | | | 0 | 0 | 0 | | | | | |
| 29 | | | | 0 | 0 | 0 | | | | | |
| 30 | | | | 0 | 0 | 0 | | | | | |

1. Datasheet | 2. List of Risks | 3. Party 1 Risk Assessment | 4. Buyer Decision Tree | 5. Seller Decision Tree | 6. Risk Allocation Principles

**Fig. 2:** Initial View of the "Party 1 Risk Assessment" Section

The contents of the risk assessment section are:

1. Column 1 – List of Risks
   This column is automatically filled in when the "List of Risks" in datasheet section is exported.
2. Column 2 – Risk Applies?
   This column allows the individual user to track which risks apply to the project in question and which ones do not.
3. Column 3 – Contract Risk?
   This column provides a means for the user to track which risks can and cannot be effectively allocated via direct contract language.
4. Column 4 – Likelihood of Risk Realization (LORR)
   This column is where the user will give each risk a value of 0 to 5 for the likelihood that the risk will occur or materialize during the project life cycle.
5. Column 5 – Relative Impact (RI)
   This column is where the user will assign a relative impact value that will be realized if the risk materializes.
6. Column 6 – Risk Rating (RR)
   This column will automatically fill in with the product of the LORR and RI from columns 4 and 5, respectively.
7. Column 7 – Expected Value of the Risk
   This column is set aside for the user to manually enter the expected value of the risk. The expected value is equal to the LORR in terms of actual percentage (%) multiplied by the RI in terms of actual cost or time.
8. Column 8 – Recommended Action
   This column is where the individual user will internally determine by what means each risk should be appropriately allocated.
9. Column 9 – Risk Allocation Recommendation
   Column 9 will record which contracting entity will assume the risk according to the recommended action specified in column 8.
10. Column 10 –"1-5" Risk?
    This column is reserved to indicate if the party has assessed a risk as a "1-5" risk, meaning the user has given a risk a LORR of one (1) and a RI of five (5). The cell in column 10 will received a red "X" if a "1-5" risk is detected. The reason for "red-flagging" this type of risk is that, although this risk has a very low likelihood of occurrence, it will have extreme impacts if it does materialize.
11. Column 11 – Comments
    This column is reserved for comments that the user may have concerning each particular risk.

## 8. Two-Party Risk Assessment Worksheet

The purpose of the two-party assessment worksheet is to conduct external risk alignment for a particular project and decide which risks are worth extra external efforts in determining optimum allocation and which risks can be left as stated or inferred in the contract documents. Before the two-party risk assessment worksheet is applied, completed versions of the "Party 1" and "Party 2" worksheets from the previous "Single-Party Risk Assessment Worksheet" will need to be obtained by the party that will be managing the two-party assessment (typically the buyer party).

## 8.1 The Three Sections of the Two-Party Risk Assessment Worksheet

The two-party risk assessment worksheet consists of three distinct sections: (1) Datasheet, (2) Two-Party Risk Assessment, and (3) Risk Allocation Principles. Each of these three sections has a separate spreadsheet within the two-party risk assessment worksheets.

### 8.1.1. Section One: Datasheet

With a few exceptions, the two-party worksheet "Datasheet" is very similar to the single-party worksheet "Datasheet". The datasheet section contains information on the project name, title of party 1, date of assessment, purpose of assessment, estimated project cost and time, and timing of assessment. However, the "purpose of assessment" is "Two-Party (Cooperative) Assessment" by default and the "Timing of Assessment" options are limited.

### 8.1.2. Section Two: Two-Party Risk Assessment

The second section of the two-party risk assessment worksheet is where the two-party assessment of risks is accomplished. This section is the most integral portion of the two-party risk assessment worksheet. Figure 3 shows the initial view of the "Two-Party Risk Assessment" section of the two-party risk assessment worksheet.

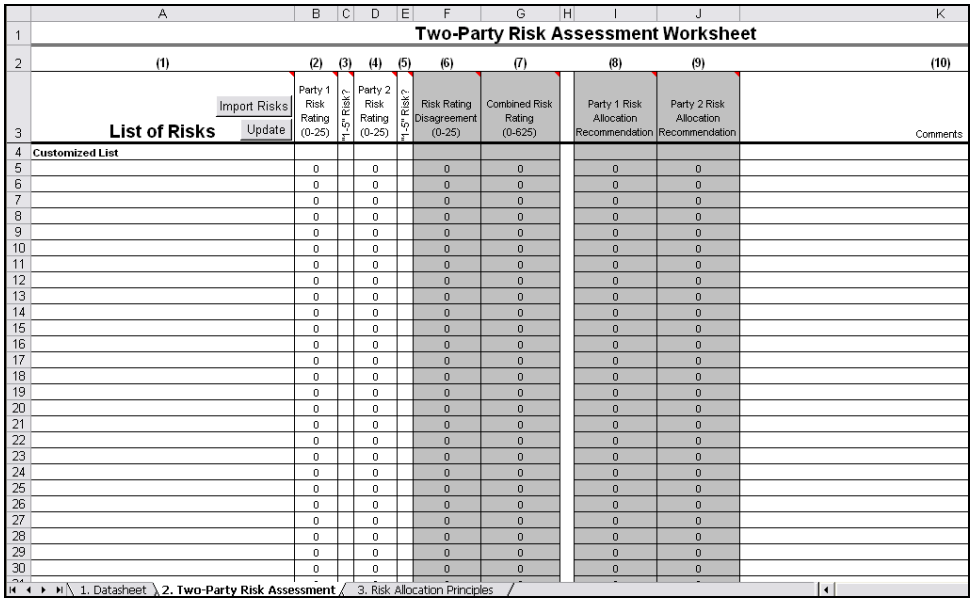



**Figure 3:** Initial View of the "Two-Party Risk Assessment" Section

The contents of section two are as follows:

1. Column 1 – List of Risks
   This column is automatically filled in with the "List of Risks" from the party 1 risk assessment worksheet "2. List of Risks" section. Subsequently, if the "List of Risks" was properly developed and transferred between the party 1 and 2 worksheets, all three worksheets will contain the exact same "List of Risks" in the exact same rows.
2. Column 2 – Party 1 Risk Rating

This column automatically references the risk rating from the party 1 risk assessment worksheet for each particular risk.

3. Column 3 – "1-5" Risk?
   If party 1 assesses a risk as a "1-5" risk, this column will indicate this with a red "X". This will ensure that both parties are aware of all party 1 "1-5" risks.
4. Column 4 – Party 2 Risk Rating
   This column automatically references the risk rating from the party 2 risk assessment worksheet for each particular risk.
5. Column 5 – "1-5" Risk?
   If party 2 assesses a risk as a "1-5" risk, this column will indicate this with a red "X". This will ensure that both parties are aware of all party 2 "1-5" risks.
6. Column 6 – Risk Rating Disagreement
   This column computes the risk rating disagreement. The maximum disagreement possible is 25. This extreme situation occurs when one party feels that the risk does not apply to the project, while the other party not only thinks that the risk applies but assigns it a five (5) for both LORR and RI.
7. Column 7 – Combined Risk Rating
   This column computes the combined risk rating. The combined risk rating is the product of the party 1 and party 2 risk ratings (Combined Risk Rating = Party 1 Risk Rating x Party 2 Risk Rating). The maximum possible value is 625, and occurs when both parties assign a five (5) to both the LORR and RI for a particular risk.

8. Column 8 – Party 1 Risk Allocation Recommendation
   This column will automatically fill in with the recommendations contained in column 9 of the party 1 risk assessment worksheet.
9. Column 9 – Party 2 Risk Allocation Recommendation
   This column will automatically fill in with the recommendations contained in column 9 of the party 2 risk assessment worksheet.
10. Column 10 – Comments
    This column is reserved for comments that the contracting parties may wish to make concerning the two-party assessment of each particular risk.

### 8.1.3. Section Three: Risk Allocation Principles

The third section of the two-party risk assessment worksheet contains risk allocation principles, and is beyond the scope of this paper.

## 8.2 Interpreting Two-Party Worksheet Notification

The two-party risk assessment worksheet has several different means by which the contracting parties are notified of risk issues that need the most cooperative attention to ensure appropriate allocation: (1) "1-5" risk red-flagging, (2) Risk rating disagreement, (3) Combined risk rating, and (4) Recommended risk allocation comparison.

Multiple notifications may occur within the two-party risk assessment worksheet for the same risk. Contracting parties need to be aware of how to interpret the different notification scenarios that may arise when using the two-party risk assessment worksheet. Severe conflicts require a discussion between parties to insure that the risk is properly allocated.

## 9. Conclusion

It is clear that optimum risk allocation is highly dependent on project-specific circumstances and participants. Recognizing these industry needs, a model called "Single-Party Risk Assessment Worksheet" was developed to allow the participants to perform internal risk alignment before contracting. Also, a model called "Two-Party Risk Assessment Worksheet" was also developed to allow participants to perform external risk alignment.

Construction will always have risk associated with it. However, careful drafting of construction contract clauses can allocate risk where it appropriately belongs, thereby eliminating some of the uncertainty and legal argument of common law principles.

## 10. References

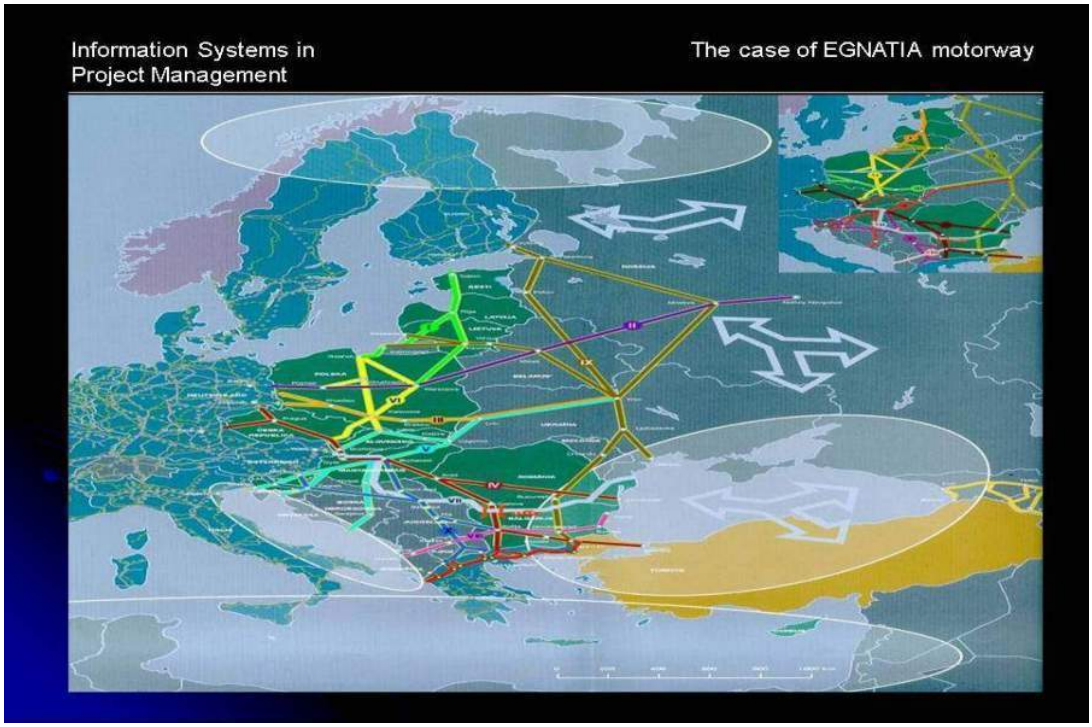
Megens, P. (1997) "Construction Risk and Project Finance - Risk Allocation as Viewed by Contractors and Financiers", *The International Construction Law Review*, 14(3), 5-32.

Smith, R.J. (1995) "Risk Identification and Allocation: Saving Money by Improving Contracts and Contracting Practices." *The International Construction Law Review*, 12(1).

*ITPM1*

# The use of Project Management Systems in Road Construction Projects:The case of the EGNATIA motorway

Thanassis Iatropoulos
*(Information Technology Manager, EGNATIA ODOS S.A., Thessaloniki, Greece)*



Information Systems in Project Management — The case of EGNATIA motorway

## The Project Identity

| | |
|---|---|
| Total length (main axis) : | 670 klm stretching from Igoumenitsa in the Prefecture of Thesprotia to Kipi in the Prefecture of Evros |
| Technical characteristics : | Dual carriageway of international standards with two traffic lanes per direction, a central reserve and an emergency lane. |
| Typical cross-section : | 24,5 meters |

## Major construction units

- 62 road interchanges
- 350 entrance / exit overbridges and underpasses
- 529 major bridges, with a total length of nearly 40 km, and many small ones
- 73 tunnels up to 4,8km long, with a total length of nearly 49,5km (or 99 km measured as single-carriageway ones)
- 43 river crossings
- 11 railway crossings

3

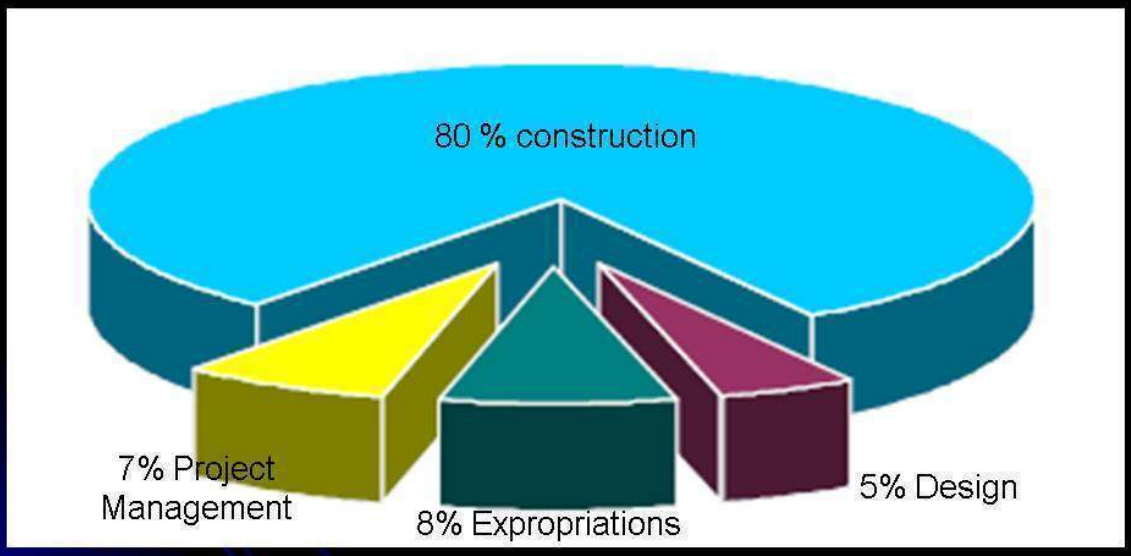
Information Systems in Project Management — The case of EGNATIA motorway

| | | TRAVEL TIME | |
|---|---|---|---|
| ORIGIN | DESTINATION | BEFORE | EGNATIA MOTORWAY |
| Igoumenitsa | Kipoi | 11 hours and 30' | 6 hours and 10' |
| Igoumenitsa | Ioannina | 1 hour and 45' | 45' |
| Ioannina | Thessaloniki | 5 hours | 2 hours and 15' |
| Thessaloniki | Kavala | 2 hours and 15' | 1 hour and 15' |
| Kavala | Alexandroupoli | 2 hours and 20' | 1 hour and 15' |
| Alexandroupoli | Kipoi | 25' | 15' |

4

Information Systems in Project Management

The case of EGNATIA motorway

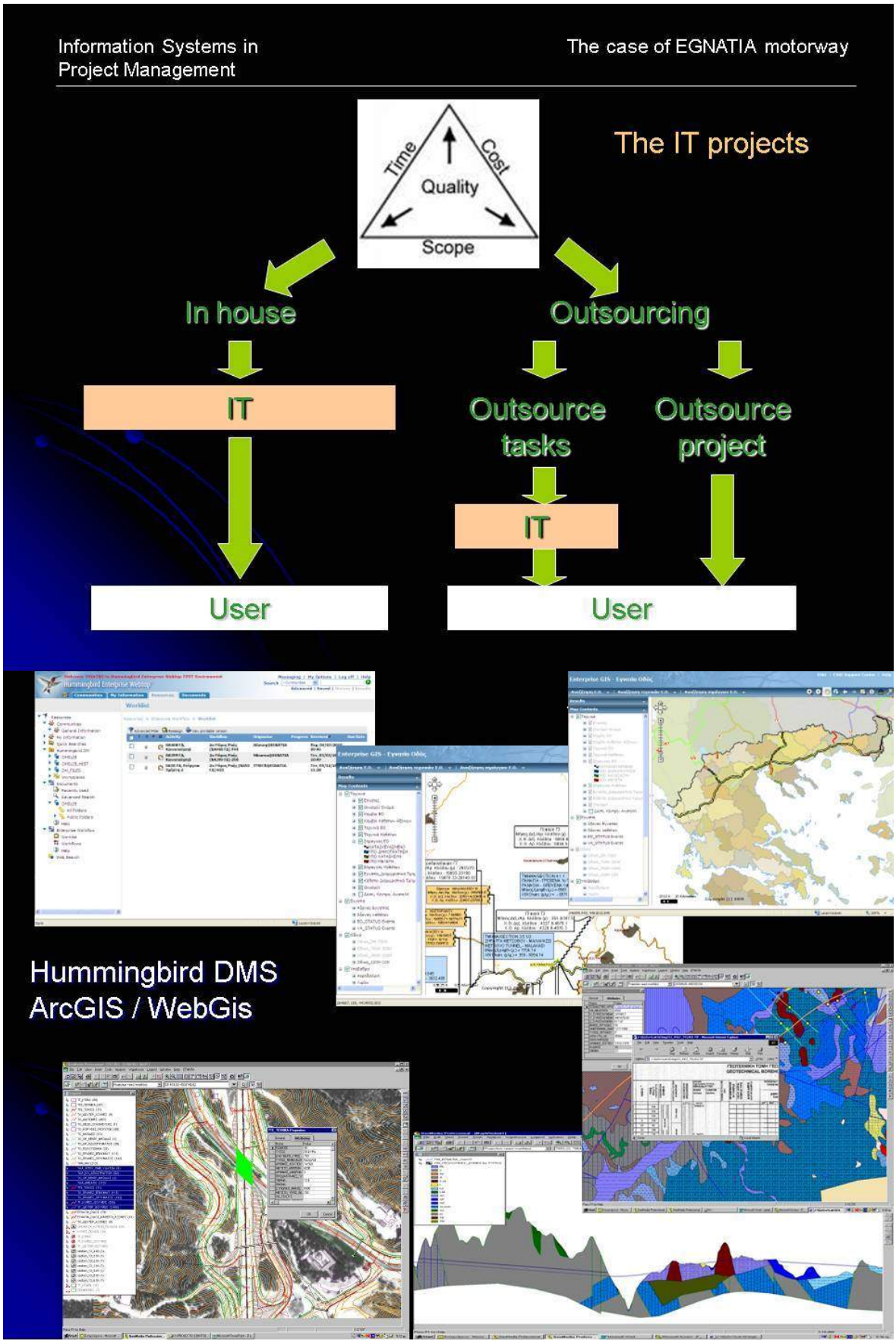



Total funding: 5.900 M€ (without VAT)

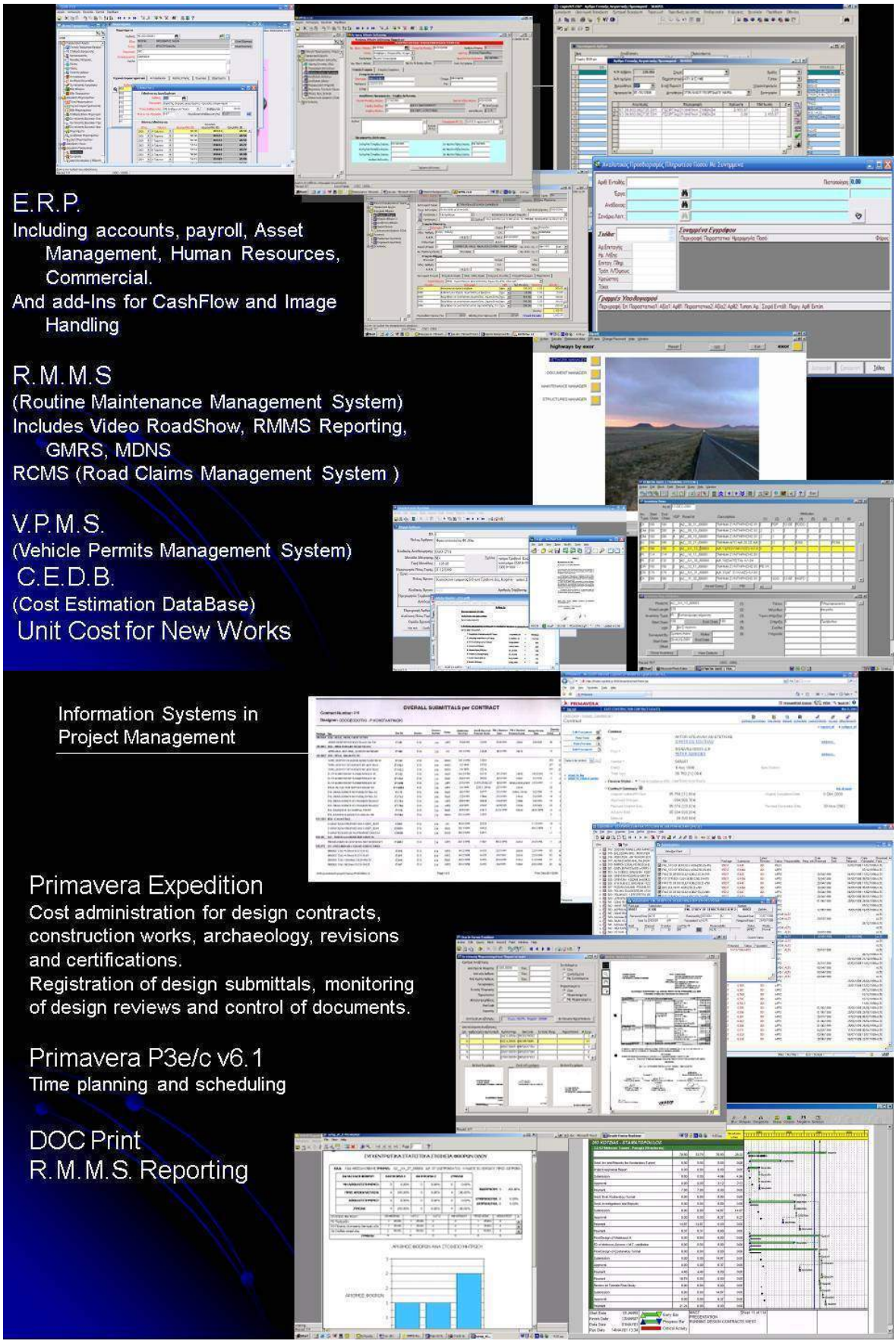
45% EU Contribution
55% Greek state

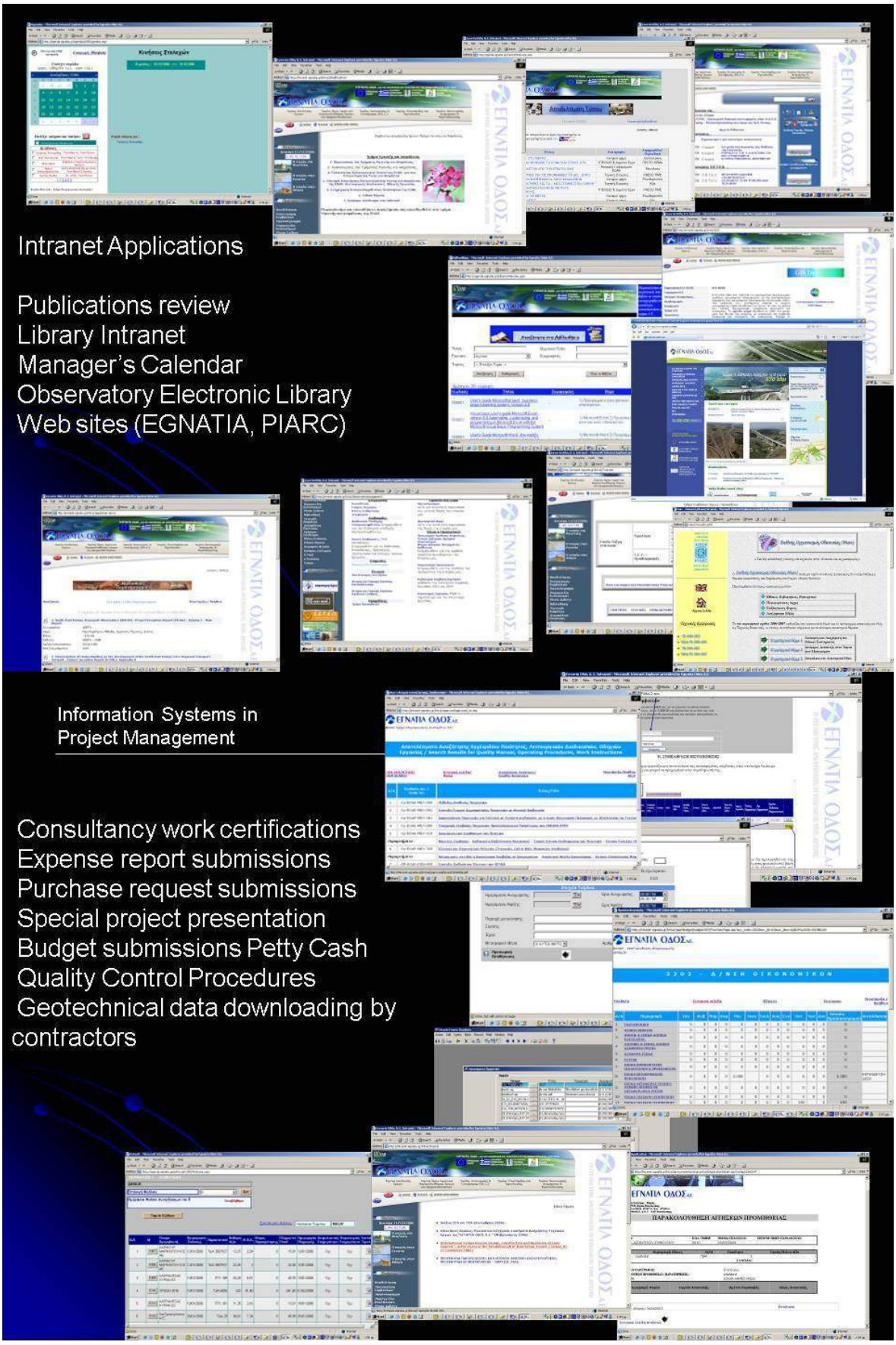
PREVEZA

60


Information Systems in
Project Management
The case of EGNATIA motorway
Time
Cost
Quality
Scope
The IT projects
In house
Outsourcing
IT
Outsource
tasks
Outsource
project
IT
User
User
Hummingbird DMS
ArcGIS / WebGis

Public Relations DB
Expense Reports for staff / consultants
Expense Reports for suppliers
Electric power consumption billing
Purchase Request Administration
Mobile Equipment Inventory Management
Incident Registration / Tunnels
IT Inventory
IT Helpdesk
Fixed Assets Labelling
Budget EO
TRAINING Database
ELEXICON (Bilingual Dictionary of Technical Terminology)
EBMS
Bridge Management System (maintenance)
BRIDGE Database
Registration of maintenance tasks on bridges
Technical Secretariat Expense Administration
Traffic Accident Report Administration


E.R.P.
Including accounts, payroll, Asset Management, Human Resources, Commercial.
And add-Ins for CashFlow and Image Handling
R.M.M.S
(Routine Maintenance Management System)
Includes Video RoadShow, RMMS Reporting, GMRS, MDNS
RCMS (Road Claims Management System )
V.P.M.S.
(Vehicle Permits Management System)
C.E.D.B.
(Cost Estimation DataBase)
Unit Cost for New Works
Information Systems in Project Management
Primavera Expedition
Cost administration for design contracts, construction works, archaeology, revisions and certifications.
Registration of design submittals, monitoring of design reviews and control of documents.
Primavera P3e/c v6.1
Time planning and scheduling
DOC Print
R.M.M.S. Reporting


Intranet Applications
Publications review
Library Intranet
Manager's Calendar
Observatory Electronic Library
Web sites (EGNATIA, PIARC)
Information Systems in Project Management
Consultancy work certifications
Expense report submissions
Purchase request submissions
Special project presentation
Budget submissions Petty Cash
Quality Control Procedures
Geotechnical data downloading by contractors

Information Systems in Project Management

The case of EGNATIA motorway

## Design tools for construction works

1. Estimation of earthquake activities (EQE)
2. Design tools (AutoCAD, ODOS, Anadelta)
3. Statistical analysis (CUBUS, SOFISTIK)
4. Surface handling tool (Surfer)
5. Tunnel lighting design tools (Calculux, Schreder/Tunnel)
6. Design review tools (Civiltech, ERGOLIPTIS, ERGO XP)
7. Geotechnical tools (DIPS, Rockfall, Slide, SWEDGE, Slope Indicator / DIMM)
8. Excavation design tools (UNWEDGE, Phase)
9. Tunnel ventilation control (SOLVENT)

Information Systems in Project Management

The case of EGNATIA motorway

## Telematics applications

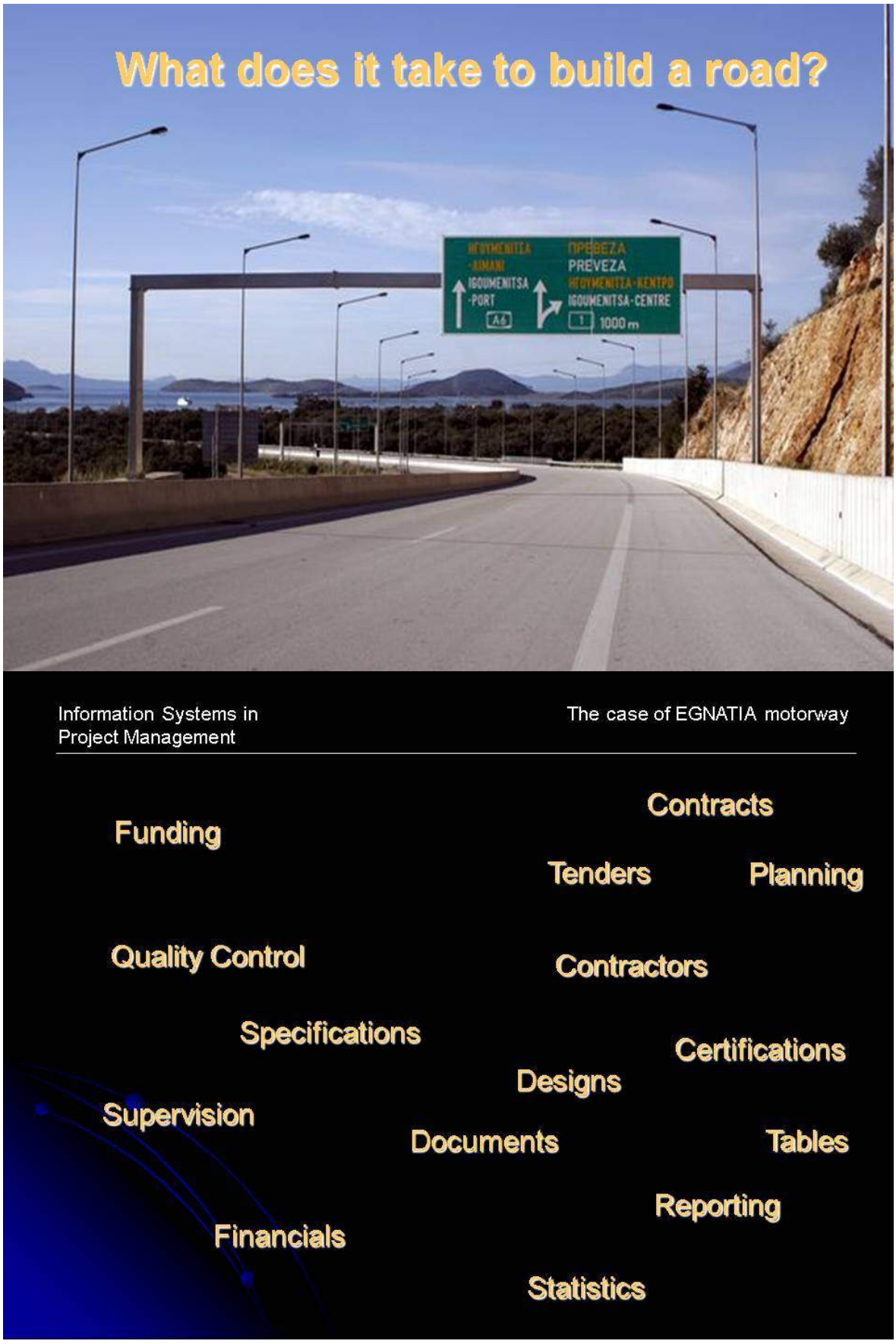
Weather conditions forecasting (weather stations)

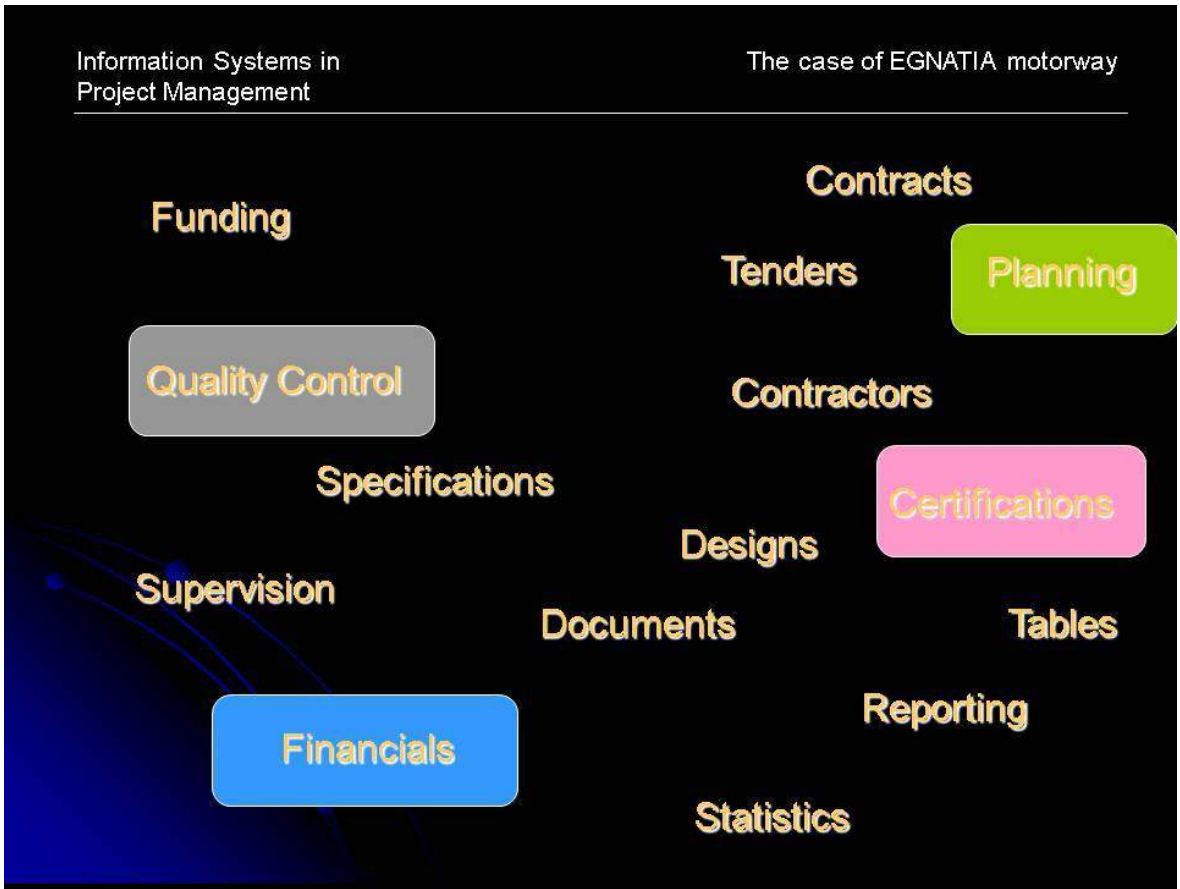
Traffic monitoring and incident management (CCTV, SOS phones, AID)

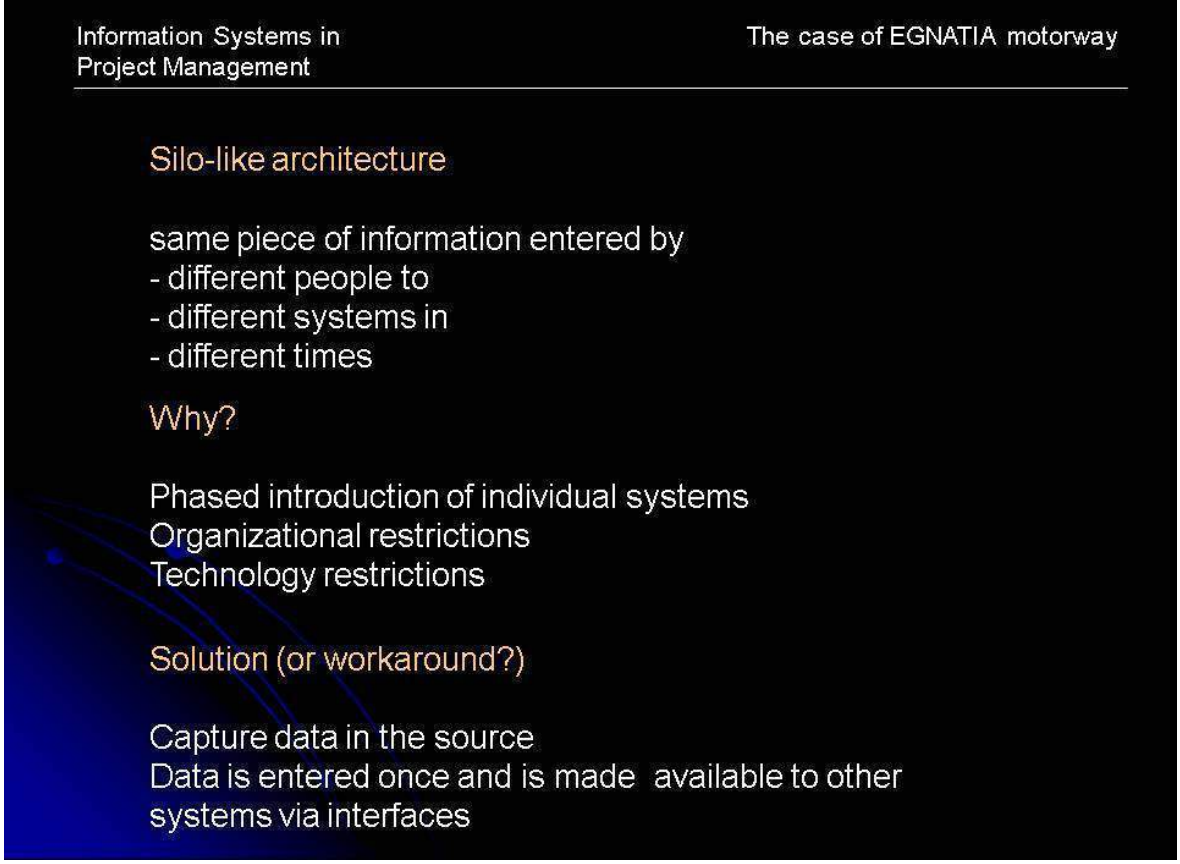
Traffic control (LCS, VMS, OHVD, inductive loops, traffic lights)

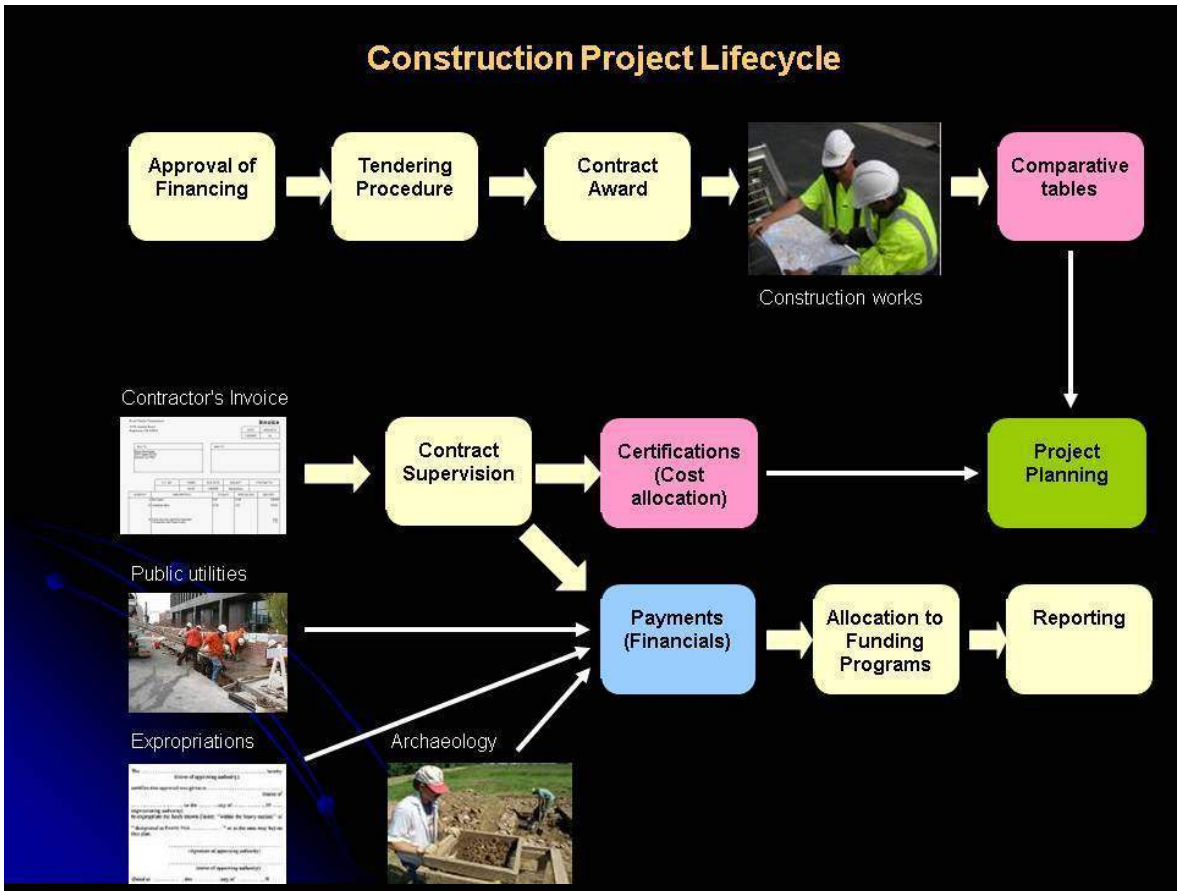
SCADA / TMS

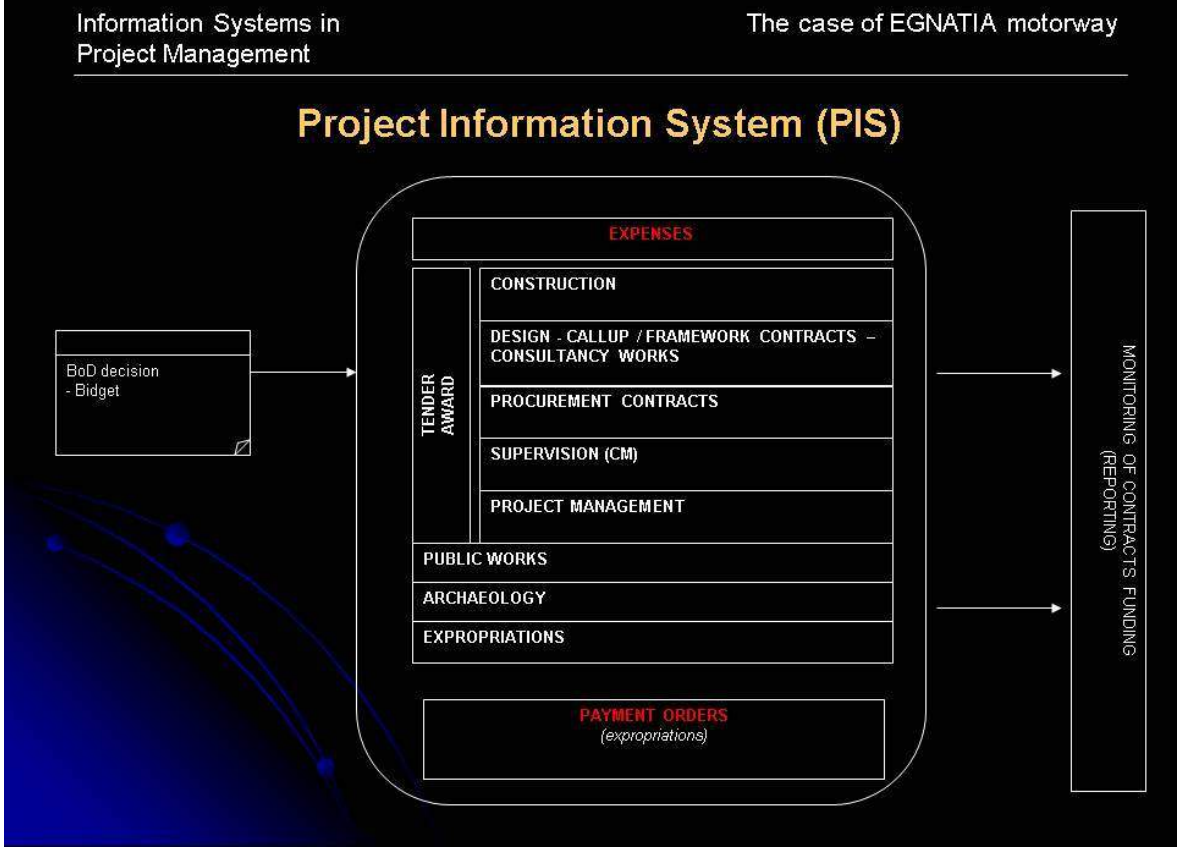
Toll stations

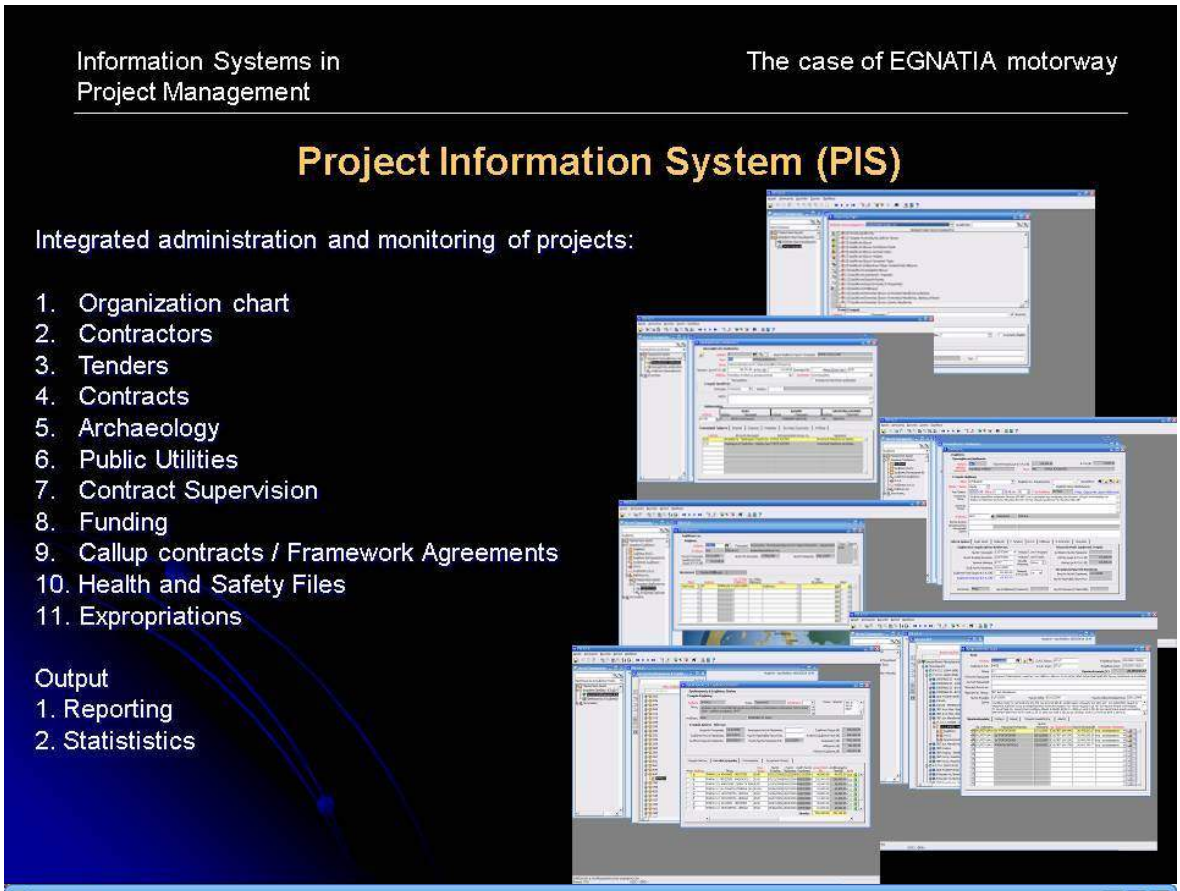

What does it take to build a road?
ΠΡΕΒΕΖΑ
PREVEZA
IGOUMENITSA
-PORT
IGOUMENITSA-CENTRE
1000 m
Information Systems in
Project Management
The case of EGNATIA motorway
Contracts
Funding
Tenders
Planning
Quality Control
Contractors
Specifications
Certifications
Designs
Supervision
Documents
Tables
Reporting
Financials
Statistics

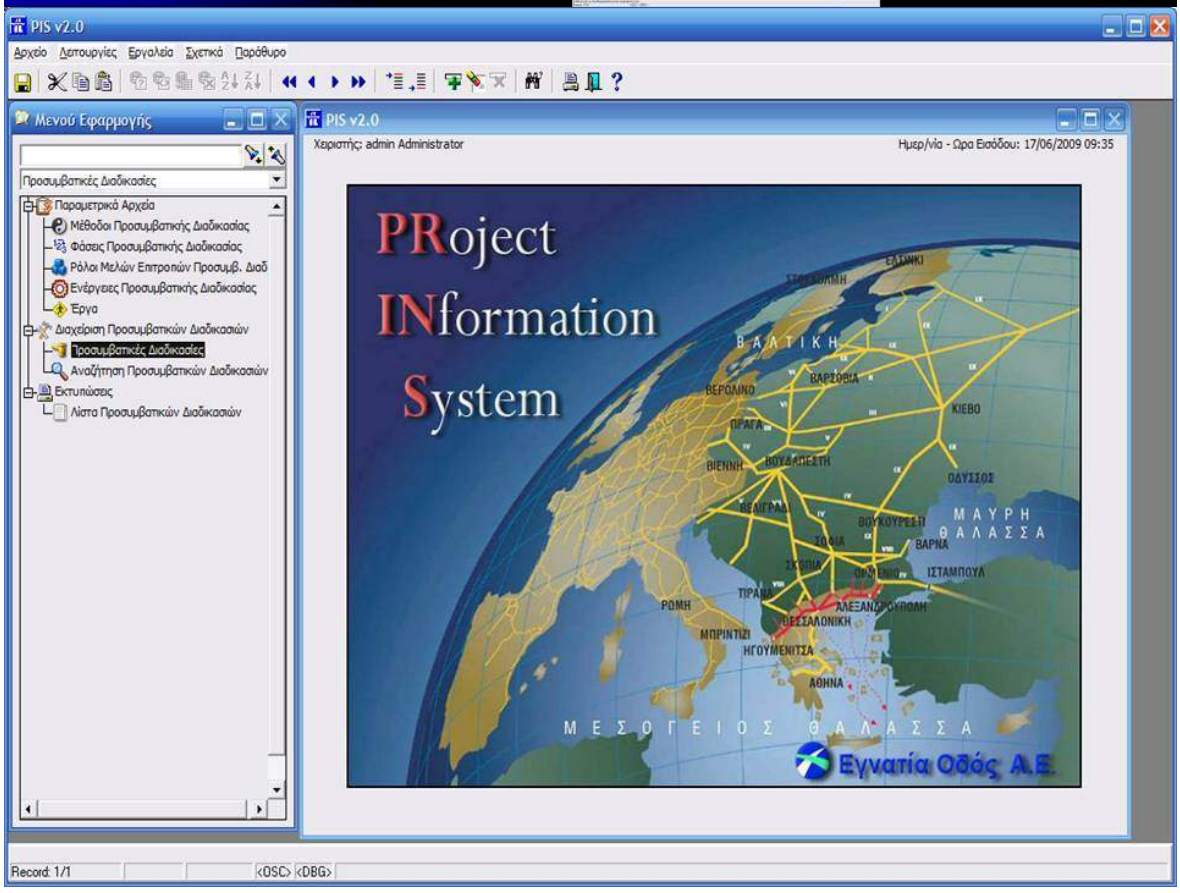

Information Systems in Project Management
The case of EGNATIA motorway
Contracts
Funding
Tenders
Planning
Quality Control
Contractors
Specifications
Certifications
Designs
Supervision
Documents
Tables
Reporting
Financials
Statistics


Information Systems in Project Management
The case of EGNATIA motorway
Silo-like architecture
same piece of information entered by
- different people to
- different systems in
- different times
Why?
Phased introduction of individual systems
Organizational restrictions
Technology restrictions
Solution (or workaround?)
Capture data in the source
Data is entered once and is made available to other systems via interfaces


Construction Project Lifecycle
Approval of Financing
Tendering Procedure
Contract Award
Construction works
Comparative tables
Contractor's Invoice
Contract Supervision
Certifications (Cost allocation)
Project Planning
Public utilities
Payments (Financials)
Allocation to Funding Programs
Reporting
Expropriations
Archaeology


Information Systems in Project Management
The case of EGNATIA motorway
Project Information System (PIS)
EXPENSES
CONSTRUCTION
DESIGN - CALLUP / FRAMEWORK CONTRACTS – CONSULTANCY WORKS
PROCUREMENT CONTRACTS
SUPERVISION (CM)
PROJECT MANAGEMENT
TENDER AWARD
PUBLIC WORKS
ARCHAEOLOGY
EXPROPRIATIONS
BoD decision
- Bidget
PAYMENT ORDERS
(expropriations)
MONITORING OF CONTRACTS FUNDING (REPORTING)


Information Systems in
Project Management
The case of EGNATIA motorway
Project Information System (PIS)
Integrated administration and monitoring of projects:
1. Organization chart
2. Contractors
3. Tenders
4. Contracts
5. Archaeology
6. Public Utilities
7. Contract Supervision
8. Funding
9. Callup contracts / Framework Agreements
10. Health and Safety Files
11. Expropriations
Output
1. Reporting
2. Statistics


PIS v2.0
Αρχείο Λειτουργίες Εργαλεία Σχετικά Παράθυρο
Μενού Εφαρμογής
Προσυμβατικές Διαδικασίες
Παραμετρικά Αρχεία
Μέθοδοι Προσυμβατικής Διαδικασίας
Φάσεις Προσυμβατικής Διαδικασίας
Ρόλοι Μελών Επιτροπών Προσυμβ. Διαδ
Ενέργειες Προσυμβατικής Διαδικασίας
Έργα
Διαχείριση Προσυμβατικών Διαδικασιών
Προσυμβατικές Διαδικασίες
Αναζήτηση Προσυμβατικών Διαδικασιών
Εκτυπώσεις
Λίστα Προσυμβατικών Διαδικασιών
PIS v2.0
Χειριστής: admin Administrator
Ημερ/νία - Ωρα Εισόδου: 17/06/2009 09:35
PRoject
INformation
System
ΒΑΛΤΙΚΗ
ΒΕΡΟΛΙΝΟ
ΒΑΡΣΟΒΙΑ
ΚΙΕΒΟ
ΠΡΑΓΑ
ΒΙΕΝΝΗ
ΟΔΥΣΣΟΣ
ΜΑΥΡΗ ΘΑΛΑΣΣΑ
ΒΑΡΝΑ
ΙΣΤΑΜΠΟΥΛ
ΡΩΜΗ
ΜΠΡΙΝΤΖΙ
ΗΓΟΥΜΕΝΙΤΣΑ
ΑΘΗΝΑ
ΜΕΣΟΓΕΙΟΣ ΘΑΛΑΣΣΑ
Εγνατία Οδός Α.Ε.
Record: 1/1
OSC DBG

Information Systems in Project Management

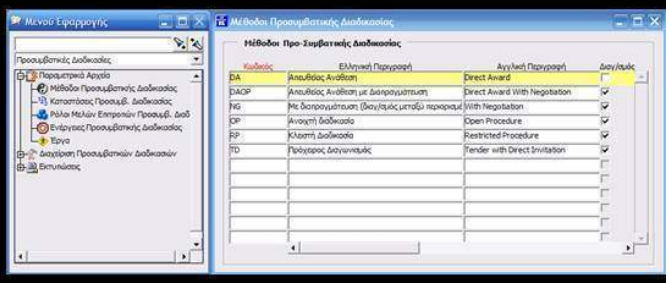
The case of EGNATIA motorway

## Tendering procedure

Call for Tender
Invitation
Publication
Bid offer
Tend. Committee report
Submission of supporting material
Objection
……

## Types of award

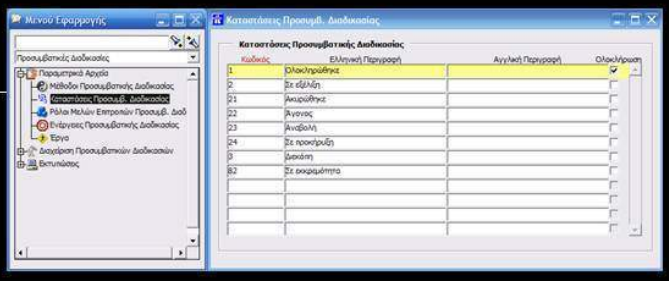
Direct award
Direct Award with negotiation
Restricted procedure
Open procedure
Tender with direct invitation
……..

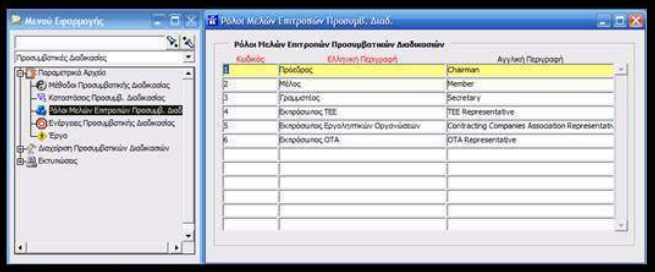


Information Systems in Project Management

## Tender states

Completed
In progress
Cancelled
Deferred
Pending
……



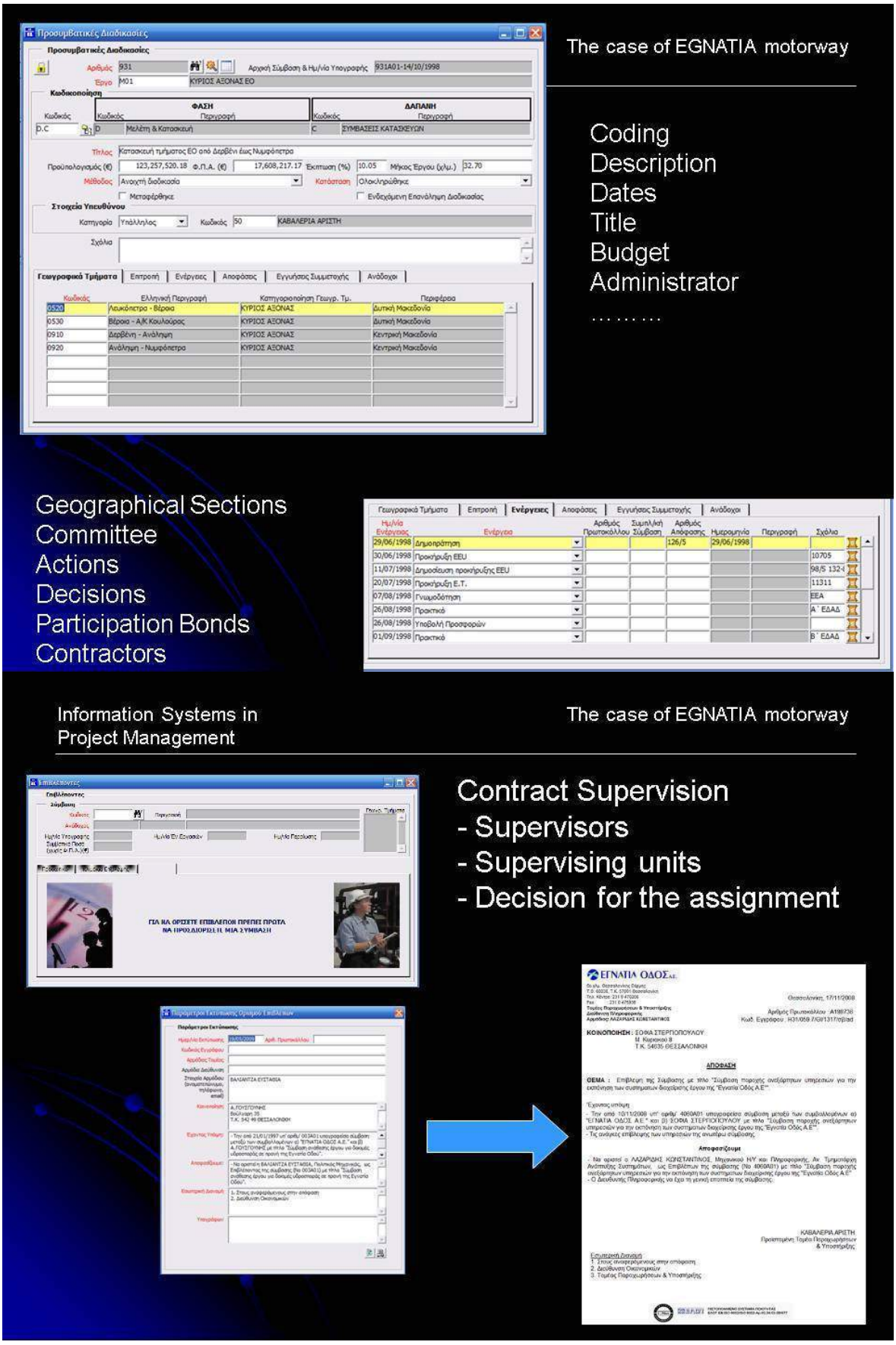


## Committee member roles

Chairman
Member
Secretary
Contracting Companies Association Rep.
Technical Chamber of Commerce Rep.
……..

## Project categories

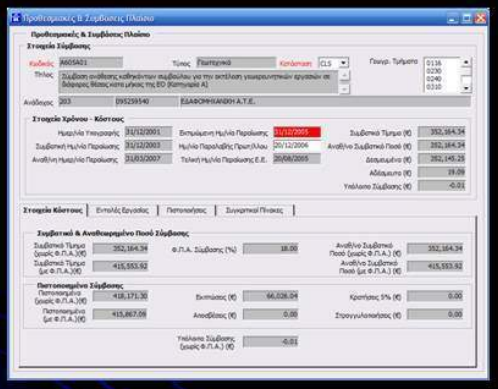
Main Projects
Concessions
Foreign Projects
Main line
Other
……


Προσυμβατικές Διαδικασίες
Προσυμβατικές Διαδικασίες
Αριθμός 931
Αρχική Σύμβαση & Ημ/νία Υπογραφής 931A01-14/10/1998
Έργο M01 ΚΥΡΙΟΣ ΑΞΟΝΑΣ ΕΟ
Κωδικοποίηση
ΦΑΣΗ
ΔΑΠΑΝΗ
Κωδικός Περιγραφή
Κωδικός Περιγραφή
D.C D Μελέτη & Κατασκευή C ΣΥΜΒΑΣΕΙΣ ΚΑΤΑΣΚΕΥΩΝ
Τίτλος Κατασκευή τμήματος ΕΟ από Δερβένι έως Νυμφόπετρα
Προϋπολογισμός (€) 123,257,520.18 Φ.Π.Α. (€) 17,608,217.17 Έκπτωση (%) 10.05 Μήκος Έργου (χλμ.) 32.70
Μέθοδος Ανοιχτή διαδικασία Κατάσταση Ολοκληρώθηκε
Μεταφέρθηκε Ενδιαμέση Επανάληψη Διαδικασίας
Στοιχεία Υπευθύνου
Κατηγορία Υπάλληλος Κωδικός 50 ΚΑΒΑΛΕΡΙΑ ΑΡΙΣΤΗ
Σχόλια
Γεωγραφικά Τμήματα | Επιτροπή | Ενέργειες | Αποφάσεις | Εγγυήσεις Συμμετοχής | Ανάδοχοι
Κωδικός Ελληνική Περιγραφή Κατηγοριοποίηση Γεωγρ. Τμ. Περιφέρεια
0520 Λευκόπετρα - Βέροια ΚΥΡΙΟΣ ΑΞΟΝΑΣ Δυτική Μακεδονία
0530 Βέροια - Α/Κ Κουλούρας ΚΥΡΙΟΣ ΑΞΟΝΑΣ Δυτική Μακεδονία
0910 Δερβένη - Ανάληψη ΚΥΡΙΟΣ ΑΞΟΝΑΣ Κεντρική Μακεδονία
0920 Ανάληψη - Νυμφόπετρα ΚΥΡΙΟΣ ΑΞΟΝΑΣ Κεντρική Μακεδονία
The case of EGNATIA motorway
Coding
Description
Dates
Title
Budget
Administrator
……
Geographical Sections
Committee
Actions
Decisions
Participation Bonds
Contractors
Γεωγραφικά Τμήματα | Επιτροπή | Ενέργειες | Αποφάσεις | Εγγυήσεις Συμμετοχής | Ανάδοχοι
Ημ/νία Ενέργειας Ενέργεια Αριθμός Πρωτοκόλλου Συμπλ/ση Σύμβαση Αριθμός Απόφασης Ημερομηνία Περιγραφή Σχόλια
29/06/1998 Δημοπράτηση 126/5 29/06/1998
30/06/1998 Προκήρυξη ΕΕΕ 10705
11/07/1998 Δημοσίευση προκήρυξης ΕΕΕ 98/S 132-4
20/07/1998 Προκήρυξη Ε.Τ. 11311
07/08/1998 Γνωμοδότηση ΕΕΑ
26/08/1998 Πρακτικό Α΄ ΕΔΑΔ
26/08/1998 Υποβολή Προσφορών
01/09/1998 Πρακτικό Β΄ ΕΔΑΔ
Information Systems in Project Management
The case of EGNATIA motorway
ΓΙΑ ΝΑ ΟΡΙΣΕΤΕ ΕΠΙΒΛΕΠΟΝΤΑ ΠΡΕΠΕΙ ΠΡΩΤΑ ΝΑ ΠΡΟΣΔΙΟΡΙΣΕΤΕ ΜΙΑ ΣΥΜΒΑΣΗ
Contract Supervision
- Supervisors
- Supervising units
- Decision for the assignment
ΕΓΝΑΤΙΑ ΟΔΟΣ Α.Ε.
ΑΠΟΦΑΣΗ
ΚΑΒΑΛΕΡΙΑ ΑΡΙΣΤΗ

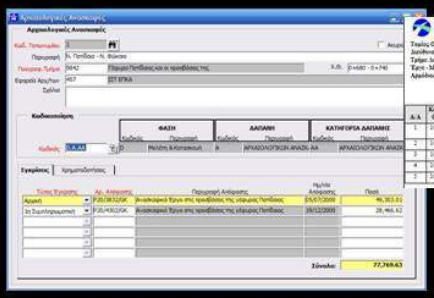
Information Systems in Project Management

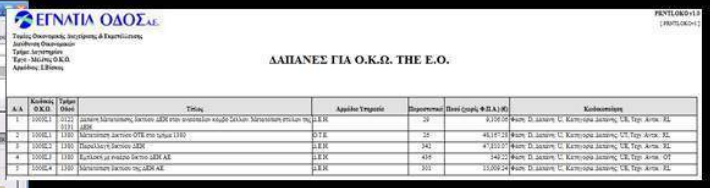
The case of EGNATIA motorway

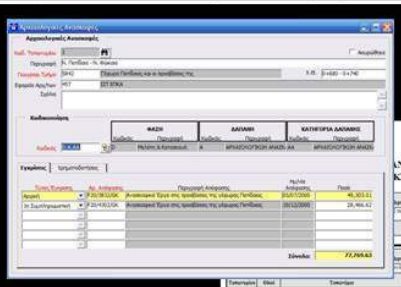
## Callup Contracts / Framework Agreements



Cost data
Work instructions
Certifications
Comparative tables





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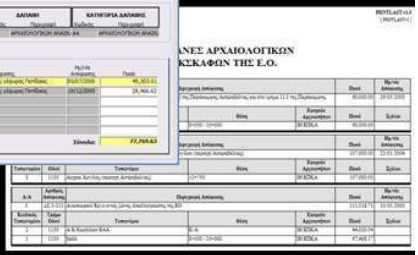


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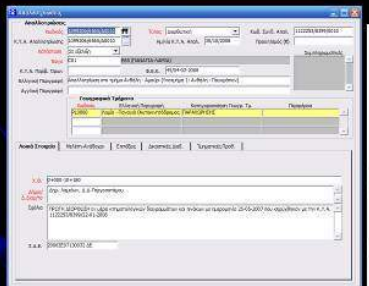

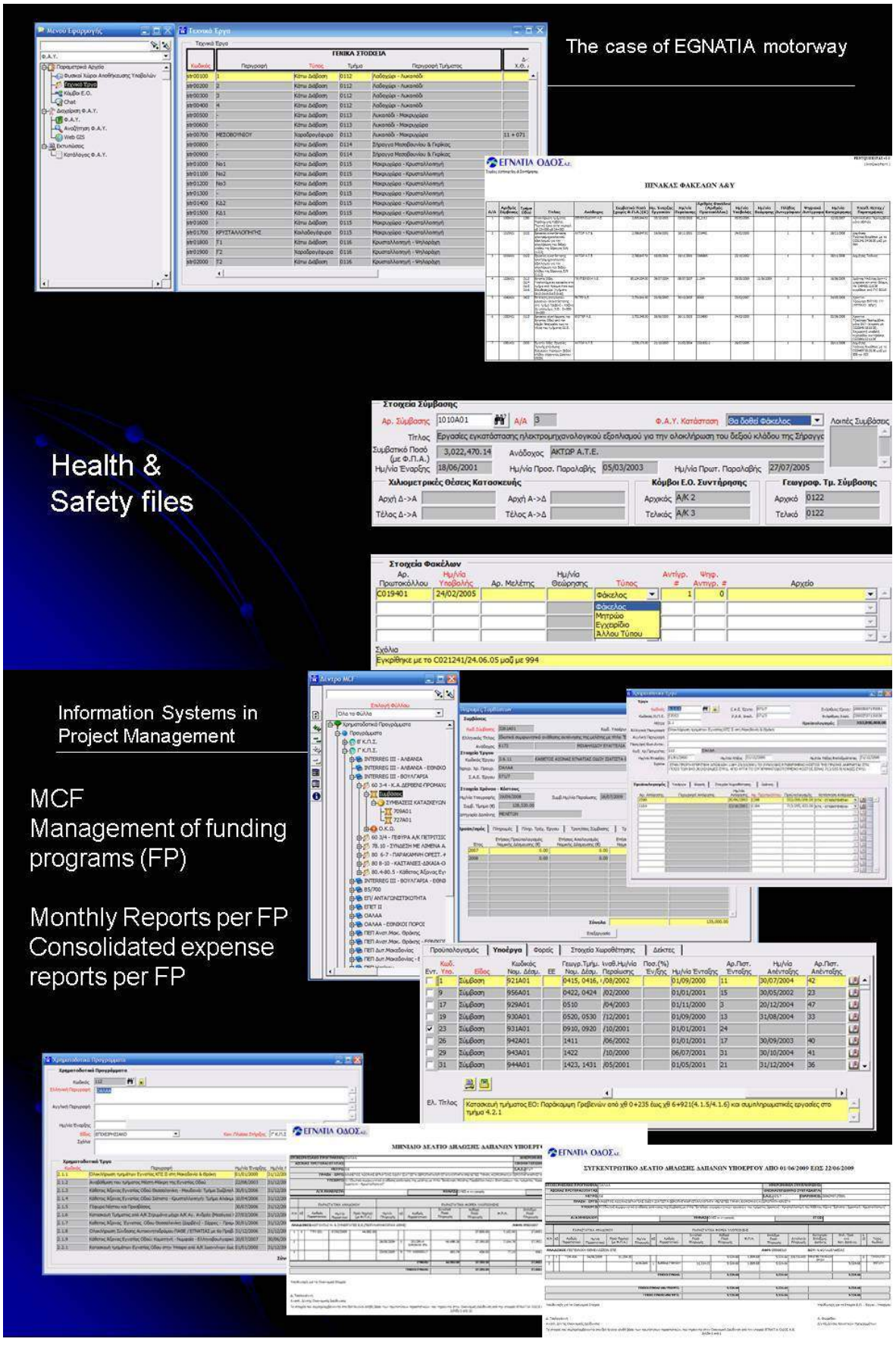
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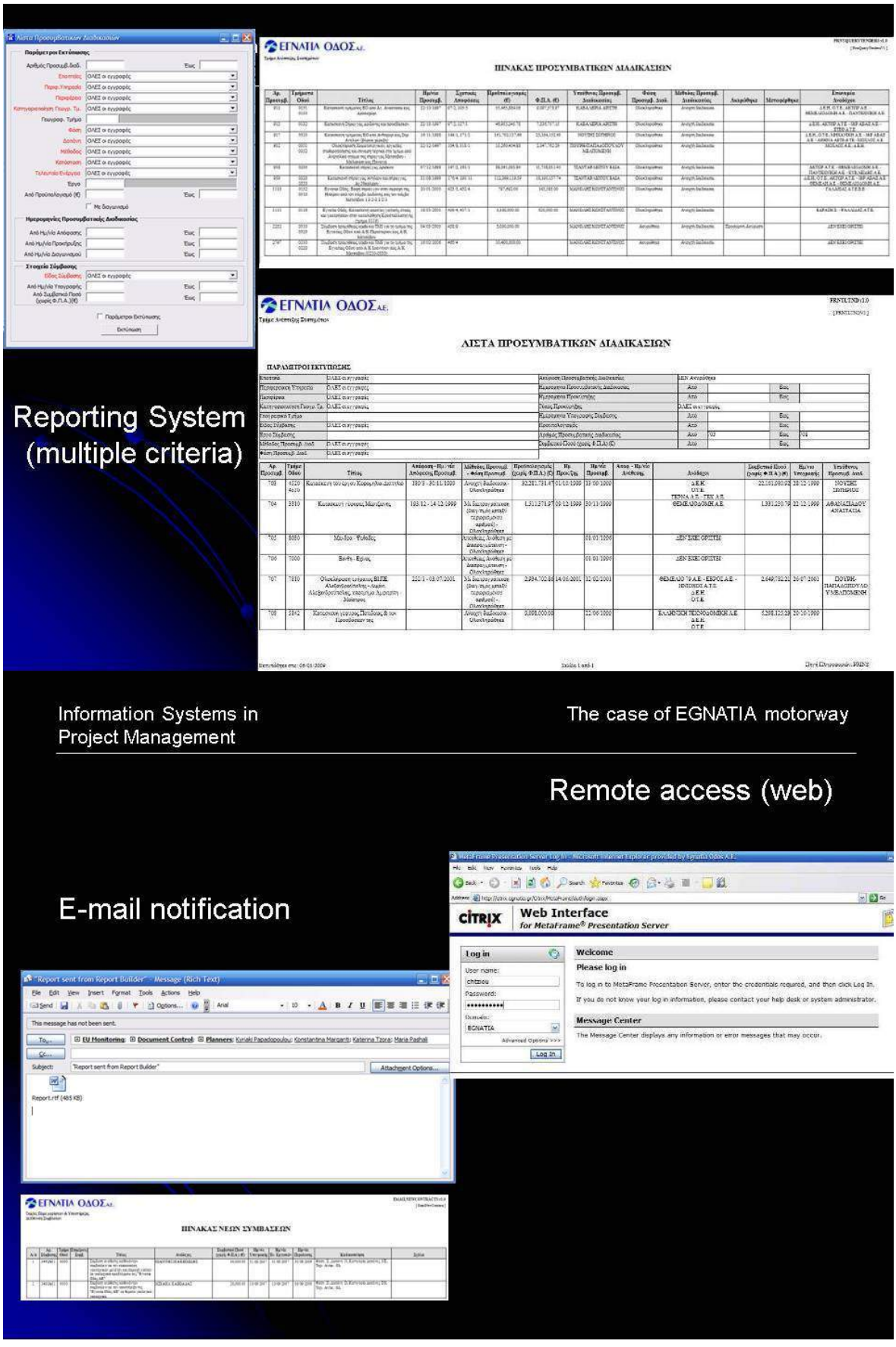
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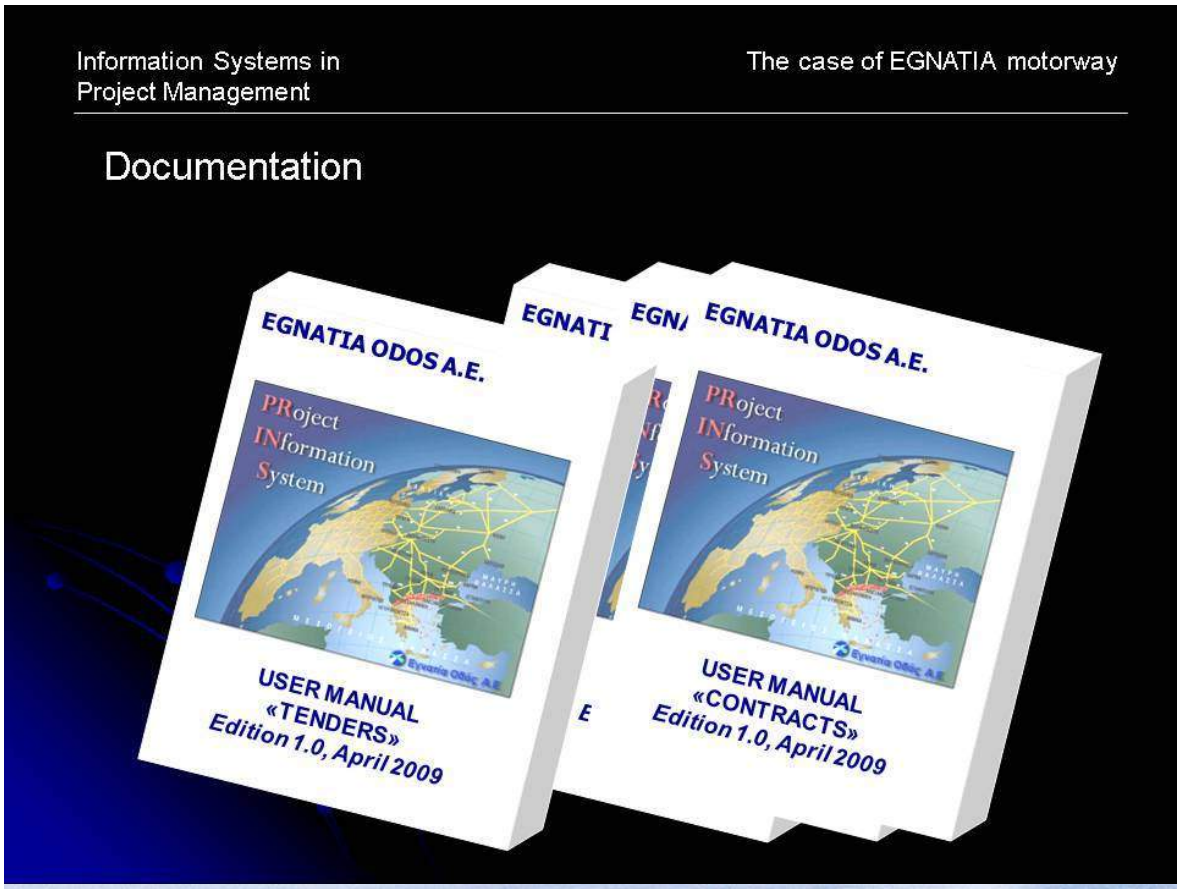
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# Absence of Corporate Environmental Disclosure (CED) in Libya: A Research Note

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## Abstract

Corporate Social and Environmental Disclosure (CSED) was one of the main topics of argument in the literature, particularly in the 1970s and 1980s. Since the early 1990s, the emphasis has been shifted to Corporate Environmental Disclosure (CED) rather than Corporate Social Disclosure (CSD). CED practice has become a topic of investigation among accounting academic researchers in both developed and developing countries. The literature has identified that the level of practices in CED in developing countries is lagging behind the developed countries. However, it is worth mentioning that pressures for CED vary from country to country and from region to region, especially between developing and developed countries. This paper presents an in-depth investigation of group of stakeholders' perceptions towards CED in Libya and concentrates upon the absence of CED in Libya. It has identified disincentives for CED in Libya. Evidence is collected from in-depth interviews with thirty interviewees from six groups of stakeholders namely: Decision Makers, Local Government, Financial Institutions, Shareholders, Managers, and Employees. The findings suggest that there is a strong consensus between the six groups surveyed on a number of disincentives for CED.

## Keywords

Corporate Environmental Disclosure, Corporate Social Disclosure, Stakeholder, Shareholder.

## 1. Introduction

One of the most significant current discussions in economic, management and accounting literature and has received much attention from researchers is Corporate Social and Environmental Disclosure (CSED) (Ahmad, 2004, De Villiers, n.d, Jaggi and Zhao, 1996). Corporate Social Disclosure (CSD) including environmental disclosure was one of the main topics of argument in the literature, particularly in the 1970s and 1980s (Ahmad, 2004, Ince, 1998, Mathews, 1997, Niskala and Pretes, 1995). However, in the early 1990s, the main concern has been Corporate Environmental Disclosure (CED) rather than CSD (Ince, 1998, Lodhia, 2005).

Jaggi and Zhao, (1996) list two basic arguments of social and environmental responsibility behaviour from organisations. The first argument "relates to the concept of social contract". The second debate "relates to quality of life". They add to these arguments "increased stakeholders' awareness", and thus several countries have forced business to become more responsible for a cleaner environment. As a result, Corporate Social and Environmental Disclosure has become an important tool to demonstrate companies' commitment to the environment which is the initial goal of much environmental reporting (Azzone et al., 1997). In addition, Hope, (2003) states that, Corporate Social and Environmental Disclosure is different among countries. The literature of social and environmental disclosure involves stakeholders or external users companies (Tilt, 2003). Literature has also emerged that some stakeholders, such as banks, insurance companies, etc., are seeing environmental disclosure as highly incomplete (Azzone et al., 1997).

As a result of this awareness, stakeholders are demanding improved environmental disclosure and better environmental performance. Azzone et al., (1997) suggest that these problems can be solved by clearly identifying the key stakeholders. That means identify for whom the environmental reports are published and what are their environmental information requirements. They add that companies must produce clear and effective environmental reports for external users, since, social and environmental reporting might be influenced by stakeholders (Tilt, 2003). Mashat, (2005) states that, corporate reporting and disclosure practices might be influenced by the individual's attitudes behaviour and values it is therefore necessary to specify the stakeholder "target" for particular CSED reports.

The variation in awareness of different stakeholders of corporate social and environmental disclosure has been investigated in a number of studies (e.g. Al-Khater and Naser, 2003, Azzone et al., 1997, Danastas and Gadenne, 2004, Deegan et al., 1995, Epstein and Freedman, 1994, Filios, 1998, Lodhia. 2003, Mashat, 2005, Mashat et al., 2005, Naser et al., 2003, O'Dwyer, 2002, Tilt, 1994, Tilt, 2003). Most of these studies have covered developed countries and little has been published in the developing world in general and in the Arab region in particular.

Although, the presentation of environmental information has been increased in annual reports due to the demand by stakeholders, Libyan organisations have not shown any great interest in providing environmental information as is evident from studies undertaken by Mashat (2005) and Ahmad (2004). Ahmad's (2004) study was the first detailed longitudinal study of CED undertaken in Libya. However, he concluded that disclosure of environmental information is not common in annual reports of Libyan corporations.

This paper aims to broaden the present CED literature by considering attitudes towards CED within the context of a developing country and with specific regard to the corporate unwillingness to disclose environmental information. The next section of the paper provides the previous studies related to this paper and is followed by the research methodology adopted in the collection and analysis of data. The paper then presents the findings and concludes.

## 2. Prior Literature

Within the social and environmental disclosure literature a number of studies explicitly comment upon disincentives of corporate social and environmental disclosure. This section considers theoretical explanations about the reasons for non-disclosure from the prior literature.

There are some studies that explicitly number the reasons for the absence of disclosure, the empirical available evidence in this area is limited, Solomon and Lewis (2002) justify that company management do not openly discuss their perceived inadequacies. It still seems to be limited to the willingness to communicate corporate social and environmental disclosure. An understanding of the reasons for the absence of environmental disclosure will allow interested parties such as government agencies to develop policies to mitigate these inadequacies. Gray et al., (1993) lists the following reasons for the absence or inadequate CED: absence of any demand for information; absence of a legal requirement; the problem that the cost would outweigh the benefits; and the possibility that the companies had never considered it. The World Industry Council for the Environment (WICE, 1994; cited in Solomon and Lewis, 2002) explains that competitors may be a good reason for companies to exclude certain information.

Adams (2004) reports that the cultural attitude within a country was an important factor for non-disclosure. Gao et al., (2005) explains the low level of CS and ED in Hong Kong because there was no strong pressure from community pressure groups and also an absence of social and environmental legislation. However, Kuasirikin and Sherer (2004) argue that there were many reasons for the absence of CS and EDs in Thailand. These reasons included: a failure to enforce legislation; a lack of effectiveness by Thai social and environmental pressure groups; and an absence of mandatory social and environmental disclosures. The importance of an absence of compulsory CS and EDs by law has been noted by Adams et al., (1995) and also suggested by Naser and Abu-Baker (1999) as the primary reason for an absence of CSD in Jordan.

Teoh and Thong (1984) suggest that a desire to keep the annual report brief and a degree of secrecy about the company's activities are reasons for non-disclosure in developing countries. Belal and Cooper (2007) also suggest that the lack of reporting of good news could be a reason for the lack of CSED. Solomon and Lewis, (2002) investigate the reasons for the disincentives of CED in the UK using a questionnaire. The questionnaire was distributed to 625 individuals and organisations, divided into three sub-sample groups namely, a normative, an interested party and a company group. The findings (Table 1) show that a number of reasons attracted high scores from each group. There is a strong consensus between the three groups on a number of disincentives for CED.

| Reason | Normative group | | Interested party group | | Company group | |
|---|---|---|---|---|---|---|
| | N | Mean | N | Mean | N | Mean |
| Reluctance to report sensitive information | 87 | 4.18 | 86 | 4.23 | 78 | 4.03 |
| To avoid providing information to competitors | 87 | 3.82 | 86 | 3.73 | 79 | 3.75 |
| To avoid providing incrimination to regulators | 87 | 3.78 | 88 | 3.83 | 79 | 3.44 |
| Possible damage to companies' reputation | 86 | 3.92 | 87 | 4.06 | 79 | 3.57 |
| General lack of awareness of environmental issues | 86 | 4.06 | 88 | 3.80 | 79 | 3.42 |
| Inability to gather the information | 86 | 3.77 | 88 | 3.48 | 80 | 3.56 |
| Cost of disclosure | 87 | 3.79 | 89 | 3.72 | 81 | 3.57 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Lack of awareness of competitive advantage | 84 | 3.52 | 86 | 3.19 | 79 | 3.18 |
| There is no legal obligation for companies to report environmentally | 87 | 4.01 | 87 | 4.12 | 80 | 4.03 |
| Companies generally believe they do not have an impact on the environment | 87 | 2.79 | 87 | 2.78 | 79 | 2.54 |
| Insufficient response/feedback from stakeholders | 86 | 3.30 | 78 | 3.40 | 81 | 3.47 |
| Users may not understand the information | 86 | 2.98 | 88 | 2.77 | 79 | 3.32 |

Table 1: Possible Reasons for the Inadequacy of Corporate Environmental Disclosure

Source: (Solomon and Lewis, 2002, p.162)

Belal and Cooper (2007) carried out study concentrated upon the lack of CSD via in-depth semi-structured interviews in 23 companies across ten industrial sectors in Bangladesh. They conclude that the main reasons for non-disclosure included: lack of legal requirements; lack of knowledge/awareness; poor performance and fear of bad publicity; and lack of resources of small companies.

This section has provided a review of both the theoretical and empirical literature on disincentives of CED. Most of the previous studies have undertaken empirical investigations of levels of social and environmental disclosures within annual reports and how these are related to the presence or absence of a number of factors. In contrast a smaller number of studies have addressed reasons for non-disclosure of CED within annual reports through seeking the perceptions of managers and fewer still through the views of users or stakeholders. Most of them investigated the perceptions through using a questionnaire methodology. However, smaller numbers used an interview methodology for examining the views of stakeholders which has been adopted in this study from the context of developing countries for the study of the perceptions of various groups of stakeholders towards CED.

## 3. Research Method

This paper adopts a pure qualitative research method. The rationale for the choosing of a qualitative approach stems from the nature and context of the study. Researchers used qualitative research when they seek to understand the context the study matter in terms of how and why it occurs (Cassell and Symon, 1994) and when the study phenomena is emergent rather than prefigured (Creswell, 2003). This paper reports on a study of stakeholders' perceptions concerning the current state and the absence of CED in Libya. The evidence in this paper was collected using face-to-face (FtF) semi-structured, in-depth personal and representative interviews with 30 stakeholders from six groups of stakeholders in Libya between mid December 2008 and March 2009. These stakeholder groups include: Decision Makers; Local Government; Shareholders; Managers; Employees; and Financial Institutions. These groups have been chosen because they have a direct relationship with the company. That means the company cannot survive without these groups of stakeholders. The particular interviewees were chosen on the basis that they have knowledge about CED or they are responsible for handling environmental information. The interview questions were in Arabic because the official language in Libya is Arabic. One part of the interview was devoted to understanding the current level of CED in Libya. The second part of the interview was devoted to developing a critical understanding of the reasons for non-disclosure of environmental information.

A phone call was made to the organisations or individual stakeholders requesting an interview with the individual who had knowledge about the subject of this paper. Most of the contacts were made through this process. The internal stakeholders (Managers and Employees) were from the Ahlia Cement Company. This has been chosen for some reasons. These reasons including:

- The Ahlia Cement Company is a joint-stock company registered on the stock market in Libya. It was a public company until 2005;
- The Ahlia Cement Company is the unique cement company in the west of Libya;
- This company is widely recognised as being amongst those with the greatest environmental problems and having the greatest expenditure on pollution control. De Villiers and Barnard (2000) and De Villiers and Lubbe (2001) indicated that, companies that have an obvious environmental impact according to the notion of legitimacy, are more likely to disclose more environmental information in an effort to legitimise themselves (their aims and methods) in the eyes of society and will therefore be more inclined to use environmental disclosure than other companies that have a less obvious impact. Thus, environmental information within this company has greater potential usefulness to its stakeholders than information from firms in non-environmentally sensitive industries. Cement companies have a greater need to legitimise their operations by means of environmental disclosure, because their environmental impact is extensive and obvious;
- The Ahlia Cement Company was the first cement company in Libya and it is one of the largest companies in Libya and it has six plants with sites across Libya. García-Ayuso, and Larrinaga, (2003) stated that, it could

be argued that larger firms are subject to stronger pressure from stakeholders. Moreover, Saunders et al., (2003, P.261) point out that "the single case may in fact encompass a number of settings, where for example it involves a study in a large organisation with sites across the country or even around the world". Gray et al., (1995) gave three reasons for using a sample of the largest companies. One of these reasons is: the largest companies are more likely to disclose environmental information than medium and small companies. In addition, some researchers indicated that certain industries, such as the mining, and larger companies consistently disclose more environmental information than smaller companies or companies in other industries (Gray et al., 1995, Hackston and Milne, 1996);

- The Ahlia Cement Company has commenced the procedure for obtaining ISO 14001; and
- The company is chosen because the headquarters of the company situated in Khums city which is near where the researcher lives. This feature allowed the researcher to contact them easily and considerably reduce travelling time.

The interviews were conducted at the interviewees' place of business during the period of December 2008 and March 2009. The interviews involved two steps. The first step was contacting and making appointments with interviewees in a suitable interviewing environment (time and the place of interviews according to interviewees preference, which may be placed in their offices or elsewhere). The second step was the interviewing process starting with a brief introduction and explanation about the research. Twenty six interviews were recorded with the permission of the interviewees and notes were taken during all interviews and later the notes were confirmed by the interviewees. In addition, all interviewees signed the consent form of the Ethical Approval for using the collected data in this research. A promise of anonymity was given to all interviewees. After each interview, the researcher thanked the respondents. All interviews were transcribed immediately afterwards.

Collis and Hussey (2003) consider that there are two different approaches for analysing qualitative data. One approach is to quantify the data, either formally or informally. In other words, turn the qualitative data into numerical data. Another approach is to non-quantify the data. Following a reiterative process suggested by O'Dwyer (2004) interview transcripts and notes were then summarised and analysed thematically together with personal reflections by the authors using NVivo version 8. Before using NVivo primary analysis of the data collected was undertaken. The primary analysis of the data collected was a four-step process. Each interview was transcribed to the Arabic Language in a Microsoft Word 2007 document format almost entirely, leaving out only those portions where the interviewee or interviewer digressed from the research focus completely. The second step was to conduct a microanalysis of each interview, striving to understand any hidden meanings within the words, phrases, sentences, and finally paragraphs in each interview that could impact researcher understanding of the data as recommended by Miles and Huberman (1994). The third step was for each interview to be translated from Arabic to English and effort was made to keep the original meaning in place. The final step is for all interviews to be transferred and sorted as a project in the NVivo 8 software.

The secondary analysis using NVivo version 8 developed a system of codes to categorise the detailed data and facilitate its retrieval through content analysis as Kumar (2005) recommended. The results are reported in the following section.

## 4. Findings

This section explores the absence of CED from the context of Libya. In particular, it describes the current state of CED, the reasons for non-disclosure, the motivations for disclosure, and the factors for enforced CED provided by interviewees. Firstly, interviewees were required to comment on the current level of ED by a company. Most of the respondents 22 out of 30 (73%) said that their environmental information was not disclosed by Libyan companies.

However, the remaining interviewees (8 – 27%) thought that there is a clear lack of CED in Libya and half of these (4 – 14%) where from the Decision Makers group. Thus, it can be noted that because some government authorities and agencies required companies to provide some environmental information in compliance with the 15 Act 2003, this disclosure is not voluntary disclosure and not all or most stakeholder groups can access this information. The next section will discuss the reasons for the lack of CED in Libya.

### 4.1 Reasons for Non-Disclosure of Environmental Information

Table (2) presents the disincentives for CED that are identified by the interviewees. There are some compound reasons for companies and organisations not to disclose their environmental information. These reasons have be classified as follows:

| Reasons | Decision Makers | Local Government | Financial Institutions | Managers | Employees | Shareholders | Mean % |
|---|---|---|---|---|---|---|---|
| Lack of legal requirements | 80% | 100% | 100% | 100% | 80% | 100% | 93% |
| Lack of environmental awareness | 60% | 60% | 80% | 20% | 40% | 60% | 53% |
| Lack of knowledge | 80% | 60% | 60% | 40% | 0% | 20% | 43% |
| ED would have an obligation for others | 0% | 40% | 60% | 60% | 20% | 40% | 36% |
| Emphasis on economic performance | 40% | 20% | 20% | 20% | 60% | 40% | 33% |
| Lack of demand | 0% | 60% | 40% | 40% | 20% | 20% | 30% |
| Public lacks the knowledge | 20% | 40% | 40% | 20% | 40% | 0% | 27% |
| Sensitive and confidential | 0% | 20% | 20% | 40% | 40% | 40% | 27% |
| Administrative difficulties | 0% | 20% | 0% | 60% | 40% | 0% | 20% |
| Lack of awareness of helping the government to solve environmental problems | 0% | 40% | 0% | 0% | 0% | 0% | 7% |
| Lack of competition | 0% | 20% | 0% | 0% | 20% | 0% | 7% |
| Lack of staff | 0% | 0% | 20% | 0% | 20% | 0% | 7% |
| Fear of the decisions of the government | 20% | 0% | 0% | 0% | 0% | 0% | 3% |
| Government agencies are not strict | 0% | 20% | 0% | 0% | 0% | 0% | 3% |
| Lack of awareness of management of the negative economic aspects | 0% | 20% | 0% | 0% | 0% | 0% | 3% |
| The absence of civil societies | 0% | 0% | 20% | 0% | 0% | 0% | 3% |

Table 2: Disincentives for Corporate Environmental Disclosure

### 4.1.1 Lack of Legal Requirements

Like many other countries of the world CED is not a mandatory requirement in Libya. Most interviewees (93%) expressed the view that the main reason for not disclosing these significant issues is the absence of a legal requirement. The prevailing managerial attitude is: we will only comply if we are legally bound to do so. The following quotation is illustrative of this attitude.

> *"There are no regulatory requirements for companies to disclose their environmental information to users"* (S3).

The above quotation illuminates corporate unwillingness and a lack of sincere commitment in Libyan companies towards CED. It appears that the absence of mandatory requirements for CED provides Libyan companies with a convenient pretext for avoiding these serious issues which need to be addressed for the reasons noted earlier. In order to address these issues businesses would require a fundamental shift in traditional thinking of profit making as the sole objective. Otherwise, any kind of attention to these issues would be treated as diversion of scarce business resources and a distraction from the fundamental corporate objective of shareholders' wealth maximisation.

### 4.1.2 Lack of Awareness / Knowledge

Given the fact that the phenomenon of CED is comparatively new to the companies in developing countries many of them may not be familiar with its processes and requirements. More than half of the interviewees shared this view (16 – 53%). They contended that some of the reasons for non-disclosure might be attributed to lack of awareness and knowledge amongst corporate managers and the public regarding CED.

> *"The reason for the absence of CED is the lack of environmental awareness, whether by companies or by people.* I think the media such as TV and newspapers should play the role to increase the environmental awareness in the people" (DM4).

13 out of 30 interviewees (43%) from all groups of stakeholders except the employee group state that the reason is also because companies are not concerned about this type of information due to a lack of knowledge.

> *"I think the lack of knowledge concerning this type of information prevents organisations from disclosing this information"* (DM1).

Moreover, 8 out of 30 respondents (27%) –except from the shareholders group- stated that the general public do not have enough knowledge about the importance of environmental information. Increasing the knowledge about the environmental information could lead to demand for this information. This was recognised by some interviewees (13 - 30%). They expressed the reason that there is no explicit demand for environmental information whether internal or external demand.

> *".....the public lacks the knowledge and understanding of the importance of environmental information"* (FI3).

It can be noted that there is an absence of environmental awareness and knowledge in terms of both companies and the public. Subsequently, there is an absence of the pressure on companies to disclose environmental information. However, one interviewee from the local government group (3%) added another reason for the absence of CED. This reason is that the management of companies are not aware of the negative economic impact of non-disclosure.

> *"Lack of awareness of management of the negative economic aspects as the result of the non-disclosure is the reason for the absence of CED"* (LG1).

Moreover, two interviewees (7%) from the local government group believed that companies do not disclose their environmental information because the management of companies do not recognise that the government can help any company to solve any environmental problems. Commenting on this reason he stated:

> *"I think the other reason for non-disclosure is the lack of awareness of the cooperation that the government is ready to help any company to solve any environmental problem"* (LG1).

### 4.1.3 Issues Management and Fear of Bad Reputation

Six more factors, which conflict with the lack of awareness suggested above, have been identified for not disclosing. These relate to the fact that companies were not actually undertaking enough activities for protecting the environment and that environmental disclosure could bring adverse publicity, particularly if the disclosures are not positive. Some interviewees (10 - 33%) revealed that one reason for companies not disclosing environmental information is that companies aim to achieve profit maximization for their shareholder and they are not concerned about environmental performance. The following comments reveal some of the interviewees' thoughts regarding this issue:

> *"I think another reason is because the objective of the company is to emphasize on economic performance over environmental performance. In addition, achieving the profits is at the expense of the environment because the environmental aspect is the only one that could have been avoided and no one is concerned about it. For example, companies allocate amounts in their budgets for their environmental activities even though sometimes included under other items. At the end of the fiscal year you will find these allocations were either under spent or transferred to the following year. Also, sometimes it was spent on other activities through transfer to other items"* (M3).

Moreover, one third of respondents (11 - 36%) from the groups of managers, employees, shareholders, local government, and financial institutions revealed that the other reason is that management of companies thought if they disclosed environmental information; it would have an obligation for others against the company. Therefore, this is an implicit recognition by the company for any environmental damage that may be caused by the company's activities to others as a result of its operations. An interviewee from shareholders group and the financial institutions group provided the following comments:

> *"Another reason is that the management of the company believes that this information would create an obligation for others and would have a legal obligation which could force the company to pay sums of money. So, for that reason they do not disclose environmental information"* (S5).

Similarly, (8 - 27%) interviewees from the same groups above believed that companies do not disseminate environmental information because the management of the companies thought this information was sensitive and confidential. In other words, this information should be kept secret and should not be read by others especially external parties. For this, some companies disclose environmental information in their annual reports hidden under other items. The following response reveals one interviewee's opinion:

> *"This kind of information is sensitive and confidential to disclose. Sometimes environmental information is disclosed in annual reports but it is not clear, because it is hidden among other items"* (E1).

In addition, some interviewees (7 - 20%) from the managers, employees, local governments, and financial institutions groups added another reason among management issues which is administrative difficulties. In the same vein, (2 – 7%) of interviewees from the groups of employees and financial institutions expressed the reason as the lack of staff who are qualified and have experience on environmental disclosure. The following response reveals some of the interviewees' opinions:

> *"I think another reason is because the lack of staff that are qualified and have the expertise and knowledge of environmental disclosure" (E4).*

Two interviewees (3%) from the decision makers group mentioned that there is non-disclosure in Libya because the management of companies fear the decisions that could be undertaken by the government agencies against the company. The following response reveals these opinions:

> *"Furthermore, the management of companies fear the decision of the government restricting the activity of the company if it discloses environmental information such as to increase the taxes" (DM4).*

### 4.1.4 Other Disincentives

There are three other reasons for non-disclosure which were mentioned by one or two respondents. Firstly, 2 interviewees (7%) out of thirty from the groups of employees and local governments expressed that there is no existing competition in the market that makes companies disclose their environmental information. Companies need to see the tangible benefits from disclosure and this could happen in the free market. It can be noted that the economic system in Libya has been changing and the Libyan government has encouraged foreign investors to invest in Libya. Thus, it has established a Privatisation and Investment Board which aims to supervise the national and foreign investment in the local market. Moreover, it works to increase the participation of the private sector through ownership of public companies such as the company that is studied and also to promote the establishment of private projects. Moreover, it has established a stock market since 2006. Thus, it could be expected that voluntary disclosure in the following years will be very important.

In addition, one interviewee (3%) from the group of local government mentioned that government agencies do not play such a strict role against a company that its activities affect the environment. He thought that this could be the reason for non-disclose. Furthermore, the absence of environmental civil society organisations was revealed by one interviewee from financial institutions group as a disincentive for disclosure. Environmental civil society organisations can put pressure on companies to disclose their environmental information such as Friends of the Earth in the UK. The following comments reveal some of the interviewees' thoughts regarding these issues:

> *"Moreover, government agencies which are responsible for protecting the environment are not strict in the case of the discovery of environmental violations" (LG4).*
>
> *"The absence of environmental civil society organisations such as Friends of the Earth pressing to preserve the environment is also a reason for non-disclosure"* (FI2).

It can be concluded that there is a strong consensus amongst the six groups surveyed on a number of disincentives for corporate environmental disclosure. The most important disincentives for CED in Libya in terms of all groups of stakeholders are: a lack of legal requirements; an emphasis on economic performance; and lack of environmental awareness. Less important is that: ED would have an obligation for others; a lack of knowledge; sensitive and confidential information; the public lacks knowledge; and a lack of demand.

## **5.** Conclusion

Based on the paper's findings, there are several important reasons for non-disclosure. The most important reason for the absence of CED in Libya is the lack of requirements which could be accounted for the argument that companies disclose their information to respond to the state institutions in the form of regulation (Jacobs and Kemp, 2002) also, from non-government organisations (Mangos), in the form of informal regulation (Tilt, 1994). Thus, some countries have required companies to disclose environmental information in annual reports such as Demark, France, Portugal, Spain, and Sweden (Fleischman and Schuele, 2006). In Libya neither formal nor informal regulation presently requires companies to disclose their environmental information. This reason is supported by quite a number of scholars and previous studies namely: Adams et al., (1995), Ahmad, (2004), Belal and Cooper, (2007), Geo et al., (2005), Gray et al., (2003), Kuasirikin and Sherer, (2004), Naser and Abu-Baker, (1999), and Solomon and Lewis, (2002).

The absence of CED due to lack of awareness and knowledge seems to be a plausible explanation and relevant in the context of developing countries (Belal and Cooper, 2007). The results show that another main reason in Libya is the lack of environmental awareness and knowledge in terms of companies and stakeholders. This finding is consistent with a quite a number of studies that have been concluded with this issue by Belal and Cooper, (2007), and Solomon and Lewis, (2002). It is true that managers of corporations need training to achieve the required skills to be able to make CED.

The nonexistence of CED in Libya is caused by some other reasons among of issues management and fear of bad publicity. Three of these reasons (environmental disclosure have an obligation for others, companies fear of state agencies decisions, lack of staff and administrative difficulties) are supported by Solomon and Lewis (2002).

However, the reason that Libyan companies emphasis is on economic performance agrees with Belal (2007) and Gray et al., (2002). The last factor is that management of Libyan companies thought the environmental information is sensitive and confidential is supported by Solomon and Lewis (2002) and Teoh and Thong (1984).

Libyan companies do not make CED due to the absence of competition in market and environmental civil society organisations. The reason of the nonexistence of competitions is in conflict with findings of the study undertaken by Solomon and Lewis (2002). They conclude that one reason for non-disclosure was to avoid providing information to competitors. This could be true when the information is negative but if it is positive then it can improve the company and goods in the market. However, the absence of environmental civil society organisations leads to no strong pressure from community pressure as result, an absence of CED.

This paper contributes to the CED literature by exploring the disincentives for CED in a developing country context. The paper demonstrated various issues for the absence of CED in Libya which could help policy makers to undertake some serious public policy issues by understanding motives for encouraging companies to publish their environmental information.

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# Construction contracts, project delivery methods and roles of the project stakeholders. The case of Khalifa port project in Abu Dhabi

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## Abstract
The main subject of this paper is to investigate and review the main construction contracts used in international environment, the project delivery methods and the roles of the project stakeholders.
The greatest part of information and data were collected with the assistance of the "Archirodon Construction (Overseas) CO. S.A.", more specifically with the assistance of the department based in United Arab Emirates (U.A.E.). The first author stayed with the aforementioned company in U.A.E. for three months in the frame of his diploma Thesis.
In the case of Khalifa Port in Abu Dhabi a brief presentation of the involved "actors" is made and the role of each one is described. Responsibilities are recorded and presented, as a result of a "structured questionnaire" survey with key personnel and the contract documents analysis.
It appears that in certain positions the civil engineer is spending more time on issues not purely related to the main civil engineering discipline. Particularly, working in management positions in international construction the civil engineer requires a good knowledge of financial and legal issues.

## Keywords
International Construction Contracts, Project Delivery methods, Project Involved "Actors", The Khalifa Port Project U.A.E.

## 1.Introduction

The construction contracts and the project delivery methods are some of the most important issues for an Engineer. This paper introduces and investigates the main contract types and the main delivery methods, which an engineer can meet during his career. Additionally, there is a description of project stakeholders and the case Khalifa Port project is examined as a case study to show how the previous issues are applied in practice.

The greatest part of information and data were collected with the assistance of the "Archirodon Construction (Overseas) CO. S.A.", more specifically with the assistance of the department based in United Arab Emirates (U.A.E.). The first author stayed with the aforementioned company in U.A.E. for three months in the frame of his diploma Thesis (Kalyviotis, N (2008)). The work was realized by the

analysis of information, contracts and manuals submitted, also by "structured interviews" conducted with key personnel of the company is sites.

In the case of Khalifa Port in Abu Dhabi a brief presentation of the involved "actors" is made and the role of each one is described. Responsibilities are recorded and presented, as a result of a "structured questionnaire" survey with key personnel and also the contract documents analysis.

## 2. Main Construction Contracts

Main types of Construction Contracts are: Lump Sum, Unit Price, Cost Plus and incentive. These contracts with their subcategories and the Standard Form Contracts are covering most of the projects.

Lump Sum (also called Fixed fee Contract) is the kind of contract that the Contractor agrees to construct a certain and described project for a fixed price. A lump sum contract is appropriate when the scope of the project and the project planning are defined, so the consultant can easily estimate project's cost. The entire risk in lump sum contacts lies on the Contractor and that's why usually the risk premium allowed for in these projects is higher.

Unit Price Contract or Re-measurable Contract is based on rated quantities of the project and the price of each unit of these quantities. The final price of the project depends on the required quantities for finishing the total project. As it is understood this kind of contract can be used in cases that the scope of works is defined, but not the exact size/quantities. Contrary, to the lump sum contracts, the risk here lays exclusive with the client

Cost Plus Contracts allow clients to agree the total cost of the project works plus an extra amount as the contactor's profit. This kind of contract is used when the type of work is not specified or the risk is too high. That's why there are many subcategories of cost plus contracts too. The main subcategories are:
*Cost & Fixed Percentage Contract:* the compensation is standard based on the total cost of the project, but the contractor takes extra an agreed percentage for each activity.
*Cost & Fixed Fee Contract*: the contactor's compensation is standard regardless of the total cost of the project. Client agrees to cover the real cost of the project and further on to give an agreed fee to the contractor.
*Cost & Fixed Fee with Guaranteed Maximum Price Contract*: it is the same case as before the only difference is that the total cost of the project will not exceed an agreed maximum price.
*Cost & Fixed Fee with Bonus Contract*: as in the previous cases contactor's compensation is standard, but there is a bonus, if the project meets certain goals (i.e. budget is reduced or if the project's time is reduced etc.)
*Cost & Fixed Fee with Guaranteed Maximum Price Contract and Bonus Contract*: is a combination of the two previous contracts.
*Cost & Fixed Fee with Agreement for Sharing Any cost Savings Contract*: is the last case, where the client and the contractor share the excess of money.

Contract incentives refers to monetary or non-monetary motivators embodied in or arising from the terms and conditions of the contract that influence the behavior of the buyer and seller towards accomplishing desired contractual outcomes.

Incentives should be positive but balanced, when necessary, with remedies for missing specific program targets or objectives.
*A fixed-price incentives contract* contains a target cost, a target profit, a price ceiling, and a formula by which stockholders will share any differences between target costs and actual final costs, as negotiated.
*Cost Reimbursement Incentives contract* provides for payment to the contractor of allowable costs incurred during performance; that is, the final amount payable by the client and is determined by the contractor's actual cost experience.

Standard Form Contract is the kind of contract that does not allow for negotiation between the stakeholders. These contracts were drafted either from organizations or companies or federations. There are three well-known types of standard form contracts FIDIC (International Federation of Consulting Engineering), ICE (Institution of Civil Engineering) and NEC (New Engineering Contract).

*The FIDIC contract documents (www.fidic.org (2010))* are the most used contracts worldwide. The main advantages of the FIDIC contracts are the followings:

- It is an international Contract, as it used in many countries and it is translated in twelve languages.
- The documents are accompanied from a rich literature and case-law.
- The risks are balanced between the stakeholders.
- It is adopted from European Union and other international organizations (The World Bank, etc) for funding projects.

The main disadvantages of the FIDIC contracts are:

- There is unevenness between the contract terms of private and public filed
- The dependency between the terms makes the changes difficult and time-consuming.
- The provisions about the subcontracting is very limited
- Finally in the term 5.2 the phrase "…indemnity of the contractor against and from any negligence or misuse of goods…" has many traps, as the term "goods" is not specified and the radius of the possible losses is huge, also the term "any negligence" covers almost everything.

*The ICE contract documents* are the base for FIDIC contracts. They were developed by the British Institution of Civil Engineering in United Kingdom before FIDIC. The ICE is not as developed as FIDIC and it is very rare to meet them (www.ice.org.uk (2010)).

*New Engineering Contracts* have a heavy legal character, although the simplicity of their writing makes them very simple to use. The leadership of these contracts is that they are not just a simple form of contract, but a family of contracts that includes many project cases. So someone can use the included contracts to mold the final form of the contract. They are better than FIDIC in small projects and in projects that have many phases (www.neccontract.com (2010)).

## 3. Main Project Delivery Methods

There are many project delivery methods, which were developed during the last twenty years. The distinction between them is a result of the separation of different risks and subjects, but also from who owns the fixed amounts. The three main project delivery methods are Design – Bid – Build, Fast Track and Turnkey and some other, not so popular are presented here (Kalyviotis, N (2008)).

The most popular method is Design – Bid – Build (D.B.B.) being an agreement between the client and the contractor. This way a lot of time is saved as the consultant is not involved. Traditionally, the construction of the project does not begin before the architect completes and finalizes the study. This sequence dominates in the construction industry and it is known as D.B.B. During this procedure when the first step is completed then the next starts. This can be accepted by some clients, but it is not suitable to others, because of the time and cost implications.

Fast Track refers to the overlap of the project study and the construction phases. The contracts of these projects are called phased construction, because as the design of the progressive phase is completed, the succeeding can start. The early stages of the project are under construction, as the next stages are under design. For obvious reasons Fast Track and D.B.B. sometimes offer tempting advantages to the client-owner, but at the same time they can be the source of many problems.

When a contract is Turnkey, the client has to provide all the necessary information and the design requirements to the contractor, who has to design and construct the project under a single convention. The single convention eliminates the need for client's coordination and reduces the duration of the project. After the completion of the project, it is delivered straight to the client.

## 4. Main Project Stakeholders

Every project has many stakeholders, whose number depends on its size. The most common stakeholders are the Owner (Client), The Architect-Engineer, The Prime Contractor and the Subcontractors. Apart of these there is a big number of other indirect stakeholders as the law consultant, the insurance company etc (Clough, R., Sears G. and Sears K. (2000)).

### 4.1 The owner

The owner, whether public or private, is the instigating party that gets the project financed, designed, and built. Public owners are public bodies of some kind, and range from the federal government down through state, country, and municipality entities to a multiplicity of local boards, commissions, and authorities. Appropriations, bonds, or other forms of financing set the payment for the public projects, are built to perform a defined public function. Private owners may be individuals, partnerships, corporations, or various combinations thereof. Most private owners have the structure built for their own use: business, habitation, or otherwise. However, some private owners do not intend to be the end users of the constructed facility; rather, they plan to sell, lease, or rent the completed structure to others. These end users may or may not be known to the owners at the time of construction.

### 4.2 The Architect – Engineer

The architect-engineer, also known as the design professional, is the person or firm that designs the project. Because the planning is architectural or engineering by its nature, or often combines these two, the term ''architect-engineer'' is used to refer to the design professional regardless of the applicable specialty or the relationship between the architect-engineer and the owner. Traditionally, the architect-engineer

is a private and independent design company that accomplishes the design under contract with the owner.

## 4.3 The Prime Contractor

A prime contractor, also known as a general contractor, is the firm that is in prime contract with the owner for the construction of a project, either in its entirety or for some designated portion thereof. In this regard, the owner may choose to use a single prime contractor instead of several separate prime contractors. When the owner awards construction of the entire project to one prime contractor, then the system is single-contract. In this system, the contractor brings together all the diverse elements and inputs of the construction process into a single, coordinated effort and assumes full, centralized responsibility for the delivery of the finished job, constructed in accordance with the contract documents. The prime contractor is fully responsible to the owner for the performance of the subcontractors and other third parties to the construction contract.

## 4.4 The Subcontractor

The extent to which a general contractor will subcontract work depends greatly on the nature of the project and the contractor's own organization. There are instances where the job is entirely subcontracted, so the general contractor provides only supervision, job coordination, project billing, and perhaps general site services. Customarily, the prime contractor will perform the basic project operations and will subcontract the remainder to various specialty contractors. Types of work with which the prime contractor is inexperienced or for which it is not properly equipped are usually subcontracted, since qualified subcontractors generally are able to perform their specialty faster and less expensively than the general contractor. When the prime contractor engages a specialty firm to accomplish a particular portion of the project, the two parties enter into a contract called a subcontract. No contractual relationship is thereby established between the owner and the subcontractor. When a general contractor sublets a portion of its work to a subcontractor, the prime contractor remains responsible under its contract with the owner, for any negligent or faulty performance by the subcontractor. The prime contractor assumes complete responsibility to the owner for the direction and accomplishment of the total work. An important part of this responsibility is the coordination and supervision of the subcontractors.

# 5. Case Study: The Khalifa Port project in Abu Dhabi

The emirate of Abu Dhabi constructs a new port and an industrial zone, which costs almost 1.4 billion euro, in the coastline between Dubai and Abu Dhabi. The port and the industrial zone will be developed separately. The Khalifa port will be developed in five phases and will include a container handling terminal and piers for handling raw and bulk cargos. The portal will replace Abu Dhabi's largest existing port, Mina Zayed by 2012.

## 5.1 Scope of Work & Major Quantities

Work in Khalifa port is divided to five phases and includes:

- Creation of 2.6 million sq. m. marine platform.
- Dredging and Reclamation works.

- Constructing of a 32 km quay way and 7.3 km breakwaters.
- Constructing a 4.6 km causeway.

Khalifa port will be build offshore and connected to the onshore industrial zone by a four-km bridge or causeway.
The quantities in this project are big and difficult to be specified. Here are presented the major quantities

- Revetments 17 km
- Breakwaters 7.4 km
- Main Bridge 1 km
- Utility Bridge 1 km
- EMAL Trestle 1.6 km
- Main Quay wall 3.2 km – at 18m
- EMAL Quay wall 0.8 km – at 18m
- Other Quay walls 0.5km
- Dredging/Reclamation 47 mill cubic meters

## 5.2 Project Stakeholders

Abu Dhabi port Company awarded the contract of Khalifa port to a Consortium comprising of Archirodon Construction (Overseas) Company, Boskalis Westminster Middle East and Hyundai Engineering and Construction Company. The consortium named "Khalifa Port Marine Consortium (KPMC)". The prime contractor (who has the management of consortium) is Archirodon. International Bechtel Co. Ltd. is the Project Management Consultant, who controls the contractors. The project will take four and a half years to complete. Unusually, at the time of the contract award, much of the final design work surrounding the port's construction was yet to be done. The client, Abu Dhabi Ports Company, was looking for contractors with the skills and multidisciplinary services needed to deliver this design expertise as the work progressed. As a result, the three companies are co-coordinating the design activities, not only in the dredging and reclamation work, but also in the construction of the quay walls, bridges and breakwaters. This deep-level involvement means that the Consortium can act as both advisor and partner of the client and so arrive at the optimum solution.

## 5.3 Contract Form and Delivery Method

The contract of Khalifa Port is based on FIDIC Form contract. The main reason for this format is that the project is too big and by this format the risks are balanced with a tested contract in international environments. The different works of the project can be either Lump Sum or Re-measurable contracts. This has to do with the type of the work. Dredging & Reclamation, for example, are Re-measurable, because these works depend on the quantities. Personnel payments and bridge construction are Lump Sum as these works are defined and can be easily deigned and constructed.

## 5.4 Challenges

Tight project schedule is a classic challenge for this type of project. The offshore construction (without initially access by land) is another challenge. All the personnel and material was transported by sea. The exposure to extreme weather is the next challenge. The winter storms bring NW winds with speed > 20m/sec and the waves study height measures 5m. Logistics can be a problem in this project. Adjustment

of material supply with critical times for construction of the breakwaters and Dredging/Reclamation is another consideration.

Early-stage design and planning were particularly crucial in this project because of the unique combination of environmental, commercial and political pressures. On the one hand, Khalifa Port is close to the most extensive coral reef in the Arabian Gulf. This meant the project had to be planned using the latest methods to protect the marine environment. On the other, the project area is close to the TSFCO facilities which consist of seawater intakes for the desalination plant of the Abu Dhabi Water & Electricity Authority and the power plant of the Taweelah Asia Power Company. These are the main producers of drinking water and power for the Abu Dhabi region. Protecting both these areas from excessive turbidity levels is vitally important in the execution of the dredging and reclamation works. Thirdly, the integration of the port development with the construction of the Emirates Aluminum (EMAL) smelter heightens the commercial and political sensitivity of the project. EMAL, a joint venture between the emirates Abu Dhabi and Dubai, carries significant economic consequences for the region.

Coordination and communication between the three contractors and the client is, probably, one of the biggest challenges. The main problem in such consortium is the different working cultures and the different ways of approaching various issues and problems. Each company has its own specific methods for project design and management. This means that even details and minor issues may evolve into major disagreements.
Communication is a common problem in international sites (or The Tower of Babel Problem is present (as it is usually called). The management team of Khalifa port project comes from different backgrounds and in total speak four different native languages, namely Greek, Dutch, English and Korean. If we look deeper in site personnel and labours, we realise that there are nationalities such as Chinese, Arabic, Filipino, Indians, Nepalese etc., where effective communication is definitely not an easy task.

## 6. Solutions

The early involvement of the Consortium in the project has paid dividends, with members of their environment, design and engineering teams remaining on-site from the tender into the execution phase. This has ensured the plan was put into action with maximum efficiency.
Consortium is bringing leading-edge expertise to all aspects of the work:

- The differences, between the stakeholders, are being solved from a trustful person, who is accepted from all the three companies of the Consortium and the Client.
- The decisions are irreversible, so there will be no delays from appeals or disagreements.
- 16 fixed monitoring stations have been installed around the site, transmitting real-time data on turbidity, waves, currents, water levels and weather conditions. This online reporting technique has rarely been used on this scale before.
- Consortium have designed special heavy-duty silt screens which have been placed over a distance of several kilometers, separating the marine operations from the corals and the seawater inlets of the desalination and power plant. These screens were designed by Boskalis in cooperation with

the supplier for use in rough open water - tailored to the local conditions. The screens are repositioned as the work progresses.
- A 6 km-long 'environmental breakwater' has been build, specifically designed to protect the coral reef and desalination and power plant.
- The construction companies are using a specially developed 'spreader pontoon' in the reclamation area that evenly disperses coarse and fine material to ensure the best distribution and end product.
- Continuous hydrographic surveying is performed to monitor changes in the level of the seabed.

## 7. Conclusions and recommendations

If you read the Contract you get Education, if not you get Experience… from your mistakes. It should be noted that the executives who rise to the upper levels of the companies are those, who involve themselves early with the contracts and the delivery methods. The engineer nowadays must possess a set of economic and legal knowledge beyond the technical knowledge. It is a fact that an engineer spends more time on matters not related purely with civil engineering subject.

Project delivery methods are driven by specific cost and schedule requirements of a project. Another important issue in projects is the relationship developed with the consultants/clients, who supervise the contractors. This why contractors and clients/consultants should work together as a team and foster a win-win attitude for the benefit of the project.

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*AA102*

# The Decision-less Environment of the Future PM

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## Abstract
Project managers (PM) routinely make decisions in managing projects. Decisions are made when the project manager does not have sufficient information. Decision making increases risk, and usually forces an increase in project management, direction, and control. The future PM model is one where decisions, direction, control, and risk are minimized. Decision making will be forced to the lowest level, where the expert has been hired to minimize risk. The new model is one of observation instead of using technical expertise, and one of quality assurance rather than direction and management, and leadership based rather than information based. The new decision-less environment is being developed at the Performance Based Studies Research Group (PBSRG) at Tempe, AZ in the areas of the delivery of construction, IT, food services, sports marketing, and document control. The decision-less environment has a new contract model, a new risk model, a new outsourcing model, and a new project management model which manages a system instead of a technical function/service.

## Keywords
Future PM Model, Decisions, Decision-less Environment,

## 1. Introduction

The objective of project management (PM) is to deliver projects on time, with minimized cost and time deviations, and meeting the expectations of the buyer/client. In both the delivery of construction and IT services, PMs representing buyers have had a difficult time. Instead of proposing the traditional direction, management, and control approach of the Project Management Institute (PMI) and the International Project Management Association (IPMA) which focuses on the technical knowledge of the PM, this paper uses deductive logic to solve the problem and design the new PM model.

Traditional PM research to improve project management practices uses inductive approaches. The inductive approach has the following methodology:

1. Do a complete literature search to identify the state of knowledge of the industry and best practices.
2. Identify a hypothesis that improves PM performance.

3. Either run a sufficient amount of tests testing the hypothesis, or do a survey on the concepts of the hypothesis, and depend on the industry participants to validate the potential of the hypothesis.

The inductive approach is an exploratory approach which uses statistical analysis on test results or on the responses of industry participants on the concepts of the hypothesis to validate the hypothesis. Repeated and random testing of PM practices is difficult due to the number of variables and uniqueness of each delivery of services. Surveys and the analysis of industry participants is the usual method to identify potential improvements of PM practices. Deductive research is not exploratory, but confirmatory. It is the observation and use of dominant concepts that exist. Deductive logic is responsible for the majority of breakthroughs in improving value and having impact (Einstein (1919)). Deductive logic uses dominant concepts that are non-technical in nature. Dominant logic and concepts include:

1. When the initial conditions of an event are clearly understood, the outcome of the event is more predictable.
2. When the outcome is predictable, there is only one outcome, and decision making is minimized because the outcome is easily predicted.
3. All outcomes of events are predictable if enough information is given on the initial conditions of the event.
4. Decisions are made when the initial conditions of an event are not clearly predictable, and potentially multiple potential outcomes are perceived.
5. Decision making increases risk of not meeting the expectations of a buyer/client.
6. Decision making is not a good practice of a PM who is minimizing risk.
7. A risk minimizing practice would minimize decision making.
8. information defining initial conditions always exist, but need to be perceived.

## 2. Hypothesis

Decision making increases risk in project management. Project managers must minimize decision making to minimize risk. A structure/process will be created that minimizes decision making and therefore minimizes risk. If a structure that minimizes the buyer's PM's decision making is implemented by a PM, the risk of not meeting the buyer's expectations is minimized. The future PM model will be where the PM does not manage the project's technical risk, but where he manages a systems structure that minimizes the risk of the project.

A decision minimizing structure will be created. The objective of the project management structure is to minimize the risk of not meeting the client's expectations. After the structure is created, tests will be run to show that when decision making is minimized, the risk of not meeting the client's expectations is also minimized.

## 3. More Deductive Concepts

An event is defined by the authors as anything that takes time (Kashiwagi (2010)). A project where services are delivered is an event. It has initial conditions and it has final conditions (Figure 1.) If all the information was known on the initial conditions, the final conditions can be predicted. The authors also propose the following deductive concepts:

1. The more accurate the understanding of the initial conditions, the more accurate their prediction of the final outcome.
2. For any event, subject matter experts (SME) of an event can most accurately identify the initial conditions.
3. Experts have two major characteristics: they have experience with the event, and they have expertise to identify the initial conditions, and efficiently and effectively deliver the final outcome of the event.
4. Less qualified participants, will not be able to accurately identify the initial conditions, nor know how to deliver the service from the beginning to the end, and cannot accurately predict the final outcome of the event.

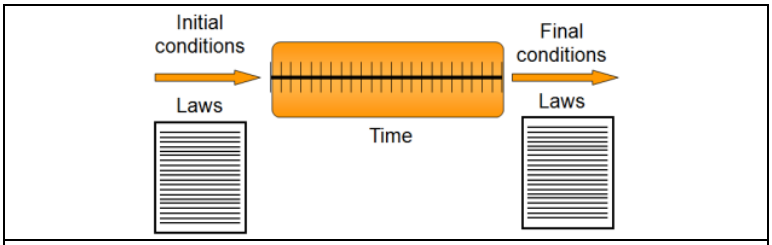


**Fig 1**: Event (Kashiwagi, 2010)

A quick analysis of the participants in a project, who are attempting to define the initial conditions of a project, identifies that the expert vendor or expert can most accurately identify the initial conditions. The buyer of the service/project is the least expert, and will have the most inaccurate perception of the initial conditions. They will make the most decisions to predict the outcome, and will have the most false expectations. If the false expectations are placed on the vendor, the risk of not meeting the buyer's expectations is maximized. Therefore, to minimize the risk of not meeting the buyer's expectations, a PM structure must be put into place that minimizes the decision making of the buyer and other professionals representing the buyer by putting into place a structure/process that identifies the expert/vendor who most accurately identifies the initial conditions of the project, within the affordability of the resources of the buyer.

## 4. New PM Model Structure Requirements

Using the deductive logic and concepts discussed above, the requirements of the new PM model structure include:

1. Minimizing the use of SMEs and decision making of the buyer's PM.
2. Minimizing the management, direction, and control of the SME in the new structure due to the definition of the vendor being the expert. The expert can most accurately perceive the initial conditions, the final conditions, and how to move from one state to the other.
3. The expert and not the buyer's PM will determine what will be provided.
4. The new PM model will identify what the buyer will receive. The PM model structure and not the PM will determine the service provided in the project.
5. The buyer's expectation will be modified/corrected with the expert's accurate assessment of the initial conditions while still in the initial conditions.
6. The system will force the vendors to compete, differentiate, and identify who is the best value vendor within the budget, minimizing the PM's decision making.

## 5. Deductive Formulation of the New Model

The new PM model will have the following components:

1. The identification of the requirement by the buyer/client using their expectations of the initial conditions (assumed to be inaccurate, and to be later modified by the expert's perception.)
2. The identification of the best value expert/vendor which most closely fits what the client expects and within the resources of the buyer.
3. The identification of what the vendor will deliver.
4. The management of the structure that will ensure that the best value vendor's delivered services.

The changes needed to the current PM model will now be discussed. The client/buyer no longer needs to know exactly what will be delivered. They just need to convey their expectations. This will minimize the amount of work the PM is required to do. A good estimation of what is expected is sufficient. The selection process of the new model and not the PM will determine what will be delivered. This is a change in paradigm. The PM no longer has to be a technical expert in what is being delivered. This requires the system to do the following:

1. The best value expert must clearly identify itself through the presentation of simple, dominant information that they can most accurately perceive the initial conditions, predict the future outcome, and know how they can move from the initial conditions to the final outcome to offer the best value.
2. The movement from the initial conditions to the final outcome must be within the resources/budget of the owner.
3. If there is no dominant information to differentiate the vendors, the lowest priced vendor will be selected by the system as the best value.
4. The system will ensure that the expert vendor will more accurately identify the initial conditions, the final outcome, and how to get from one state to the other.

If the above is accomplished, the new model will have met the objectives of:

1. Minimizing risk.
2. Minimizing decision making of the PM.
3. Transferring risk and control to the vendor.
4. Increasing the value to the buyer/client (minimizing the cost and increasing the satisfaction of the client.)

## 6. Measurements to Identify if the New PM Model is more Effective

The previous section identified the major differences between the traditional or current PM model and the futuristic PM model. The futuristic PM model will be more systems oriented than detail oriented (technical expertise is needed less); this is a paradigm shift for a PM. Once this paradigm is accepted and used, the impact on the PM's practices will be identified by the following concepts (measurement in parenthesis):

1. The client does not need to know their exact requirement, but merely be able to most accurately identify their intent (yes or no.)

2. The amount of information communicated to the experts can be decreased (perceived percentage.)
3. The number of decisions of the PM will be minimized (number of decisions required.)
4. The time and effort of the PM will be minimized by the structure (perceived relative time and effort.)
5. The amount of direction and control over the competing experts and the selected best value expert will be minimized (amount of management and expertise required by PM.)
6. The satisfaction of the buyer/client will be increased when compared to the results of the traditional process (perceived by the buyer.)
7. Measured value of the new process in terms of saving of resources (manpower and cost.)

## 7. The New PM Model

The new model does not require the client to know the requirement in detail, but merely know the intent (the what and not the how.) The intent can be anything from a short description to a full set of specifications and drawings. The vendors will be allowed to determine the final product/service. The entire system assumes that the vendors are more expert than the client's PM and other representatives. Therefore, the process will minimize the amount of instruction and detail given to the vendors. This favors experts, who need less information to identify what is required. The system will also minimize what the vendors submit. The submittals should be short, concise, and concentrate on dominant information to solve the client's unique requirement. If the dominant information is lacking in the competing vendors' proposals, the PM should quickly score every submittal the same (not dominant.) The key experts of the vendor will be interviewed. The experts will be graded on how accurately they can predict the outcome, how they know they can predict the outcome, and if they exhibit human characteristics of the expert (accountability, proactive, can predict, concise and simple communication.)

If dominant information is lacking and the vendors are perceived as offering the same value, the low price vendor will be selected as the best value, and the best value expert will then be requested to pre-plan to identify clearly what they will provide and also be required to manage and minimize the risk that the vendor does not control that is caused by the interface between the existing conditions and what the vendor will provide.

The new PM model that was tested by the researchers at the Performance Based Studies Research Group (PBSRG) is the best value Performance Information Procurement System (PIPS). The major differences in the new model are:

1. The best value vendor is the expert and not the client's PM.
2. The client's PM does not need to be an expert.
3. The best value vendor writes the contract.
4. Dominant information identifies the best value vendor and replaces PM technical expertise and decision making.
5. The best value vendor uses a risk management report that manages and minimizes the risk that the vendor does not control.
6. The best value vendor measures their performance.

## 8. Test Results

The new PM model has been under development and modification for the past 15 years. The testing results include (PBSRG (2010)):

1. 700 tests and the delivering of $800M of construction services.
2. The delivering of $1B of infrastructure construction services in the Netherlands.
3. The testing of the system in Botswana to select and manage a contractor.
4. The delivering of $1.3B of non-construction services by Arizona State University (ASU).
5. The minimization of up to 90% of the project management and risk management of clients' PM (state of Hawaii, University of Minnesota, US Army Medical Command, and ASU test results.)

The process was run at ASU on two specific deliveries of services: the delivery of a 10 year $400M food services contract, and the five year $60M outsourcing of ASU networking services.

## 9. Food Services Delivery

The food services were delivered in 2007, and the measurements of increased value are listed below (Michael (2008)):

1. The client identified the existing food service contract, and requested vendors to review it if they needed to understand the scope of the current operations. The client specified that they wanted higher customer satisfaction, more commissioning money, more capital investment funds to improve dining areas at the university, and more food sold.
2. This was successfully done with 1/10 of the documentation.
3. The number of decisions of the PM was minimized. The selection committee was made up of 32 personnel, and all 32 identified the same vendor. The selection committee rated a risk assessment value added submittal without knowing the vendor's names (blind), and were directed to give a 10 rating if the submittal was dominant different, but a 5 if the difference in value was not dominant. After all the information was put together, the difference in value was dominant ($32M more than the incumbent, and the best rating in 10 of 14 categories.
4. The time and effort of the ASU selection team was minimized. The risk assessment and value added plans were only five pages long, instead of the traditional 400 pages. After the best value vendor was put into place, 80% of all ASU management personnel were transferred, quit, or working somewhere else.
5. In the last two years the food services vendor has managed and minimized the risk of the food services.
6. The satisfaction of the students increased when compared to the results of the traditional process (student ratings.)
7. ASU increased their financial reward over the ten years by $32M (when compared with the service delivered by their traditional delivery system.)

## 10.Outsourcing of the IT Networking Services

The new PM model was also used to outsource the ASU IT Networking Services.

1. The client identified the existing IT networking services as best as they could. The budget for the maintenance of the existing system ($14M/year) was given to the vendors. The vendors were allowed to ask questions of the existing system during the procurement process. The client did not identify their requirement in terms of cost or level of service.
2. This was successfully done with minimal documentation.
3. The number of decisions of the PM was minimized. The competition started with five competitors and only one could provide the services being requested (the maintenance of the existing network.)
4. The time and effort of the ASU selection team was minimized. After the best value vendor was selected, the management staffs at ASU were minimized by 50%.
5. The satisfaction of the new services increased by 40%.
6. ASU decreased their cost of the networking system by $1.25M and were given added value services of $1.4M that they could not normally afford. The dominant result of the vendor's service was that the spend rate for maintenance/new equipment went from 17%/83% to almost 50%/50%.

The ASU IT Director had been trying to quantify and identify improvements in their networking systems for the past two years. He was attempting to identify the scope and the competitive cost for the services. He was unsuccessful as his staff could not come up with a complete enough description of the scope and costs. The IT Director used the PIPS delivery process to quantify the scope and cost of their system, and also to find the best value vendor who optimized the efficiency of the system. Without a complete specification, the new PM model was incorporated and the project was advertised. As the vendors were preparing their submittals, the answers to the questions they asked shaped the scope and cost of the operation. The project managers who ran the project had no IT experience. They were the same PMs who ran the food services contract, and they also had no food service experience.

The ASU business services and contracting personnel were impressed with the results of the new PM model and adopted the model to deliver major services for ASU. The financial benefit to ASU in the ten year period (2007-2017) is $100M due to the new PM model. The success of the new PM model has spread quickly, with the following results:

1. The State of Alaska is purchasing a $200M state wide ERP system using the new PM model.
2. The State of Idaho is purchasing a $30M Driver Vehicle Management (DMV) system.
3. The General Services Administration (GSA), the largest buyer of non-military services in the U.S., is implementing the new PM model in a 4 year, $800K research effort.
4. The State of Oklahoma is purchasing commodities using the new PM model.
5. The universities of Minnesota, New Mexico, Boise State, Idaho, Northern Arizona, Arizona, and Missouri are testing the new PM model.
6. Although the $1B Dutch tests are not completed, the research/test group is being directed to do another $2B of test applications.
7. Test efforts are being conducted in Finland and Botswana, and being discussed in Australia, Malaysia, Germany, Korea and Japan.
8. The Best Value PIPS annual conference attracted 250 participants (largest in five years,) all industry participants who are participating in the new PM model.

9. Research funding for the Performance Based Research Group (PBSRG,) which is totally funded by industry participants running research tests, has reached the $8.5M funding mark, with $1M funding the last two years.

## 11.Conclusion

The traditional PM model/environment is a management, direction, and control model. The model is being improved incrementally by technical training and education. The PM model of the future has been designed using deductive logic. The dominant logic includes:

1. Minimize management, direction, and control.
2. Clients need to know the intent of their project and not the exact requirement.
3. Project managers should not be making decisions.
4. Project managers should use the best value PIPS process to hire vendors who are expert at their trade/expertise.
5. Control should be transferred to the expert vendor.
6. The expert vendor should measure their performance continually.
7. The PM's role in the future is to select the best value vendor and to force a measured environment by doing quality assurance.

The transformation of the new PM model is being fueled by the documented dominant increase in performance, the increase in financial opportunity and reduction in cost, and the combination of increased requirements and decreasing funding. The futuristic PM model continues to be optimized and developed.

The new PM model is where the PM manages a system which uses dominant information and minimal decision making. Instead of managing technical functions/services, the future PM will be managing systems which align high performance vendors. Further information and details can be found at pbsrg.com or with the CIB W117 Using Performance Information in Construction.

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*AA103*

# New Contract Model for Project Management

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## Abstract
A new contract model has been developed which changes a project manager's (PM) responsibilities from writing and enforcing a contract, to transferring the responsibility of writing and administering the contract to the vendor. The new environment changes the PM's role from management, direction, and control, to quality assurance. Quality assurance is ensuring the vendor has a quality control and risk management plan. The new model is based on the assumption that the client cannot control the vendor through the contract. The control mechanism is deleted, and the vendor creates a contract document that minimizes risk. The contractual document, which must be approved by the client's PM and legal, includes a risk managing mechanism called the risk management plan (RMP) and a weekly risk report (WRR.) The new contractual mechanism is the expert contractor's mechanism to document and minimize risk and transactions.

## Keywords
New Contract Model, Managing Risk, Transfer of Risk and Accountability

## 1. Introduction

The delivery of construction and IT services has traditionally been done through specifications written by professionals who represent the client. The performance of these services has not been stellar. Performance in construction is estimated at 70% (no cost or time deviation by the vendor, and meeting the expectations of the client) (Post (1998)). The performance in the IT industry is even lower at 30% (Vital Smarts (2006)). The poor performance is difficult to solve in the relationship and politically oriented environment of the price based sector represented in the construction industry structure (CIS) in Figure 1. The authors are proposing that the performance is low in the price based environment because the environment is built upon inefficient and inaccurate practices of control that result in vendors/people not being accountable, reactive, and basing their value on relationships. The following actions are driving down the performance of vendors:

1. An expert vendor is being directed by a person with less expertise.
2. Vendors are directed to submit the lowest possible price (Figure 2.)
3. By communicating the requirement in terms of minimums in a price based environment, clients direct the vendors to transform the minimum into a maximum, creating an adversarial win-lose environment (Figure 3.)
4. The solution of clients to the vendor non-performance is to increase direction and control.

**Fig 1**: Construction Industry Structure (Kashiwagi, 2010)

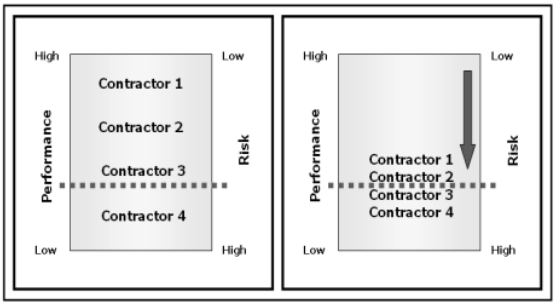


**Fig 2**: Price-Based Award (Kashiwagi, 2010)

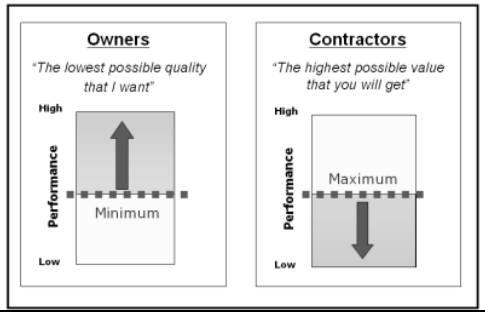


**Fig 3**: Min/Max Dilemma (Kashiwagi, 2010)

## 2. Hypothesis

The authors are proposing that one party cannot control another party. The authors are also proposing that if any control mechanisms are being used by a buyer and their project manager to manage and minimize risk, the performance will be minimal, the vendor will be reactive, and the project manager may be forced to increase their management, direction, and control functions.

## 3. Control and Influence

Control and influence are functions of today's project manager. Project managers minimize risk by management and control of vendors. Management and control have been used by parties to influence the outcome and behavior of vendor services. The authors will use deductive logic to propose that control is not as effective as alignment of resources.

Two different deductive models will be used. The first will be the use of an extreme opposites model of an influence model vs. a no influence model (Kashiwagi (2007)). The extremes make the result dominant, simplifying the concept and minimizing decision making. The second model will be a teacher and his four students and their ability to learn the same subject matter. Figure 4 shows the no influence model on the left hand side, and the influence model on the right hand side. The person who uses the extreme influence model believes that:

1. Forces from outside of their control may influence their life. This is by definition of the model in Figure 4, where external forces are impinging on the individual.
2. Things can happen by chance and affect their life even though it has nothing to do with the individual being influenced. These things are unpredictable and not understandable by the person because the source is the external environment.

3. Without their choice, they can be controlled/influenced by other people.

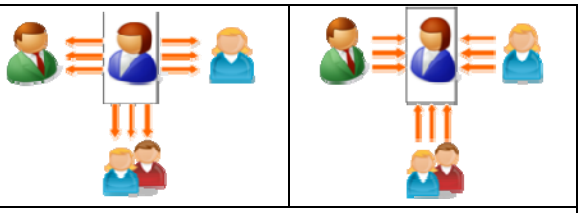

**Fig 4**: No Influence / Influence Model (Kashiwagi, 2010)

The extreme "no influence" model believes that everything that happens around them has something to do with what they have done. They believe that:

1. They have complete control over their lives.
2. Nothing happens to them by chance. If they use hindsight, they can clearly see why an event happened in their life, what actions they did which caused the event, and understand the relationship of the event to themselves.
3. They cannot be controlled by someone else, neither can they control others.

People with the two extreme approaches to life will have different characteristics. By asking which extreme model the characteristic is more likely to belong to, the relationships between the characteristics can be easily identified.

According to which approach is more likely to have the following characteristics, the "influence" model represents:

1. Believes in chance.
2. Believes in control and influence.
3. Does not understand other people.
4. Believes in win-lose.
5. Will blame others if something goes wrong.
6. Does not continuously improve.
7. Does not pre-plan, or attempt to predict the future outcome.
8. Are ineffective and inefficient.
9. Are reactive and short sighted.
10. Are more illogical.
11. Makes decisions and increases risk

The "no influence" model is the extreme opposite. It represents accountability, pre-planning, the alignment of resources instead of using control, win-win, continuous measurement and improvement, and minimized decision making.

The second deductive model is a teacher that has a class of four students. If the teacher had influence or control, the teacher could ensure that all the students learned the same exact knowledge. Deductive logic identifies that the person who controls the amount they learn is the student, and not the teacher. A lack of information leads some people to believe that the teacher has influence and control, but they have no validating information. It is only a proposal of an idea. All information tends to support the concept that people have control over their own selves and results. This is the concept of accountability. If this is true, it is impossible for one party to control or influence another.

The following are examples of the attempts of one group to use control and influence to change another party. According to the deductive logic discussed above, the attempt should be ineffective and inefficient (cost is high, transactions and problems will be perceived as stubborn and unsolvable, and results are not as expected or unsatisfactory.) The events of attempted control include:

1. The attempt by a person to change their spouse.
2. The attempt by the United States to change the political environment of Iraq.
3. The attempt by the penal system to reform people who have broken the law.
4. The attempt of the U.S. federal government to stop the use of drugs in the U.S.
5. The attempt of law enforcement to change the behavior of people and stop them from breaking the law.
6. The attempt of companies to enforce standards in their companies.
7. The attempt of companies to use leadership training to influence people.

One of the major reasons for divorce is the incompatibility of spouses. Spouses who believe they can change or influence their spouse are less likely to pay attention to compatibility before marriage. In location where pre-arranged marriages are practiced, and where family status, wealth, and education are considered to minimize risk, the divorce rate is less than 1% (Divorce in India (2008)).

The war in Iraq is a dominant example of someone's belief that they can control another group of people by changing their lifestyle, beliefs, and form of government. What was once the breadbasket of civilization and an example of technology is now a war torn country. The U.S. thought the war against Saddam Hussein's forces was the biggest obstacle in Iraq. They learned that changing the people's culture is much more difficult. The U.S. has attempted this before in Vietnam, Iran, Korea, Bosnia, Haiti, Somalia, Russia, China, and now in Afghanistan. The results have been costly and poor.

The penal system is designed to rehabilitate criminals. The measurements show we have no control over the any of the criminals. Many of them do the same thing in prison that they do out of prison. The return rate for offenders is at 80% (Langan (2002)). The solution to a lack of funding in a down economic cycle is to release them because we cannot afford to incarcerate them and the practice is ineffective. Ironically in the U.S., we incarcerate more people than any other country.

The attempt to control the trafficking and use of illegal drugs in the country is one of the most dominant examples of the lack of control. The U.S. spends $400B per year on the attempt to control drugs. Over 70% of the funding is used in legal costs of court cases and administration (Jones (1999)). The drug war has increased violence in all countries where the drugs are either grown or trafficked. Because drugs are now controlled substances, the profit for illegal cartels is high and lucrative. Availability of the drugs is everywhere. This is not unlike the period of prohibition, where for 12 years, the federal government tried to control alcohol. After seeing the high cost, the flourishing of illegal mafia groups, and the inability to stop the consumption of alcohol, alcohol was made legal. Today, people drink alcohol as a beverage. The legalizing of drugs in both the Netherlands and Portugal has radically reduced cost, crime and drug problems.

Deductive logic and dominant examples of history identify the control or influence

model as ineffective and inefficient. The use of control or influence has not minimized risk.

## 4. Supply Chain Management and Best Value Procurement

In the delivering of services, there are many attempts to influence and control. One of the major mechanisms of control is the contract. In the previous section, deductive logic was used to identify that experts minimize risk and not legal documents such as a contracts. The deductive logic discussed proposes that the entire concept of one party dictating to another party what should be done and attempting to enforce or control the party may be ineffective.

A system has been developed called the Performance Information Procurement System (PIPS.) A derivative of PIPS is called the Performance Information Risk Management System (PIRMS.) PIPS and PIRMS are best value alignment systems that have been tested since 1994. The purpose of this paper is not to discuss the details of PIPS/PIRMS, but to address the practice of direction and control to minimize risk, the use of contracts, and the alignment of resources.

Best value procurement has the following difference with the traditional procurement used by project managers:

1. The project manager (PM) does not have to create a specification which identifies the requirement of the client/buyer which will be delivered by the vendors, but merely identifies the intent of the buyer.
2. The PM uses best value procurement to identify what the vendors can offer which attempts to meet the intent of the buyer.
3. The PM will pick the alternative that best satisfies the intent of the buyer.
4. The PM then ensures that the vendor has a risk management system that delivers what the vendor has promised.

These changes have the following impact on the delivery process:

1. The PM and buyer's team no longer has to be a technical expert.
2. The risk of the service not performing is transferred to the vendor.
3. What is being procured is a service/systems delivered in an environment that the vendor does not control that meets the expectations of the buyer.
4. The transfer of risk and control to the vendor forces the vendor to be an expert or to learn what the expert should know, and perform accordingly.
5. The expertise of the vendor can now be identified in dominant terms: has the vendor accomplished their task before, can the vendor distinguish the risk of the environment which they cannot control, and can they manage and minimize the risk of the unique environment, can the vendor identify what they are delivering in terms of performance, and can they write a simple contract on how they will deliver the service.

The changes in the paradigm force vendors to compete (price and performance) and change the buyer's PM responsibilities from technical expertise to quality assurance.

## 5. New Procurement Paradigm

The new procurement paradigm is shown in Figure 6. The requirement of the client/buyer PM is now to identify the intent of the buyer. The intent could be anything forms a simple requirement statement to a detailed design and

specification. Regardless of the detail in the explanation of the intent, the requirement is merely an intent of the buyer.

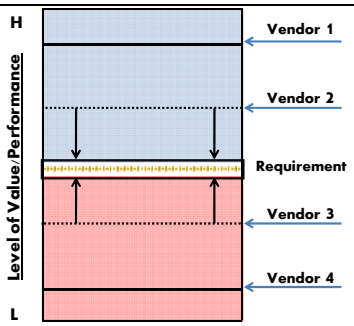


**Fig 5**: Traditional Procurement Philosophy (Kashiwagi, 2010)

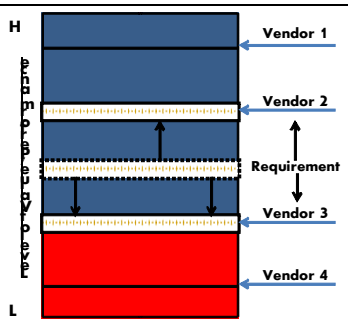


**Fig 6**: New Procurement Philosophy (Kashiwagi, 2010)

Every vendor perceives the intent slightly differently, and the proposal of the vendor has an accompanying price and level of performance. No two vendors will deliver exactly the same service/system. In the traditional price based procurement paradigm, the procurement officer representing the buyer will either assume that the vendor's deliverable service is the same as the requirement, or not understand that the vendor's level is different and attempt to force the vendor to modify their deliverable to match the requirement. From Figure 5, the procurement officer would eliminate the lower two vendors, or force them to modify their deliverable. Or they would identify the higher two vendors as being the same, and award to the lowest price. In the traditional best value process, the buyer's procurement agent would either force vendor #3 to increase their value/performance of their proposal and maintain their low price, or get vendor #2 to lower their price and deliver the higher proposed value/performance of their proposal. This is often known as "best and final" or negotiated price.

In the new procurement paradigm, the application of logical, effective, efficient and dominant practices minimizes risk and accompanying transactions:

1. Minimize risk of non-performance. Risk is minimized when the vendor is an expert and knows exactly what they are going to do, before they deliver. This includes their price, their deliverable, and their schedule.
2. Minimization of direction to the vendor from parties who are not experts.
3. Minimization of the risk of over-expectation, as the vendor dictates the final deliverable service/system and not the client.
4. Minimization of the risk of requiring what may not be available.

The buyer's PM no longer needs to know what they are procuring when issuing the solicitation or request for proposal. The requirement is now simply the buyer's intent, a budget, and a time frame of delivery. The new procurement paradigm will identify all three previously buyer determined factors: the delivered system/service, the price, and the schedule. The new procurement paradigm has changed the PMs responsibility from management, direction, and control (which requires technical expertise) to quality assurance (identify the best value and ensure that they are practicing quality control and risk management.) The vendor will now improve quality by minimizing time and cost deviation (Deming, 1982.)

## 6. New Contract Paradigm

The contract paradigm changes from the client/buyer attempting to control the vendor by use of a contract (Figure 7), to the new paradigm of using the contract to manage and minimize risk by the expert (Figure 8.) Using the concepts of deductive logic that mechanisms of control will only result in increased transactions and inefficiency, the sole purpose of the contract is to manage and minimize risk. The party most effective to manage and minimize risk is the expert vendor. The new contract mechanism forces the vendor to pre-plan, and to manage and minimize risk. They must identify:

1. Performance requirements that must be met.
2. Technical requirements of the project.
3. Legal contract requirements of the client for bonding, insurance, local codes.
4. A mechanism of documentation of risk that clearly identifies deviations (risk) on the project and accountability of the risk in terms of cost and time.

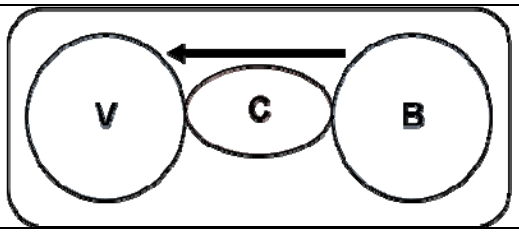


**Fig 7**: Traditional Contract Model (Kashiwagi, 2010)

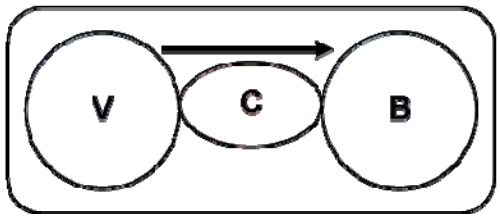


**Fig 8**: New Contract Model (Kashiwagi, 2010)

The new contract paradigm involves no control or influence, but the selection of an expert contractor that meets the intent of the client within the constraints of the buyer's environment, time and funding. The new contract paradigm in conjunction with the procurement philosophy creates an environment of transparency that simplifies the management of projects. A part of the transparency is the risk management documentation that the contractor maintains that does the following:

1. Identifies all the risks and concerns of the client, technical experts, and the contractor before delivering and forces a plan to manage and minimize these risks as a part of preplanning and as a major component of the contract.
2. Uses a weekly risk report that identifies any risk that will lead to cost and time deviation, the source of the risk, and how the risk is being minimized.

Both these risk management tools have been developed as a part of PIPS/PIRMS and are known as the risk management plan (RMP) and the weekly risk report (WRR) (Kashiwagi, 2010.) These documents are a major part of the contract written by the vendor. The vendor written contract must be reviewed and approved by the client/buyer's legal and technical staff.

## 7. Testing of the New Procurement and Contract Paradigm

The new procurement philosophy and contract paradigm has been tested at Arizona State University (ASU) for the past three years on contracts totalling $1.5B of delivered services (food services, sports marketing, gym equipment, IT networking, IT data center, help desks, document control, and long distance education. The impact on the delivered services includes (PBSRG (2010)):

1. The minimization of vendor created risk. In the four years, there have been no deviations caused by the vendors.

2. The increase of value of the delivered services when compared to the previous services delivered with the traditional processes ($100M over the next 10 years.)
3. The minimization of management, direction, and control transactions by 80%.
4. The minimization of risk that normally would have to be managed by the client's PM which included the re-establishment of services after a non-vendor related disaster at the university.
5. The measurement of all vendor services by the vendor in comparison with past services and vendor performance requirements using objective measurements.
6. Contract administration by the vendors.

The new procurement philosophy and contract paradigm have been implemented at ASU as the new method to deliver services.

## 8. Conclusion

The new procurement philosophy and contract model changes the project manager's (PM) role from the technical expert who is managing, directing, and controlling, to a quality assurance coordinator who runs systems that ensure the alignment of the best value vendor with the buyer's intent. The PM now transfers risk, control, and accountability to the best value vendor who is expert. The best value vendor identifies what they will deliver, how they will deliver it, and administers their own contract using documentation that identifies deviations to their proposal, and how they will manage and minimize the deviations. The new philosophy and procurement will force the transition from the traditional models to the new model due to dominant value/performance differences, the deductive logic behind the new concepts, and the minimization of risk and transactions caused by the traditional management, direction, and control practices. When control and influence based concepts are removed, the cost savings have been dominant. When researching the efficiency and effectiveness of control/influence concepts, the authors were surprised at the cost and results of such practices. The dominant results of previous efforts attempting control give tremendous motivation to change to the new philosophy and paradigm. Project management (PM) will be transformed by the movement of owners/clients/buyers to efficiency and value.

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*AA105*

# Strategic Plan for the Implementation of a New PM Model

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## Abstract
The University of Minnesota has been implementing the best value Performance Information Procurement System (PIPS) for the last four years. PIPS uses a new project management model which transfers risk and control to the vendor, and minimizes the client's PM activities. The performance of the vendors has increased and the number of transactions has been minimized, however, many of the project managers have resisted the new PM model. The resistance of the PMs has resulted in the analysis of the strategic plan to implement the new project management model. The result of the analysis is that the strategic plan must concentrate on the development of the core team of visionaries and not on the implementation of the new PM model. The tactical plan on the mechanics of the new PM model is also required, but is not as important as nurturing the core team of visionaries who are leading the change. The strategic plan ensures the sustainability of the new PM model.

## Keywords
New Project Management Environment, Transition of PM Responsibilities.

## 1. Introduction

The University of Minnesota (UM) has been implementing the new PM model in delivering construction for the past four years. Led by the visionary head of construction, and a core team of implementers (who are selected based on their affinity to the new PM model,) the group transformed from the traditional delivery process of management, direction, and control, to the new PM model of quality assurance. The major goals were efficiency, effectiveness, competition, and increased vendor participation. The UM core team results of PIPS implementation is listed below (PBSRG, 2010, Sullivan et al, 2007)):

1. Number of Best-Value Procurements: 142
2. Average Proposal Cost: $46 M
3. Awarded Cost: $40 M (-12%)
4. Average Number of Proposals: 4
5. Projects Where Best-Value was also Lowest Cost: 55%
6. Projects Where Best-Value had Highest Cost: 7%
7. Completed Projects: 111
8. Contractor Cost Increases: 0%

9. Contractor Schedule Increases: 4%
10. CPPM PM post project rating of Contractor: 9.5
11. CPPM PM management requirements: -65%
12. Awards made to TGB firms: 15% (22 out of 142)
    a. 111 Number of completed projects surveyed
    b. 9.9 Overall satisfaction of Best-Value process
    c. 9.5 Overall satisfaction of contractors performance
    d. 65% Decrease in PM's management requirements due to process
    e. Targeted Businesses Statistics:
    f. 32% of qualified vendors are TGB vendors (18 firms)
    g. 15% of all awarded Best-Value projects have been made to TGB vendors (30 awards out of 113 projects)
13. Vendor Statistics:
    a. 53% of contractors have been awarded at least 1 best-value project (25% have not participated on any projects). Shows that process if open and fair
    b. Vendors have documented a 4% increase in profit (significant since over 55% of projects were awarded to lowest price)

The reduction in awarded costs, the minimization of contractor cost and time deviations, the high customer satisfaction, and minimized management transactions make the UM PIPS testing a success. In another comparison, Table 1 shows the comparison between projects using the traditional PM model and the new PM model at the UM. Note that when using the traditional model, the sources of deviation cannot be identified.

| NO | CRITERIA | TRADITIONAL | BEST VALUE |
|---|---|---|---|
| 1 | Total Number of Projects Analyzed | 30 | 34 |
| 2 | Total Awarded Cost ($) | $ 9,844,822 | $ 10,862,605 |
| 3 | Total Final Cost ($) | $ 10,765,577 | $ 11,297,813 |
| 4 | Percent Increase in Cost | 9.4% | 4.0% |
| 5 | Percent Increase due to Client | n/a | 3% |
| 6 | Percent Increase due to UMN | n/a | 0% |
| 7 | Percent Increase due to Designer | n/a | 0% |
| 8 | Percent Increase due to Contractor | n/a | 0% |

**Table 1**: Comparison between Traditional PM Model and New PM Model Results

The original strategic plan was that PBSRG would educate and train the UM core team (small group led by the visionary) and then the UM core team would lead their own organization by taking over the major functions of the PIPS implementation:

1. Compiling and documenting the selection data and weekly risk report (WRR) performance data.
2. Educating the vendors, PMs and internal clients.
3. Running the PIPS system.

The timetable and strategic plan is listed below:

1. Year 1, 2005 – Pilot Testing & Core Group Education by PBSRG
2. Year 2, 2006 – Measurement and Continued Testing Led by PBSRG
3. Year 3, 2007 – Refinement and Expansion Led by UM

4. Year 4, 2008 – Refinement and Expansion Led by UM
5. Year 5, 2009 – Transition from PBSRG control to UM control
6. Year 6, 2010 – Infusion into Other Areas

The new PM model has the following challenges:

1. It takes away control from the client's PMs and transfers it to the vendors.
2. The new PM model is not congruent with the traditional client PM model practices of control, management, and direction.
3. It is a leadership based system, working on alignment and not control.
4. It is a top down philosophy, and has to be well understood by a visionary core team of individuals who can do systems management.
5. It stresses quality assurance and not technical direction and control.
6. It becomes a systems issue and not a detailed technical issue.
7. It requires discipline and both a strategic plan and a tactical plan from the core team.
8. It is non-technical in nature, making many technical PMs who are subject matter experts (SME) very uncomfortable.
9. It cannot be understood by the majority of PMs in an organization.
10. It brings transparency that measures performance.
11. It minimizes the importance of relationships and job positions/titles.
12. It assigns accountability by identifying the value of all individuals.

What makes PIPS/PIRMS difficult is that it is disruptive change, and not incremental change. It is a complete change in paradigm. The new PM model had been under development since 1994 by the Performance Based Studies Research Group (PBSRG.) Even though, PIPS had a 98% performance record, and minimized up to 90%, no client/user had been able to implement PIPS and sustain the implementation for over four years (State of Hawaii, 1997-2001, United Air Lines, 1996-1998, Federal Aviation Administration, 1995-1996.)

Reasons for attempting to implement PIPS in the past have been:

1. Visionaries wanted to solve the problems of non-performance from vendors.
2. Visionary recognized that the bureaucracy of their organization added to the non-performance of the vendors.
3. Visionaries recognized that the existing system was not working and wanted change.
4. Visionaries saw the value for their organization.

Success of PIPS has been more dominant than any other system to deliver construction services. It is very attractive to heads of client's organizations due to the environment of diminishing funding and increasing requirements. The dominance of the PIPS development, testing, and implementation includes (PBSRG (2010)):

1. 16 years of continual, increasingly successful testing.
2. Research funding approaching $8.5M from industry research partners who also test the system.
3. Performance has been stunning and dominant: 98% success (no contractor generated deviations and high client satisfaction), clearly better than the 70% of traditional projects.

4. It has been developed, tested, and implemented within such a short period of time with few resources. It has not had federal research, university funding, or other internal funding to assist in its development.
5. It is not a management solution that creates more management. It actually minimizes management and transactions by as much as 90% (one person can do the work of as many as ten people.)
6. Win-win-win. Solution assists the vendors to increase their profit, minimize their risk, without charging more and increasing the cost of the service.
7. Over 700 tests, delivering over $800M in construction services.
8. Tests have been in large and small organizations.
9. Solution has been implemented in different countries, from very developed to countries that are considered "third world."
10. Tests have included all types of construction delivery systems and all ranges of scopes of work.
11. Solution has gone outside of the construction industry to impact other industries which are perceived as more complex and less predictability.

After five years of testing and implementation, the test results were as predicted, but the transfer of control of the new PM model to the UM was not as successful as there was still internal resistance of PMs (inside and outside of the core team at UM) to the new model. The resistance did not go away with the success of the PIPS tests as planned. The researchers were surprised and reanalyzed their strategic plan.

## 2. Resistance of the Industry and Academic Research Community

The first thing the researchers did was to review the resistance to the testing and implementation of PIPS from the construction industry and construction management academic researchers over the course of 16 years. Dominant logic and simple analysis can explain this reaction (Muatjetjeju et. al. (2009); Kashiwagi et. al. (2008)):

1. PIPS/IMT identifies management as a manifestation of inefficiency and ineffectiveness. Management based experts have taken exception to this.
2. Many industry leaders confuse leadership with management. They consider both to be the same. They perceive management of organizations to be leaders. PIPS identifies the actions of most managers as the source of problems.
3. PIPS/IMT identifies the current system as "broken" and in need of repair. Many industry participants have taken this as a personal attack.
4. The development team at PBSRG has had neither the funding nor the time to partner with the major research and industry organizations. Instead, they have gone directly to the client to solve the problem. This has created resistance from much of the industry who may feel left out of the solution or because it is not their solution.
5. The PBSRG strategic plan to quickly identify the solution, and test and implement, and go around any resistance, can be perceived as a short cut from the traditional path of consensus within academic researchers.
6. The ability of PBSRG to actually identify the basic theoretical concepts, test the concepts, modify the hypothesis, and retest the modified hypothesis is unmatched in the academic research community. If the research and research results are valid, it can be viewed as a theoretical attack on the traditional inductive research approach.

7. The choice to use the deductive logic (confirmatory) approach instead of the inductive (exploratory) due to being more economical, faster, and has greater impact on industry practice is a different approach.
8. The dominant results disagree with many results of previous academic research efforts which stress technical development, the increase of use of technology, and the implementation of knowledge capture and transfer.
9. The perception that all operations should have transparency, measurement, and accountability, may be threatening to traditional academic research which normally is not strategic, does not included repeated hypothesis testing, and which has very little impact on the industry.

The authors proposed that the resistance to the industry would not be significantly different from the resistance from PMs at the UM construction organization. The resistance from the industry and academic research community in the past 15 years, identifies the potential problems that visionary core team (who brought PIPS into their organization) would encounter. IMT foundation concepts upon which the success of PIPS was based on has the following points:

1. Not everyone can understand IMT.
2. Not everyone will feel comfortable with using PIPS in its most optimal state.
3. Visionaries have to understand that they have no influence or control over the PMs in their organization.
4. Visionaries must align resources; overcome resistance with the PIPS structure and application of IMT principles.
5. Each PIPS application will be different. The flexibility of PIPS is its strength.
6. Visionaries will not be able to manage, direct, or control their PMs.
7. Visionaries, who gravitate to PIPS, are personnel who seek personal development, are leaders who seek personal understanding, discipline, and expertise, and who want to add value to society.
8. The key to the sustainability of PIPS is the visionaries' capability to work with PMs who are comfortable with the traditional delivery system.

In analyzing the visionaries who have attempted to implement PIPS and who are currently implementing PIPS, the researchers have identified that the misunderstanding and misuse of the PBSRG mentorship by the visionaries may be the reason for PIPS not being sustainable due to:

1. The visionaries not understanding the Information Measurement Theory (IMT), the foundation of PIPS.
2. Their personal philosophy may not in total congruence with PIPS/IMT. They generally understand the overall logic, but when left to make a decision on critical elements, they reverted to their traditional thinking.
3. Have a difficulty being consistent.
4. Thinking in terms of immediate success of the tests, and not long term, strategic sustainability of the system.
5. Attempting to change their entire organization.
6. They were still price based in assessing the value of the new PM model.
7. They underestimated the difficulty of implementing PIPS. They saw it as no different from any other management based solution.
8. They wanted total control of the system, and felt uncomfortable with the role of PBSRG as a continual mentor.

The visionaries did not understand that a major part of the problem to sustain the new PM model was themselves.

## 3. Problem

Visionaries have been successful in testing and implementing the new PM model (PIPS) but not in sustaining it in their organization over a prolonged period of time. The perception of the PBSRG researchers is that if the visionaries were totally congruent with the above characteristics of the new PM model, the system would be more sustainable. The problem with sustaining the new PM model (PIPS/PIRMS/IMT) is the visionaries are not totally congruent with the new PM model and the Information Measurement Theory (IMT) that it is based upon. The emphasis of the research mentors has been to test the system successfully in the visionary's organization and then turn the system over to the visionaries.

The researchers have perceived that the visionaries over time were reverting to their own previous experience and thus leading their organizations back to their previous practices. The problem may be their lack of understanding of IMT. Many of the visionaries thought that the objective was to successfully run PIPS, and once that was proven, they could easily embed it in their organizations by directing their staffs to use the new model. Their method of implementation was to direct and control the implementation. Their implementation was not in total congruence to the concepts of the new PM model. The problem is not the success of the PIPS tests, but the method of implementation of PIPS.

## 4. Hypothesis

The authors hypothesize that the current strategic plan was emphasizing the successful testing of PIPS in the environment of the organization, and not the sustaining of the new PM model once tested successfully. In implementing the new PM model, visionaries and their core team were perceiving that once the new PM model was tested successfully or showed dominant value in comparison to their traditional model, the implementation would be a management, direction, and control issue. The authors hypothesize that the key element in the successful implementation and sustaining of the new model is changing the paradigm of the leaders, and not the mentoring of the core team, and not the successful testing of the PIPS process. The testing of the PIPS process is a tactical action, and the strategic action must address the mentoring of the core team, to change them to a leadership based alignment philosophy based on IMT principles. The authors are proposing that the strategic plan must address the sustainability of the core team to include education, personal growth in implementing the IMT in their operations, and the ability to become an educator of IMT and PIPS, to implement the concepts in their own lives, and to become educators of the new PM model outside of their organization. The strategic plan should be oriented to the sustainability of the core team visionaries and the IMT principles.

## 5. Methodology

This paper will identify the proposed plan, and a follow on study/paper will survey the visionaries to validate the conclusion. The responses of the visionaries will be analyzed and the results will be implemented in the research program to improve the sustainability of the new PM model.

## 6. Analysis of Visionaries

The analysis of the UM visionaries led to the understanding of the difference between a tactical plan (testing PIPS successfully) and a strategic plan (sustaining the PIPS model.) Using deductive logic, and case studies, the researchers identified the following inconsistencies:

1. Felt uncomfortable with constant PBSRG research expertise assistance.
2. Was inconsistent in implementing the IMT principles.
3. The core group did not trust each other's understanding of PIPS, and ended up using traditional practices (leadership training, consensus, expensive data systems.)
4. Core team reverted to traditional PM practices (management, direction, control, and inspection, concentrating on technical details)due to the lack of knowledge and trust in IMT concepts.
5. Assumed they had control and influence over their staff.
6. Mistakenly thought the core team had to belong to their own organization.

## 7. PBSRG Involvement

Instead of PBSRG (new PM Model creators) being viewed as a consultant running the new PM model, PBSRG should be viewed as a part of the core team, as the source of IMT implementation. The PBSRG support costs are relatively inexpensive (one man year of costs which includes all travel and education costs, and overhead.) The organization's objective is not to control PIPS, but to sustain PIPS.

## 8. Tactical and Strategic Plans for the Implementation of the New PM Model

A tactical plan should identify the schedule of the testing and implementation of the new PM model. The tactical plan can include how to respond to resistance to the PIPS process. The strategic plan is the plan to enhance the sustainability and expertise of the core team members. As the core team members attempt to implement a paradigm changing concept in a bureaucracy, they will face resistance at every stage. The core team members need to have the ability to use IMT to align resources in the bureaucracy, to know which parts of PIPS needs to be modified and which parts need to remain to sustain PIPS, and how to respond to the management of bureaucracy with dominant performance measurements. The strategic plan must include the following to sustain the efforts of the core team:

1. Educational opportunities (masters degrees and PhD)
2. Presentation opportunities (national conferences, internal organization meetings, other clients, and professional training meetings.)
3. Authoring conference and journal papers.
4. Coming up with solutions to problems using IMT.
5. Mentoring sessions to answer questions about the implementation of the new PM model.
6. Application of IMT in their personal lives.

The above should be set aside using a weekly risk report, a milestone schedule, and a risk management plan. Dates events and deliverables should be included in the milestone schedule.

## 9. Conclusion

PBSRG created a strategic plan to assist the University of Minnesota (UM) implement the new PM model (PIPS.) The implementation plan was to have all the PMs switch over to the new PM model. The strategic plan did not identify the sustainability of the core team as the major issue of sustainability. The implementation plan used principles that were not in congruence with the Information Measurement Theory (IMT.) The strategic plan was in error, and led to the continuing resistance of some of the PMs. The strategic plan should be oriented around the PIPS visionary/core team, and not the implementation of the new PM model (PIPS.) A successful effort to implement and sustain the new PM model must include a strategic plan and a tactical plan, the strategic plan being more important than the tactical plan. Without a good strategic plan, the new PM model is not sustainable. These concepts will be communicated to the visionaries of current and past PIPS implementation and their input will be analyzed to validate the hypothesis.

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# Evaluating IT as Source of Competitive Advantage in Engineering and Construction Organisations

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## Abstract
Many studies have suggested that Information Technology resources do offer strategic advantages to organisations and enhance their competitiveness through efficient and cost effective delivery of the organisations' value chains. However, because most of these studies were carried out through imprecise and unstructured theoretical constructs the empirical results were equivocal. Thus, the inconsistencies in the outcomes of research on IT business value were ascribed to difficulties associated with modelling the payoffs of IT investment, mode of data analysis, industrial context, and choice of dependent variables as some of the major reasons. The paper adopts multi-theoretical concepts of process-based, resource-based views and microeconomics theory as the research framework to present a non-parametric model for evaluating the impact of information technology utilization in gaining competitive advantage in engineering and construction organisations. A pilot survey was conducted to verify the model value chain and empirically tested the concept.

## Keywords
Information Technology Business Value, Competitive Advantage, Construction Organisation, Performance.

## 1. Introduction

It has been suggested IT-enabled strategy do have a significant impact on construction organisations competitiveness. These may include improvement in overall construction processes thereby creating new construction business opportunities. Furthermore, using IT in construction projects is found to enhance collaboration by supporting communication among project members and sharing information and documents (Skibniewski and Nitithamyong, 2004). This paper presents a theoretically structured model for evaluating the impact of IT resources on competitive advantage of engineering and construction firms. A conceptual model based on multiple theoretical paradigms was extended using non-parametric concept, empirically tested and the results presented.

## 2. Theoretical Frameworks

Due to the complex linkage of how IT resources utilization may impact on organisational performance Melville et al. (2004) suggested the need to apply

multiple theoretical paradigms to model the relationship. Multi-theoretical paradigms are collection of related 'world views' explaining the impact of IT on improving organisations performance and gaining competitive advantage. Therefore, to investigate the impact of IT on the competitiveness of construction engineering and organisations, this research adopted multiple theoretical concepts of process-based view; resource-based view and microeconomic-view in order to develop a conceptual model. An extension of the conceptual model was suggested using a non-parametric technique of data envelopment analysis (DEA).

## 2.1 Process-Based View

Porter (1998) argues that competitive advantage comes from creating value for buyers that exceeds the costs of generating it. He suggests that a systematic way of examining an organisation's business processes and how the individual activities interact to gain competitive advantage is by analysing the organisation's value chain. An organisation gains competitive advantage by performing these strategically important activities more cheaply or better than its competitors (Porter, 1998). Thus, Porter's value chain concept satisfies process-based view which postulates that IT investments create competitive advantages by improving operational efficiency of intermediary business processes which in turn, under the appropriate conditions, lead to better firm-level performance (Barua et al, 1995; Qing and Jing, 2005). Using this paradigm a typical construction value chain was developed, which consist of five primary activities: strategic planning, engineering design, procurement, construction and start up and operation & maintenance.

## 2.2 The resource-based view (RBV)

The resource-based view (RBV) proposed that the deployment and exploitation of valuable, rare resources, and capabilities contributes to an organisation's competitive advantage, which in turn contributes to its performance (Barney, 1991). Based on this theory it could be argue that IT-enabled strategy can improve firm performance by creating sustainable competitive advantage via unique, immobile, and path-dependent strategic resources and capabilities (Newbert, 2008). To satisfy this requirement complementary resources such as culture and work environment are incorporated in the model as independent variables.

## 2.3 Micro Economic Theory

The microeconomics-based view postulates that IT investments create excess return over other types of capital investments in production processes of organisations (Dewan and Min, 1997). Microeconomic theory is useful in conceptualizing the process of production and providing empirical specifications enabling estimation of the economic impact of IT (Melville *et al*., 2004). This led to the argument that microeconomic production theory is the natural choice for investigating the productivity impact of IT (Mukhopadhyay, et al., 1997). In microeconomics, the combination of feasible inputs and outputs is called the productivity possibility set (PPS). The economic view of IT value is that of input in the production function of an organisation and there is a substituting effect between IT and other production factors (Dewan and Chung-ki, 1997). The concept allows estimation of the measure of IT resources usage as an economic production function using a non-parametric technique such as DEA.

## 2.4 Competitive Advantage

Competitiveness is an elusive and multidimensional concept with no universally accepted definition. Thus, there is a plethora of theories explaining how organisations could achieve competitive advantage. Porter (1998: 11) equates high performance to a sustainable competitive advantage, while Powell (2001) views the two construct conceptually distinct. Nevertheless, it is expected that the performance of firms that are able to attain competitive advantages will be greater than the performance of those firms that are not (Newbert, 2008). Thus, competitive advantage is operationalized as better organisational performance.

## 3. Research Conceptual Model

The contribution of IT to the improvement of various measures of organisation's performance metrics such as productivity, profitability, cost, differentiation and market share is variously termed as "IT business value", "strategic value of IT", "strategic advantage", "competitive weapons", and "IT-dependent strategy" by different researchers (Melville *et al*.,2004; Piccoli and Ives, 2005; Oh and Pinsonneault, 2007). Thus, IT business value (ITBV) is viewed as the outcome of deploying IT resources in the execution of the associated work functions within engineering and construction projects value chains on the projects' performance metrics including cost, schedule, profitability, safety and stakeholders' satisfaction. Adopting multiple theoretical concepts of process-based; resource-based and microeconomic-views, Kassim *et al*., (2009) developed a conceptual model for evaluating ITBV in the organisations.

## 4. Variables Constructs and Measures

IT resources improve productivity in construction organisations by supporting the delivery of organisation's value chain and cause sustainable improvement in its competitive position (Bharadwaj, 2000). These resources are termed as IT infrastructure (ITI) and are conceptualized in four dimensions: shared technical components, IT Human competence, IT applications, and business process (Bhatt, 2000). The measure of the IT resources is conceptualised as level of usage rather than their monetary value (Tallon and Kraemer, 2007). The measures of the organisation's performance metrics are used as dependent variables. With the industry being project-oriented in nature, a focus on the aggregation from project performance to organisational performance has been recognized. Therefore, schedule and cost performance, customer satisfaction, safety performance, growth in contracts and profit are adopted as the dependent variables (El-Mashaleh *et al*., 2006 and Kassim *et al*., 2009), which will sum up to the organisation's performance. The dimensions for measuring the inputs and output variables are presented in Table 1 below.

| Input Metric ( $x_i$ ) | Output Metric ( $y_r$ ) |
|---|---|
| | Schedule performance |
| Measure of shared ITI | Cost performance |
| Measure of IT human capabilities | Customer satisfaction |
| Measure of IT business applications | Safety performance |
| Complemetary resources | Contract growth |
| | Overall profitability |

**Table 1**: Dimension of Input and Output Variables (Kassim et al., 2009)

## 5. Research Methodology

For many decades there has been a fervent debate over the choice of paradigm to conduct research by several disciplines. Similar debates within construction management field have been raging too (Seymour and Rooke, 1995; Raftery et al., 1997; Runeson, 1997; Seymour et al,. 1997; Chau et al., 1998; Holt and Faniran, 2000). The proponents of phenomenological inquiry insist that there is a need to apply a naturalistic approach when investigating issues related to construction management in order to understand the phenomena within its contextual setting. The positivists however argue for quantitative measures to help test hypotheses and possible generalization. Raftery et al.(1997) argue for a case where multi-paradigmatic approach is embraced. Chau et al.(1998) suggest pragmatic approach is likely to generate practical solution since construction management is a practical subject. Peter et al.,(2002) are of the view that construction management research should be in an era of methodological pluralism and paradigm diversity. Underlying the debate on the choice of a research paradigm is the argument of incommensurability of the positivist and interpretive paradigms (Burrell and Morgan, 1979). However, Kirkwood and Campbell-Hunt (2007) reported that multiple paradigms can be bridged while recognizing each paradigm's different world views and assumptions in epistemological and methodological pluralism approach. Furthermore, research methods can be detached from a paradigm and use critically, within a context that makes different assumptions (Minger 2001). Therefore, both qualitative and quantitative orientations can be used at different stages of a research as a form of triangulation (Denzin, 1989).

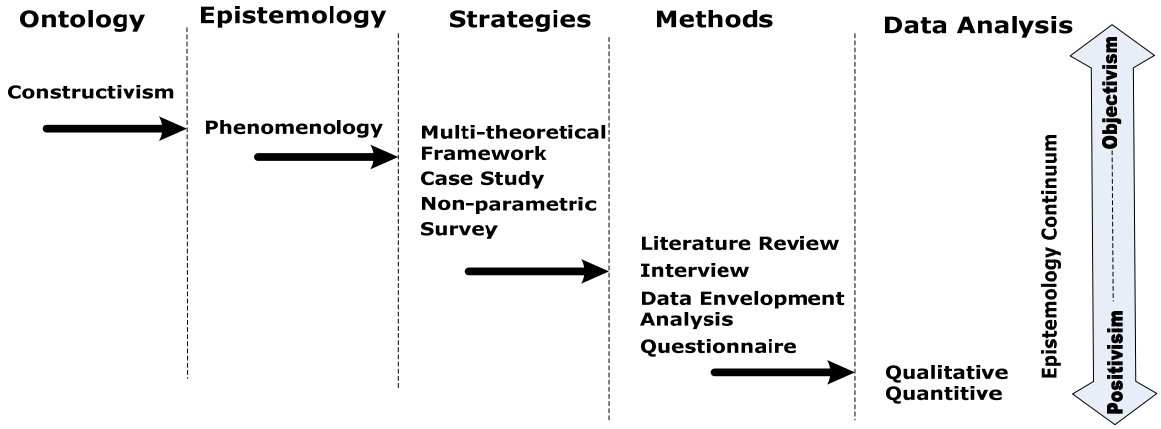


**Fig 2**: Research Paradigms and Methodologies Adapted from (Crotty, 2003: 5)

The research process involves different phases that pose different tasks and problems. However, the ontological position for the research is constructivism as depicted in Figure 2.This is because the research is investigating the how IT impact on the organisation's performance as socially constructed by the interaction employees and environment. The first phase of the research involved a comprehensive literature review in the relevant fields, which led to the development of a conceptual model using multiple theoretical concepts as a framework and hypotheses developed addressing the research objectives and scope. Thus, at this level the research adopted a deductive approach (Loose, 1993) with objectivism and positivism views because of the reliance on the current body of knowledge to develop the research model and hypotheses (Sutrisna, 2009). The second phase involved validation of the proposed conceptual model and the engineering and construction value chain through unstructured interviews in the form of case studies of selected firms. The choice of case study strategy at this phase of the research is informed by the requirement to carry out a holistic in-depth investigation of the complex phenomenon of IT business value of a construction organisation within the context it occurs (Yin 1994). Thus, a phenomenological view was adopted under this phase. The validated conceptual framework is then extended and modified through mathematical modelling using Data Envelopment Analysis (DEA). For data collection phase; a survey questionnaire is designed to include closed-ended items with numerical responses as well as open-ended items that could support discovery of new information. Thus, as argued by Lewis & Grimes (1999), in analyses of a common phenomenon paradigm images need not operate at the extremes, but may overlap and foster counterintuitive insights.

## 6. Data Envelopment Model of ITBV

DEA is a mathematical programming technique that uses multiple inputs and outputs to construct piece-wise linear convex production frontiers and measure relative efficiencies within a group of decision making units (DMUs) such as engineering and construction organisations. The technique was first proposed by Charnes et al. (1978) and later extended by Banker et al. (1984). The relative efficiency of a DMU is defined as the ratio of multiple weighted outputs to multiple weighted inputs. The merit is that the weights of factors are not assigned in advance and the weights used for each DMU are those which maximize the ratio. DEA is used for performance evaluation of DMUs in public and private sectors (Chang and Chen, 2008) along with benchmarking organisations (Wöber, 2007).The term 'envelopment' reflects the fact that DEA measures efficiency within a production possibility set which 'envelops' all input-output correspondences. A full description of DEA can be found in many texts such as (Thanassoulis, 2003).

Consider N number of engineering and construction organisations referred to as DMUs each utilizing sets of IT and complimentary organisational resources as input vector $\mathbf{x} \in \Re_+^m$ to execute projects involving engineering design, procurement and construction activities leading to the project performance outcome as output vector $\mathbf{y} \in \Re_+^s$ including measure of cost and schedule performance, contract growth and profitability. The production possible sets (Φ) is given by $\Phi \equiv \{(\mathbf{x},\mathbf{y}) | \mathbf{x} \text{ can produce } \mathbf{y}\}$. Using the output oriented model the efficiency of the $j_0$ construction organisation under consideration could be evaluated by solving the following linear programming problem:

$$\theta^* = max \sum_{r=1}^{S} \mu_r y_{rj0}, \text{ s.t. } \sum_{i=1}^{M} \alpha_i x_{ij} = 1, \ \sum_{r=1}^{S} \mu_r y_{rj} - \sum_{i=1}^{M} \alpha_i x_{ij} \le 0, \ \forall i,j; \mu_r, \alpha_i \ge \varepsilon > 0; \forall r,i \qquad (1)$$

$x_{ij}, y_{rj} > 0$ are indexes of IT and other resources and performance metrics as inputs and outputs of the $j^{th}$ construction organisation respectively, $\alpha_i$ and $\mu_r$ are the inputs and outputs weights. $x_{io}$ and $y_{ro}$ represent the variables for $co_o$. Equation (1) maximizes the weighted output of the $j_0$ organisation subject to the constraint that weighted inputs equal one. The optimal vector weights $\mu^*$, $\alpha^*$ represents that weights that will provide the organisation under consideration with the highest efficiency rating possible, while maintaining feasibility for the remaining N-1 organisations in a given N sample groups. The values of $\mu^*$ and $\alpha^*$ may vary for each organisation as unit evaluated. The equation needs solving N times, once for each organisation. The dual form of equations (1) is provided below. This form provides information on how inputs and outputs of inefficient DMUs can be adjusted as indicated in their respective slacks in order for them to be considered efficient.

$$\phi^* = max\, \phi - \varepsilon \left( \sum_{i=1}^{M} S_i^- + \sum_{r=1}^{S} S_r^+ \right), \text{ s.t. } \sum_{j=l}^{N} \lambda_j y_{rj} - S_r^+ = \phi y_{ro}, \ \lambda_j \ge 0, \forall i,j, \sum_{j=l}^{N} \lambda_j = 1 \qquad (2)$$

$\phi^*$ represents the efficiency score of an organisation $s_i^-$ and $s_r^+$ are the input and output slacks, respectively. An organisation is efficient if, and only if, $\phi^*=1$ and $s_i^{-*} = s_r^{+*} = 0$; $\forall i,r$; an organisation is weakly efficient if $\phi^*=1$ and $s_i^{-*} \neq 0$ and/or $s_r^{+*} \neq 0$; $\forall i,r$ $\varepsilon > 0$ is non-Archimedean element.

## 7. Pilot Study

A pilot survey was conducted to empirically test the research concept. The questionnaire is designed based on five-point Likert scale for measurement of the input and output variables. Sixty engineering and construction organisations were targeted with 40% responses. The survey covered measures of IT business applications (ITBA), IT shared infrastructure (ITSI), IT human skills (ITHS) and business work environment (BWE) as inputs. The output variables are the cost and schedule performances (COST and SCHD); SAFETY, customer satisfaction (CUST), contract growth (CONTR) and profitability (PROFI).

| Input/Output Data | | | | | Efficiencies | |
|---|---|---|---|---|---|---|
| DMUs | ITBA | SCHD | COST | CUST | CRS | VRS |
| A | 4.6 | 1.0 | 2.0 | 2.0 | 37 | 50 |
| B | 4.0 | 4.0 | 3.0 | 2.0 | 65 | 80 |
| C | 3.5 | 4.0 | 5.0 | 2.0 | 98 | 100 |
| D | 3.8 | 3.0 | 3.0 | 3.0 | 67 | 75 |
| E | 4.0 | 4.0 | 3.0 | 2.0 | 66 | 80 |
| F | 3.2 | 4.0 | 4.0 | 3.0 | 86 | 95 |
| G | 4.2 | 3.0 | 3.0 | 2.0 | 50 | 60 |
| H | 4.6 | 2.0 | 3.0 | 4.0 | 76 | 100 |
| I | 3.8 | 2.0 | 2.0 | 1.0 | 36 | 40 |
| J | 4.3 | 2.0 | 2.0 | 2.0 | 40 | 50 |
| K | 3.7 | 5.0 | 5.0 | 3.0 | 92 | 100 |
| L | 2.8 | 3.0 | 3.0 | 2.0 | 73 | 100 |
| M | 5.0 | 2.0 | 2.0 | 2.0 | 35 | 50 |
| N | 3.7 | 4.0 | 3.0 | 2.0 | 70 | 80 |
| O | 4.0 | 2.0 | 1.0 | 1.0 | 33 | 40 |
| P | 3.5 | 5.0 | 5.0 | 4.0 | 100 | 100 |
| Q | 4.4 | 4.0 | 3.0 | 1.0 | 60 | 80 |
| R | 4.3 | 2.0 | 2.0 | 1.0 | 32 | 40 |
| S | 3.7 | 4.0 | 4.0 | 4.0 | 94 | 100 |
| T | 3.3 | 5.0 | 4.0 | 3.0 | 100 | 100 |

***Table 2.*** Data and results of the pilot study

For the purpose of this paper however, the impact of ITBA on the COST, SCHD and CUST was evaluated. The measure of efficiency obtained for each organisation is relative to the PPS, thus, the efficiency measure tells us how an organisation can improve its performance relative to the benchmark (Thanassoulis, 2003). The first efficiency measure Table 2 is based on constant return to scale (CRS) output-oriented model equations (1). The model assumes that an increase in organisation's inputs produces a proportional change in its outputs. Only two organisations (P and T) are found to be efficient based on this model. In order to provide for the differences in the scales of operations across the organisations, a variable return to scale (VRS) DEA model in equation (2) is used to evaluate the IT-induced performance. This model assumes that an increase in organisation inputs does not produce a proportional change in its outputs. Therefore, an inefficient organisation is only 'benchmarked' against organisations of a similar size. The example illustrates the potential of DEA for extracting useful information related to the IT business value. It is possible to identify organisations that operate at the highest efficiency in terms of maximum output using minimum input. For organisations that operate at less than 100% efficiency, the slack variables provide an indication of how much the output should be improved for the same level of ITBA utilization in order to match the performance of more efficient firms.

## 8. Conclusion

The paper presents a theoretically structured framework and empirically tested model for evaluating impact of utilization of IT resources as factors of 'production' on the performance of engineering and construction processes using a non-parametric technique. It is shown that a frontier that 'envelops' the most efficient organisations can be identified using this approach, thereby proving a basis for benchmarking the performance of similar organisations. The input variable is directly related to investment and utilization of IT, while the output variables are directly related to the delivery of engineering and construction value chain. The use of slack based DEA model provided information on how the inputs and outputs of the inefficient organisations can be adjusted in order that they will become Pareto-efficient. Thus, this approach has mitigated the difficulties associated with lack of theoretical framework in modeling ITBV, the prior assumption required for the relationship between IT investment and firm performance, and the arbitrary and subjective assigning of weights to the variables in the previous studies.

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# PROMETHEUS *Construct*: A Societal and Environmental Responsibility Framework for Medium, Small and Very Small Construction Companies

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## Abstract
The issues of Societal and Environmental Responsibility are related to the holistic approach of Sustainable Development and remain at top level of priority for theoretical and applied research. The framework PROMETHEUS addresses these issues, oriented to Greek Medium, Small and Very Small, private owned Companies, valorising a number of elements from recognized and widely in use models of Business Excellence and frameworks for Corporate Social Responsibility. It is constructed to be friendly and easy-to-use for owners / managers of all levels of formal managerial education. In this paper a specialised version "PROMETHEUS *Construct*" of the framework is presented, targeting the sector of construction projects. The businessperson records key elements of the permanent organisation and project methods, in the form of questionnaires, and then uses the toolbox, which includes material such as charts and tables, to help him towards the goal of leading the business in continuous improvement of Economic, Social /Societal and Environmental Results.

## Keywords
Societal and environmental responsibility, Business development, Medium – Small and Very Small enterprises, EFQM PE Model, IPMA PE Award

## 1. Introduction

Organisations in the private sector survived historically by generating maximum profits for their partners or shareholders. Today this approach is simply not enough to guarantee survival for every type of organization. All organizations (small or big – for profit or not for profit – producing or delivering services) are obliged to account for the social, environmental and economic impacts that they have on every community in which they operate, as well as on the natural environment. They operate under a provisional license, given by the society and they constantly have to prove that they leave a beneficial mark on the human and natural environment. Therefore they have to incorporate into their business practices economic, social and environmental actions that are beyond the ones imposed by legislation and are connected with all those affected by the business's activities. Of course, keeping positive and balanced results for the community, the business and the environment is not always easy. That is why a number of models and frameworks have been developed, enabling businesses to choose the ones that best fit their needs, their size and their development phase. The PROMETHEUS

framework is based on international models and provides a friendly, flexible and easy-to-use tool especially targeting the needs of medium, small and very small businesses.

## 2. Characteristics and particularities of Medium, Small and Very Small Businesses

It is imperative to determine the special characteristics of medium, small and very small sized businesses, as these particularities shape their needs. We cannot simply regard them as large businesses of a smaller scale or as future large businesses in an embryonic state. In a medium, small or very small business the personality of the owner/manager plays such a vital role that influences its function. The relationships and the communication structures in the daily routine are rather informal and considerably less based on hierarchy. The management style is different and the work delegation less rigid. Of great importance are the interpersonal relationships between co-workers and the motivation methods used have to be more personalized.

Apart from their characteristics, we have to recognize the differences in medium, small and very small businesses. Nowadays it is possible to be small and successfully remain small because it suits you better! A smaller size does not mean less complexity or easier management, but does lead to a different approach. There are significant differences between the various branches and even regional ones. Although models on business development and management do exist, to simply transfer these models, which are based on and target large businesses, to medium, small and very small ones would be rather misleading.

Many argue that medium, small and very small businesses are not capable of implementing societal and environmental programmes, unless it is an action outside the scope of the business and the business owner is morally and ideologically motivated. Such actions would not have an effect on the internal structure and organisation of the business. Others believe that medium, small and very small businesses are oriented towards actions with the sole objective of internal improvement without any effects on other environments, or have only their own benefit (e.g. profit) in mind. It is high time to see past these myths and superstitions. Societal and environmental responsibility is more than an emerging trend; it is a necessity. The new internationalized economic environment appears to have strengthened the connection between success and responsibility in medium, small and very small businesses, even if not in an obvious way. These businesses, in their straggle to remain in the market, have to take into consideration new, social and sometimes intangible demands, such as:

- know-how improvement and careful human resource management
- quality control of products (or services), systems and internal communication
- pursuit of innovation.

These actions have a positive effect on the business's profit because they lie on the very core of the business activity. The owner of a medium, small or very small business cannot ignore the social impact of his activities and his relationships with the external environments are direct and personal. There is also the need for social recognition: his is a factor of local development and by personally engaging in such actions, he emerges in the social, economic and cultural reality.

## 3. The PROMETHEUS Framework

The PROMETHEUS framework is especially developed for medium, small and very small businesses, as a flexible, easy-to-use tool (containing two parts: a set of questionnaires and the toolboxes), open to improvement. It is not an external rating and evaluating model that rejects businesses who want to implement it, but aims at bringing out their best features. It is largely based on the EFQM Excellence Model. Other frameworks that have influenced PROMETHEUS are the European Corporate Sustainability Framework ECSF and the Small Business Journey BITC.

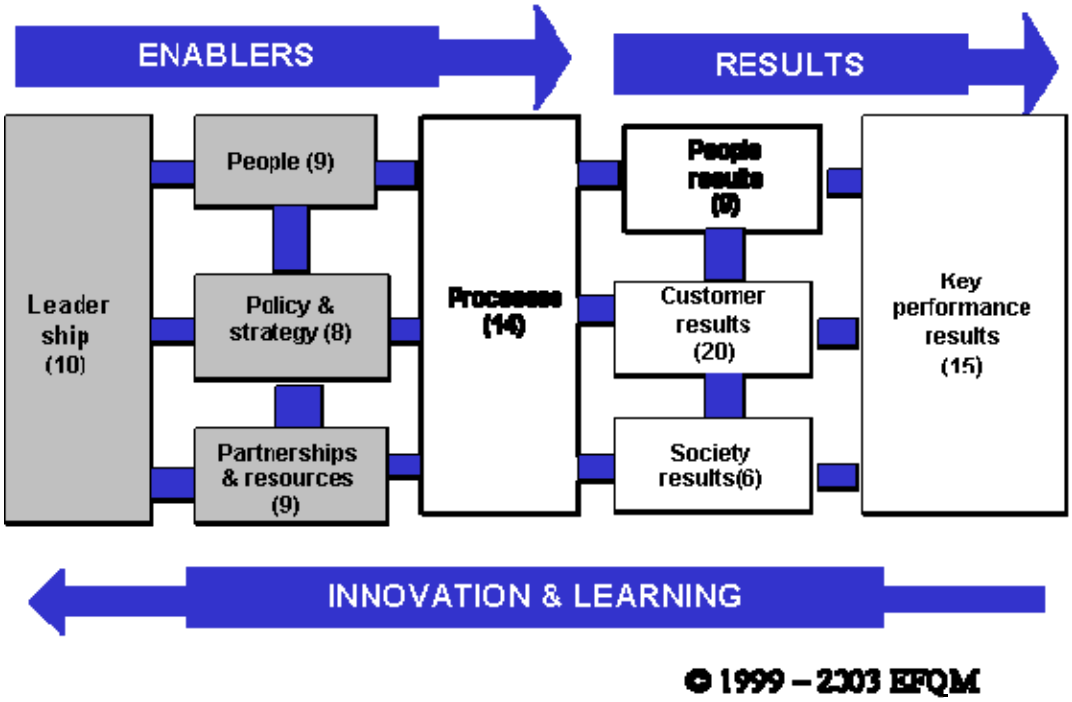


**Fig. 1**: The EFQM Excellence Model for Organisations

The first step of PROMETHEUS (self-knowledge) targets the introduction of the first four criteria of the EFQM Excellence Model. The second step (self-evaluation) targets the introduction of the fifth criterion along with the in depth knowledge of the first four. The third step (self-assessment) targets the introduction to the last four criteria along with the in depth knowledge of the first five. At this point, it is important to notice that the toolboxes for the last two steps are under construction. Meanwhile, specialized versions of the PROMETHEUS framework are under development for various sectors of businesses, such as PROMETHEUS – *Construct* for the corresponding sector.

PROMETHEUS bases the activity of social and environmental responsibility oriented, medium, small and very small businesses on four pillars:

- the professionalism of the business owner
- the central role of learning and the pursuit of innovation
- the orientation of the business to quality
- the open mind of the business owner and the recognition of the value and the necessity of the participation in networks.

PROMETHEUS is developed on Spiral Dynamics; there is evolution from one level to the next, but each new level maintains and incorporates the positive elements of the previous levels.

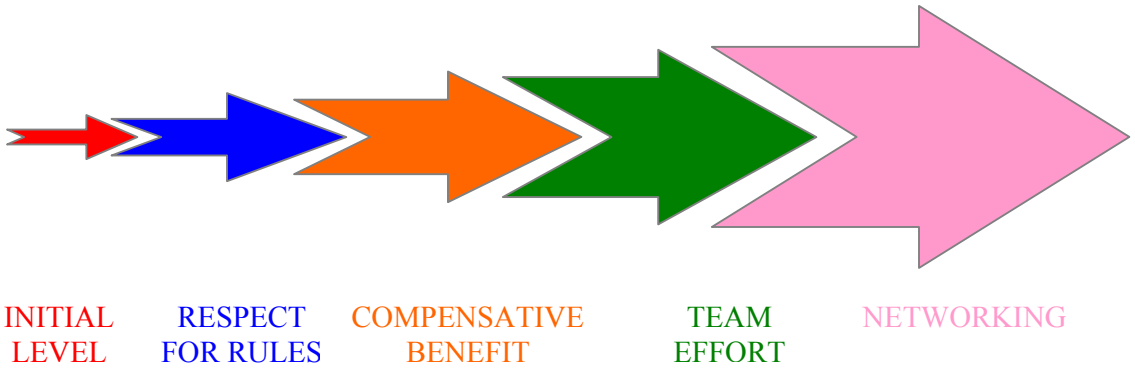


**Fig. 2**: Spiral dynamics

The business is assisted in finding its current place in the continuum and deciding whether to proceed forward. In the initial level where the business requires improvement, the value of the connection between societal and environmental responsibility on one hand and corporate development on the other is unclear and the possibilities of volunteering actions are limited. It is thus possible to react to external incentives or pressure, such as stricter legislation or pressure from customers. In the "Respect for rules" level, the value of the connection between societal and environmental responsibility and corporate development can be traced and leads to an effort to comply with existing legislation and moral values. It is also possible that the business reacts in a positive manner to issues of charity and donation, even if not systematically. In the "Compensative benefit" level, the value of the connection between societal and environmental responsibility and corporate development is recognized insofar it has a positive economic effect, whether direct or indirect. The business orients its operation towards social, environmental and ethical practices through systematic actions, recognizing opportunities for growth. In the "Team effort" level, the value of the connection between societal and environmental responsibility and corporate development is integrated in the operation of the business, over-exceeding its legal obligations. The business bases its operation on the principle that economic, social and environmental aspects are equally important.

The first step of PROMETHEUS addresses the issue of self-knowledge. The business owner has to fill two questionnaires with four topics of several questions each, as shown in table 1. It is important to stress that there are no correct and incorrect answers and that the *real* present situation of the business has to be described.

| The way we think | The way we operate |
|---|---|
| Which is the role and the influence of employees on the business? | What are the characteristics of our customers? |
| Which is the relationship of the business with the natural environment? | What are the characteristics of our products (or services)? |
| Which objective best describes the business? | When are we satisfied with the course of the business? |
| Which principles and values are the most important for the business? | What do we expect the business to gain by getting involved in social and environmental responsibility issues? |

**Table 1**: Self-knowledge questionnaire topics

The accompanying tool helps translate the answers to all the questions into graphs and charts that give a better view of the current conditions.

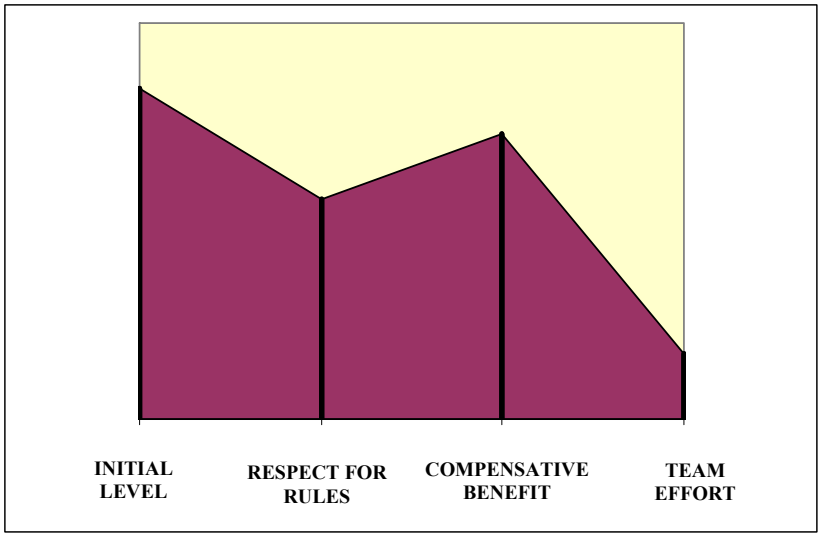


**Fig. 3**: Graph example of the first questionnaire "The way we think"

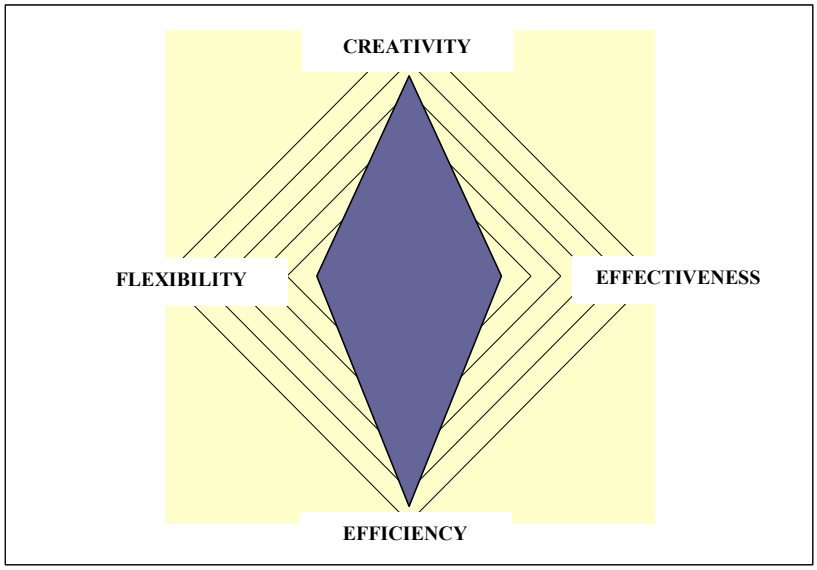


**Fig. 4**: Graph example of the second questionnaire "The way we operate"

Creativity is a phase found in markets with no obvious display of actual demand. The business needs to find new customers and introduce innovations in products or services. This phase is also suited for businesses in an early stage of operation. Effectiveness is a phase of a market with existing demand and where the customers have specific needs, but are either not in the position of evaluating all the possible solution or are not aware of all the existing products or services. Of importance is the continuous effort to communicate with potential customers and try to understand their behaviour. Efficiency presents itself in markets with constant demand, where the customers are in position to compare the existing products and services and choose according to their needs. The ratio of quality/price is decisive for the competition. The business has to improve its products and control the costs. Flexibility is a phase of exigent market demand, where the customers have some clearly expressed needs and others that remain fussy to them. They are not loyal to the business, but expect from it to line up with their unpredictable behaviour. The business runs in a very fragile and changing environment and has to maintain the costs to a viable level while satisfying the customer.

### 3.1 PROMETHEUS – *Construct*

In the construction sector, which works by projects, the above sited approach is linked to the IPMA Model for Project Excellence.

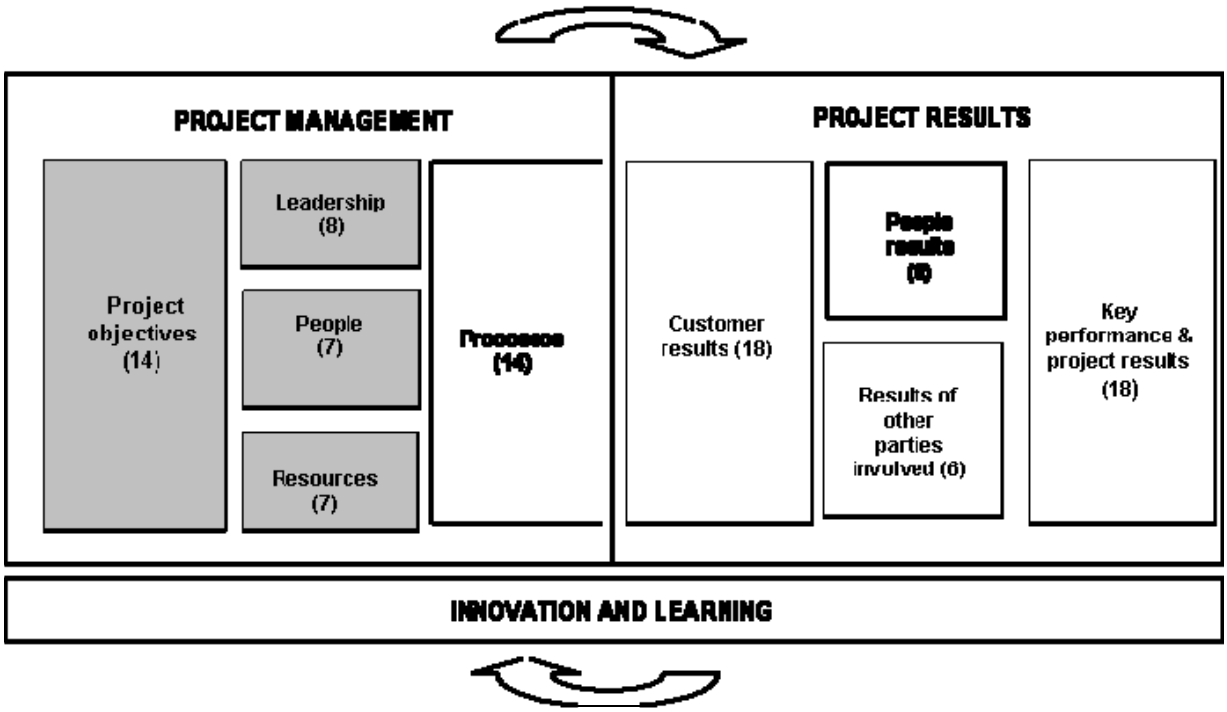


**Fig. 5**: The IPMA Assessment Model for Project Excellence

PROMETHEUS – *Construct* follows the general pattern of the PROMETHEUS framework and in addition to the EFQM Model for the permanent organisation mentioned above addresses the corresponding set of criteria of the IPMA Excellence Model focused on projects in each step. There are additional questionnaires and toolboxes focusing on the business's projects that compliment the questionnaires and toolboxes that focus on the business's permanent organisation.

Whereas PROMETHEUS has already been adopted by a large number of medium, small and very small businesses, including some from the construction sector, PROMETHEUS – *Construct* has recently been tested by a sample of construction companies in a pilot phase.

## 4. Conclusions

A comprehensive and easy-to-use tool has been developed for and adopted by a large number of medium, small and very small businesses, helping them towards the goal of continuous improvement in Economic, Social / Societal and Environmental aspects. From the very beginning the aim was to specify this tool for the various sectors of business activity. The present paper presents the results of this specification effort for construction companies introducing PROMETHEUS – *Construct*. This project is supported by the findings of the implementation of PROMETHEUS – *Construct* in a sample of construction companies during a pilot phase. Conclusions from this implementation and further refinement of the tool should be expected in the near future.

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*NGO1*

# Guidelines and Project Management Handbook for Greek Non Governmental Organizations (NGOs)

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## Abstract
"APOPLOUS" was the outcome of a project assigned by the Coordination Committee of "the Campaign of 800 Greek NGOs", with the purpose of constructing a set of "Values for Organization, Conduct and Practice" for Greek NGOs. The main objective of the present study was to construct a comprehensive, easy-to-use project management tool for Greek NGOs, as the second add-on to "APOPLOUS". An additional objective was to facilitate Greek NGOs to be certified under the Greek ELOT 1429 & 1431-3 Standards for the "Managerial Capability of Organizations implementing Projects of Public Interest", thus ensuring their candidature for European Union co-financed Projects. The authors based their study on the latest International Competence Baseline version in use of the International Project Management Association and specifically on the Austrian and the Greek National Baselines. The guidelines and the standardised handbook contained in the add-on, were used in a pilot phase by a selected sample of NGOs and their feedback is included in the presented version.

## Keywords
Project Management Standards, E.U. co-financed projects, APOPLOUS, Greek NGOs

## 1. Introduction

Three years ago the Coordination Committee of "the Campaign of 800 Greek NGOs" assigned to its Scientific Committee the project of developing a set of "Values for Organization, Conduct and Practice" to help Greek NGOs improve their performance. The outcome of this project was "APOPLOUS". The Greek word "apoplous" means "sailing away" and it was used as an acronym meaning "principles of commitment for all of us to the quality of functioning and organization serving well our objectives". This initial "Set of Values" is now established as a "Code of Conduct", being adopted by a large number of Greek NGOs. The present study is the second add-on to "APOPLOUS", providing a tool for Greek NGOs in their continuous improvement journey, under the very spirit of this Code of Values for Organization, Conduct and Practice.

Meanwhile the Hellenic Organization for Standardization – ELOT developed and issued the 1429 & 1431-3 Standards, which are maturity organization standards, for the field of European Union co-financed Projects in Greece, which could also affect NGOs' candidature for such Projects. The additional objective of this study was to facilitate Greek NGOs to be certified under these Standards. "APOPLOUS - Code of Values, Organization, Conduct and Practice" for Greek NGOs and the ELOT 1429 Standard are briefly described. The "Project Management Guidelines and Handbook" proposed by the authors are presented.

## 2. History and background

### 2.1 Apoplous

"APOPLOUS - Code of Values, Organization, Conduct and Practice" for Greek NGOs (Katsarelis, Depountis et al. (2008)) was the outcome of a project assigned to the Scientific Committee of "the Campaign of 800 Greek NGOs" by the Coordination Committee. The final text was approved, went through the public enquiry procedure and currently undergoes the procedure of formal acceptance by the interested Greek NGOs, thus moving forward from a "Set of Principles" to a "Code of Conduct".

"APOPLOUS" is structured on six equally weighted "values" (Figure 1). In the "APOPLOUS Code" a brief description of each value is provided. These principles do not set aside the institutional articles of each organization, nor do they replace the additional terms of function or their applied practices. On the contrary, they are additional to the above, while enhancing them. They draw from the principles of the EFQM Excellence Model and the IPMA Project Excellence Model (Depountis, Katsarelis (2009)). Through the adoption of these Principles all organizations are encouraged to use more sophisticated and standardized instruments to ameliorate their performance, such as evaluation indicators, mechanisms of internal control, prototypes and standards. After the initial release of APOPLOUS, the feedback from NGOs raised the issue of a more in-depth document needed. So came the first add-on: "Comprehensive Guidelines for the application of the principles of APOPLOUS", which contained more detailed documentation and some examples of application in order to clarify the concept.

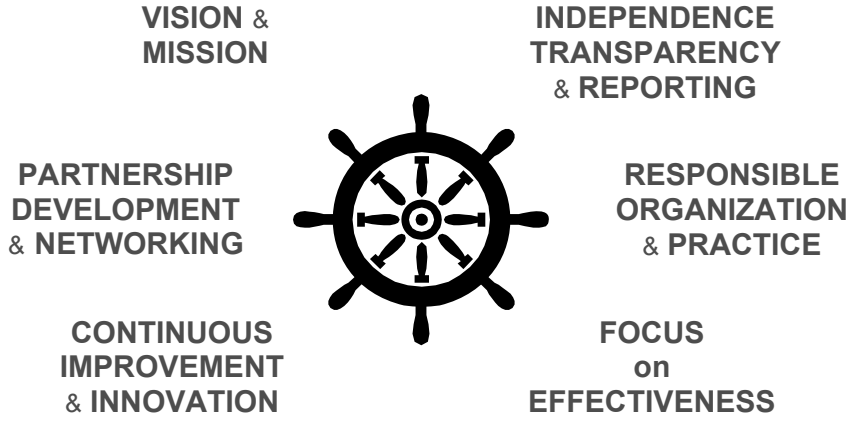


**Fig 1**: APOPLOUS

The authors have proposed the graph shown in Figure 2, which depicts the continuum of standardization for NGOs. This proposal was based on the most widely accepted approach for Corporate Responsibility Codes (Leipziger (2003)).

**Fig 2**: The continuum for standardization for NGOs

The Scientific Committee, committed to materializing the vision of improving and upgrading the Code, developed a second add-on presented in this paper. With the development of the two add-ons, the APOPLOUS Code of Conduct is moving forward towards becoming a Standard.

## 2.2 The ELOT 1429 standard: Background and field of application

The ELOT 1429 Standard for the "Managerial Capability of Organizations implementing Projects of Public Interest", along with the linked Standard ELOT 1430 – series, addresses the field of European Union co-financed Projects in Greece. NGOs must fulfill the requirements of ELOT 1429 and specifically ELOT 1431 - 3 Standards.

Disregarding the field of application of these Standards, the authors strongly believe that Greek NGOs should adopt, implement and follow in all their projects any comprehensive set of "Project Management Guidelines" under the requirements of APOPLOUS. This set of "Guidelines" must follow specifically the values of "Responsible Organization and Practice", "Focus on Effectiveness" and "Continuous Improvement and Innovation". The set of "Guidelines" proposed by the authors in this paper is a step towards this goal.

# 3. Project management guidelines and handbook for Greek NGOs

## 3.1 Methodology

The scope of the study was to develop a comprehensive document, which would be easy to use by the Greek NGOs who base their activity on volunteer work and lack of trained full-time personnel. They actually are "Project Oriented" Organizations usually supported by a "week permanent" Organization (Gareis, (2005)).

The authors based their study on the Project Management approach proposed by the International Project Management Association – IPMA and specifically on the latest International Competence Baseline – ICB 3 version in use and more specifically on the Austrian National Baseline of PMA and the final draft of the Greek National Baseline of PM Greece. Additional bibliography was used on project management for NGOs (European Commission – EuropeAid Cooperation Office (2004)).

The guidelines and the handbook were reviewed for consistency, clarity and usability during the pilot phase by a sample of Greek NGOs: "European Expression", "Cell of Alternative Youth Activities", "ARCHELON – The Sea Turtle Protection Society of Greece", "2nd Holargos System of Sea Scouts", "Gymnastic Athletic Club of Holargos" and "ELIAMEP – Hellenic Foundation for European and Foreign Policy". This sample was selected in order to encompass a wide range of activities, fields of action and organization size. These NGOs are committed to adapt the Handbook to their specific operational needs and use it in a future project, with the help and guidance of the authors. More NGOs, members of the "Campaign of 800 Greek NGOs" will take part in this implementation phase.

## 3.2 Guidelines' construction

The "Guidelines and Project Management Handbook" is a bilingual tool (in Greek and in English), as many Greek NGOs have volunteers not fluent in the Greek language, or collaborate with NGOs from other countries in common bilateral issues, or even undertake projects abroad. The tool consists of two parts: the Project Management Handbook and the Guidelines for the implementation of the Project Management methods introduced in the Handbook.

The Project Management Handbook contains easy-to-use templates (see Table 1) for all the sub-processes of a project (start, controlling, coordination and closedown, together with the continuous marketing task). It also addresses the issue of risk management, in a project risk register and with further risk analysis and alternative scenarios, which need to be monitored constantly during the project, and could be very useful in case the crisis management sub-process needs to be launched. A special contribution (which is not included as a competence in the ICB 3, but featured in the French National Baseline), associated with risk management but also with the closedown sub-process, is the "Non-completed project stop report" template, which inevitably has to replace the normal "Project closedown report", in case a project ends abruptly before its completion. The templates can be filled using low cost software or even freeware, therefore the tool represents an affordable solution even for small NGOs.

| | |
|---|---|
| Distribution list | Project list of dates |
| Project assignment | Project communication structures |
| Project objectives | Project risk register |
| Pre-project and post-project phase analysis | Risk analysis – Alternative scenarios |
| Project objects of consideration | "Professional" liability insurance contract |
| Project rules | Relationship to other projects |
| Project cost plan | Connection to the Organisation's strategy |
| Project resource plan | To-do list |
| Project organisation chart | Approval of work packages |
| Work breakdown structure | Minutes of meeting |
| Project interested | Project status report |

| | |
|---|---|
| parties | |
| Project work package specifications | Project score card |
| Project responsibility matrix | Project close down report |
| Project milestone plan | To-do list: Remaining work – Post-project phase |
| Project bar chart | Non-completed project stop report |

**Table 1**: Project Handbook contents

The Guidelines, apart from helping with the implementation of the proposed Project Management methods, contain basic Project Management glossary and databases (e.g. risk management register and potential interested parties register). Examples of the Handbook templates and the Guidelines are shown in Figures 3, 4 and 5.

The Project Interested Parties Analysis and Graph

- The project Interested Parties analysis considers the relationship of the project to its relevant Interested Parties (Stakeholders). These are the parties that have an effect on, or are affected by the project and its results.
- This project Interested Parties graph is structured as: Project internal area: Project organization (Project Owner or team + Project Manager + Project Team), and Project external area: All relevant Interested Parties.
- The distance from the Project figure depicts the importance of the Interested Party within an arbitrary scale: Critical – Important – Other.
- The correspondent mark depicts the assessed relationship "attitude" of the Interested Party within an arbitrary scale: Negative – Neutral – Positive.
- The Analysis and corresponding Chart enables the Project Team to design the actions to be planned in order to improve the relationships with each Interested Party, using an "Importance/ Attitude" matrix.

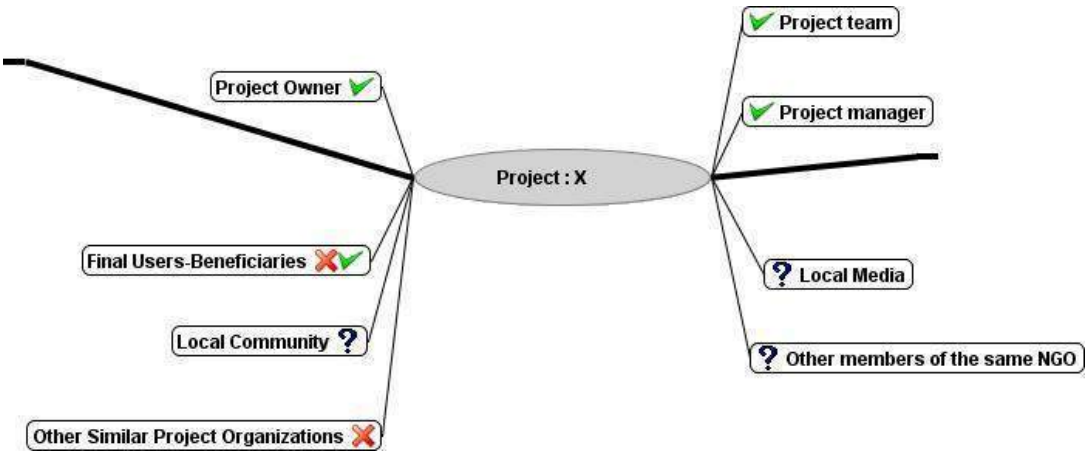


**Figure X:** Typical Project Interested Parties Analysis graph

**Fig 3**: Guidelines extract: Interested Parties Analysis

*<Project name>*
*<Project No.>*

***RISK ANALYSIS***
***ALTERNATIVE SCENARIOS***

*<NGO's logo>*

| ***Risk*** | |
|---|---|
| | |
| ***Risk cost*** | ***Cost for preventing risk*** |
| | |
| ***Preventative actions*** | |
| | |
| ***Contingency actions*** | |
| ***Alternative scenario 1*** | |
| | |
| ***Responsible*** | |
| | |
| ***Cost*** | ***Delay*** |
| | |
| ***Results*** | |
| • | |
| • | |
| ***Alternative scenario 2*** | |
| | |
| ***Responsible*** | |
| | |
| ***Cost*** | ***Delay*** |
| | |
| ***Results*** | |
| • | |
| • | |
| | |

**Fig 4**: "Risk analysis – Alternative scenarios" template

*<Project name>*
*<Project No.>*

## *PROJECT SCORE CARD*

*<NGO's logo>*

| ***Project objectives and context*** | *<Date 1>* | *<Date 2>* | *<Date 3>* | *<Date 4>* |
|---|---|---|---|---|
| *Project objectives* | 1 | | | |
| *Project objects of consideration* | 2 | | | |
| *Organisation strategies* | 3 | | | |
| *Other projects* | 4 | | | |
| ***Planning, controlling*** | *<Date 1>* | *<Date 2>* | *<Date 3>* | *<Date 4>* |
| *Project progress* | | | | |
| *Project schedule* | | | | |
| *Project costs* | | | | |
| *Project resources* | | | | |
| ***Project organisation*** | *<Date 1>* | *<Date 2>* | *<Date 3>* | *<Date 4>* |
| *Project roles* | | | | |
| *Project communication* | | | | |
| *Project culture* | | | | |
| *Project teamwork* | | | | |
| ***Project environment relationships*** | *<Date 1>* | *<Date 2>* | *<Date 3>* | *<Date 4>* |
| … | | | | |
| … | | | | |
| … | | | | |
| … | | | | |
| ***Overall*** | *<Date 1>* | *<Date 2>* | *<Date 3>* | *<Date 4>* |
| *<Project name>* | 3 | | | |
| | | | | |

| | |
|---|---|
| 1 | *Very good* |
| 2 | *Good* |
| 3 | *Ok* |
| 4 | *Bad* |
| 5 | *Very bad* |

**Fig 5**: "Project Score Card" template

## 4. Conclusions

A comprehensive "Guidelines and Project Management Handbook" tool, which would be easy to use by the Greek NGOs who base their activity on volunteer work and lack of trained full-time personnel, is proposed by the authors. The authors targeted mostly the medium and small NGOs with the above characteristics, but the proposed tool can also be used by the larger NGOs with more experience. These "Guidelines" may support Greek NGOs to be certified under the ELOT 1429 and 1430-3 Standards and ensure their candidature for European Union co-financed Projects. But, most of all, these 'Guidelines" are a tool for their continuous improvement ("kaizen" in Japanese), into their "journey towards excellence", under the very spirit of "APOPLOUS - Code of Values, Organization, Conduct and Practice".

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*AA064*

# Reengineering project scheduling with knowledge management

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## Abstract
The aim of this paper is to provide an effective method for schedule reengineering and optimisation through knowledge acquisition and corporate memory creation. The core problem of schedule development is about defining each activity's duration as well as the right dependencies among project activities. Project – oriented organisations specialised in one or more domains due to their experience can have highly accurate project schedules and thus improved efficiency. The first part of the proposed method consists of monitoring all the existing processes related to the projects execution and the corresponding knowledge acquisition through monitoring project results. The second part handles the creation of a corporate memory in the form of a schedule prototype, along with all the needed processes in order to update it after each project's completion. The paper is illustrated with a case study concerning the implementation of the method on a project in the construction sector.

## Keywords
Project management, Scheduling, Knowledge management

## 1. Introduction

Project time management includes the processes required to manage timely completion of the project (PMI, 2008). The core processes of project time management include activity definition, activity sequencing, activity resource estimating, activity duration estimating, schedule development and schedule control (PMI, 2008). The outcome of project time management is a project schedule that includes start and finish dates of each activity. Even if no risks appear, the project is unlikely to finish on schedule if either the duration of activities or the definition of dependencies is not realistic (Diamantas et al., 2007).

It is quite typical, especially in small projects (in terms of duration and budget), that the initial schedule does not match the real needs of the project and is used as a wide approximation of activities definition, sequencing and duration estimating that proves to be completely different from the real outcome. The impact of this irregularity is clear during the whole lifecycle of the project causing conflicts and stress among project team members and problems with the customer and the relevant contracts.

In this context the proposed paper aims to provide a structured approach for schedule development in projects that will embrace real outcomes to future project schedules. The proposed approach exploits knowledge management techniques and builds on the organisational experience which comes up achieving the ultimate goal of scheduling reengineering. The basic concept consists of tracking the real outcome of projects belonging to the same category and then creating typical schedules for the whole category that can be customized for any similar project.

The proposed approach is illustrated through a case study from the construction industry and concludes with the benefits that may occur, the most important being the creation of realistic schedules.

The rest of this paper is organized as follows: in Section 2 we describe the objectives and the methodology of this study. This section is divided into two sub-sections. The first one is devoted to the construction of a Corporate Memory able to acquire the Knowledge of the enterprise. The second one handles the issue of project schedule reengineering, which is also considered fundamental for the effectiveness of the process. The paper is illustrated by a Case Study presented in Section 3. The last Section of the paper consists of general conclusions and further research possibilities.

## 2. Methodology

### 2.1 Knowledge management

In a business ecosystem that is becoming increasingly competitive, knowledge is a critical factor for business activities (Kerschberg, 2001). Organisational knowledge is recognised as a key resource and a variety of perspectives suggest that the ability to organise and deploy knowledge dispersed across the organisation is an important source of organisational advantage (Tsai & Ghoshal, 1998; Prusak 1997). Knowledge management is a broad and rapidly expanding topic. Davenport has defined knowledge management as "a method that simplifies the process of sharing, distributing, creating, capturing and understanding of a company's knowledge" (Davenport & Prusak, 1998). The overall purpose of Knowledge Management is to maximise the enterprise's knowledge–related effectiveness and returns from its knowledge assets (Wiig, 1997; Davenport, 2005).

Several kinds of knowledge can be found in an enterprise. The main distinction defined by Nonaka and Takeuchi (1995) is explicit and tacit knowledge. Tacit knowledge is not easily visible and expressible. It is hard to formalise, making it difficult to communicate or to share with others. Tacit knowledge is more of a personal nature, involving such intangible factors as personal belief and perspective and it is embedded in individual experience (Nonaka & Takeuchi, 1995). Nonaka and Takeuchi place great stress on the need to convert as much tacit knowledge as possible into explicit knowledge in order that the knowledge can be shared. On the other hand explicit knowledge can easily be represented in formal language, and thus can easily be communicated among people.

The whole Knowledge process (Van Heijst et al., 1997), as shown in Figure 1, consists of four basic steps:

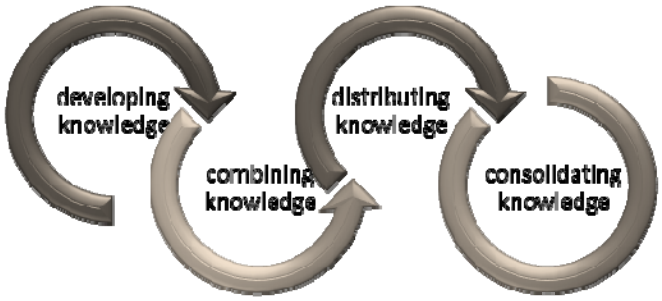


**Figure 1:** Stages of knowledge process

- developing knowledge through the ordinary day to day operations
- combining knowledge in order to extract and formalise the lessons learned from the past activities
- distributing knowledge to all the members of the organisation who can make use of it
- consolidating knowledge so individual knowledge can be made accessible to others in the organisation who need that knowledge

For the schedule reengineering two basic methods were used to acquire knowledge. The first one was interviewing experts to acquire tacit knowledge. This method is based on linguistic transmission of expertise and although this method is simple and very popular it has several drawbacks due to the fact that it is a time consuming process (Kim & Courtney, 1988). The second method concerned the acquisition of explicit knowledge through the documents and processes followed by classification and structuring of the acquired information.

Based on the knowledge acquired with the above methods a corporate memory was created. A corporate memory can be understood as a repository of valuable knowledge generated by an organisation through its continuous activity (Alvarado et al., 2004). Its basic principle is the maintenance of the past experience of the company in a knowledge base in order to be reused effectively, when needed. The deployment of a corporate memory is regarded as the most important turn to the Knowledge Management approach. Hence, the corporate memory is a data bank, which may include knowledge on products, production processes, standards and requirements, customers, business plans and strategic goals and furthermore financial information. Corporate memory is specifically structured for aggregated knowledge, which is a specific high-level knowledge required at a business level. The development of a corporate memory aims to give to the enterprise the opportunity to reuse quickly and effectively the accumulated Knowledge and moreover, to analyse and reason behaviours, actions and outcomes. Corporate memory's size is strongly depended on the size of the enterprise and consequently, the bigger the size the bigger the effort for its development (Bellos et al., 2002). Based on the above notions the proposed process to create and manage the corporate memory is depicted in Figure 2:

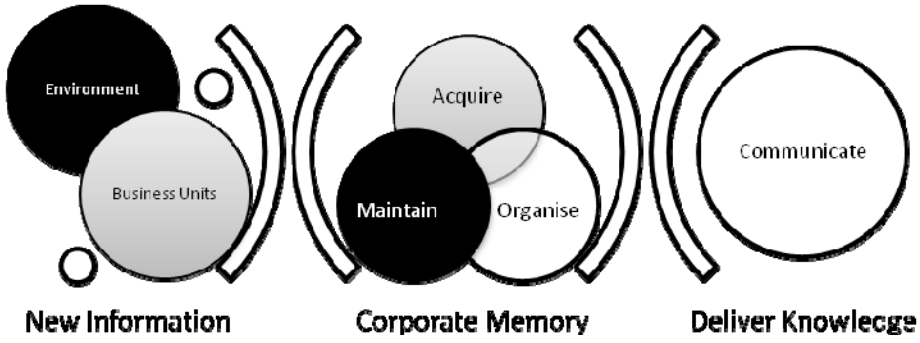


**Figure 2:** Knowledge Management Process

The proposed method for project schedule reengineering consists in developing a corporate memory containing all the available knowledge generated by the execution of past construction projects and is going to be analysed next. In relation to the schedule reengineering the proposed method is presented in Figure 3.

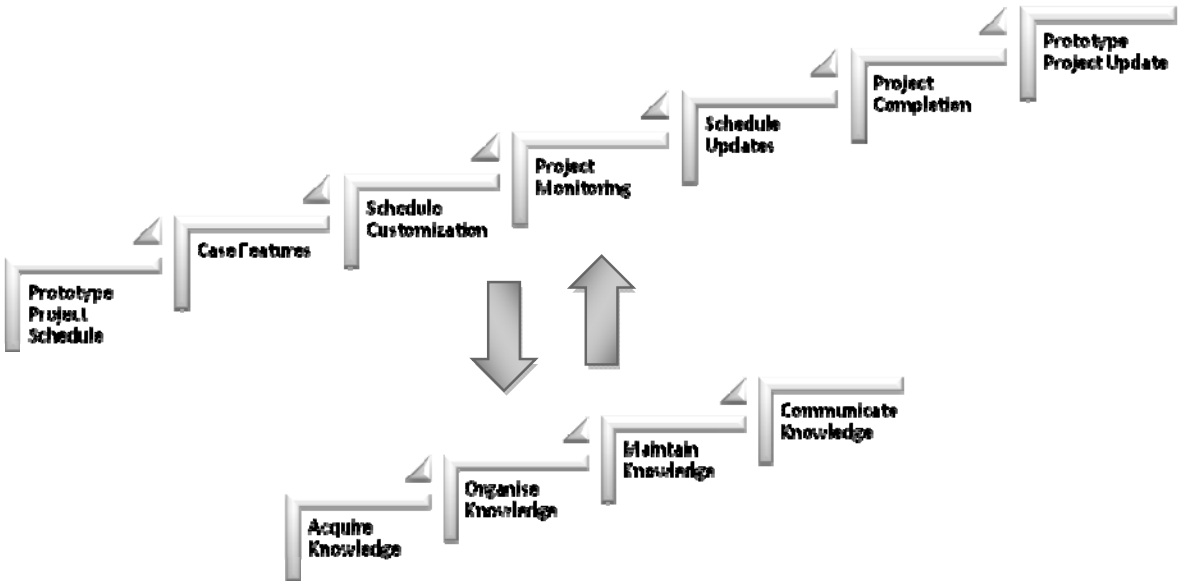


**Figure 3:** Knowledge Management during project schedule reengineering

More specifically the idea was to create a basic corporate memory using all the available past projects that would be the initial schedule prototype and then apply it to the future projects. Each time that the prototype would be applied all the needed customisations based on the case features would take place. Upon the completion of each project of a specific type the prototype would be appropriately updated and thus the corporate memory would also be updated. The aim is to create an optimum schedule prototype that could be easily customised for any similar project. As seen in Figure 3, each stage of the process requires or generates data for the corporate memory and each time that data are generated should be organised and get related to the data already residing in the corporate memory. Keeping the corporate memory updated is a critical factor for its success (Tatsiopoulos et al., 2002).

In the following section a case from the construction industry will illustrate the application of the aforementioned method and its outcomes.

# 3. Case Study

## 3.1 Company Description

The applicability of the proposed method has been tested in a company activating in housing and office development. The company is part of a major group operating, for over fifty years, in the sector of construction industry. Within this period the group has executed a multitude of worth trying projects in several countries. The group has achieved to be one of the most productive and effective International Building and Civil Engineering Contractors, operating efficiently in several countries, mainly in the Middle East, Asia, Africa and Europe.

The present study concerns the Greek market where the group begun operating in seventies. The activities of the group have substantially expanded due to strategic acquisitions and alliances with important contractors. The company has expanded its business to neighbouring countries.

## 3.2 Proposed Method Implementation

The aim of the development of the aforementioned method was the scheduling reengineering of the case study company. More specifically the idea was to create a basic corporate memory using a specific type of construction project, namely buildings refurbishment. The first schedule prototype inserted in the corporate memory was the typical schedule that the company used in offers development for such kind of projects. The company monitored the project's execution and then used the lessons learned in order to create a new schedule prototype that could be customised for any similar project. Afterwards, the created prototype was applied in a second project of the same category and the results were tracked and compared to those provided by the first one. The continuation of the process will lead to the filling of the corporate memory with reliable prototypes for as many project categories as possible.

More specifically, the two initial projects that were used as inputs for the enhancement of the corporate memory for this type of projects, referred to the refurbishment of two similar buildings in order to host two bank branches. Herein, it should be mentioned that the company has several long term agreements for this kind of projects and is quite specialised in the sector. Thus, the company's personnel have acquired valuable expertise in the sector.

The company started the corporate memory by exploiting knowledge acquired by its executives, project managers and stuff and built a schedule prototype containing about 30 tasks commonly required in this specific type of projects. This schedule was also used as a contracting agreement as far as schedule was concerned.

This project schedule was used as a basis for all the projects of the same type although there were only estimations about its actual precision and integrity. This lack of knowledge about the schedule's accuracy was caused by the fact that no retrospective analysis was done after each project's completion and thus there were no updates and refinements of the initial prototype. Thus, while the information on past projects was available, it was not transformed into knowledge about the actual tasks (appropriate level of the work breakdown structure) required for the completion of each project, the needed resources and the encountered risks.

In the effort of developing a reliable schedule prototype, the initial goal was to exploit the existing knowledge residing in the company's staff. Data were acquired from the project calendars and company's documents but also by interviewing the company's experts and extracting the knowledge from their experience.

The next step consisted of monitoring an on-going project of the same type and keeping track of the initial schedule and the actual task duration and resources allocation along with constant interviewing the responsible project manager in order to get inside information about the causes of alterations on work breakdown structure and resources. When this project was completed all the retrieved information were used in order to track all the deviations from the initial project schedule and their causes.

Based on these data the schedule prototype was updated giving a much more analytical and precise schedule. More specifically the new project schedule consisted of 70 tasks instead of the initial 30 to simplify the monitoring process and durations were based on the previous projects findings. The basic differences were identified in the level of analysis of tasks such as those related to electrical engineering (electrical fittings etc) as well as those that had to do with hydraulics (sanitation – plumbing etc). These types of tasks should be analysed further as this is the only way for assigning the right precedence constraints.

The main outcome of this endeavour was that the company managed to come up with the appropriate level of analysis in the work breakdown structure that in turn was expected to lead to a more effective and efficient project management. This generic prototype was customised to another project of the same category so that the integrity of the work breakdown structure analysis, as well as the links among tasks could be validated. For this new project 4 tasks of the prototype were not relevant and thus were removed from the schedule. These tasks were relevant to the formation of the outer space (e.g. landscape gardening). The monitoring process followed during this second project, was exactly the same with the first one. Upon the project's completion a comparison of the actual tasks implemented and those based on the prototype was done along with a discussion among the members of the company in order to pin point the causes of changes and possible ways of avoiding them next time. The results were entered in the corporate memory and caused the schedule prototype to get readjusted.

Summarising the goal was to use the corporate memory in order to create an accurate project schedule for building refurbishments and establish a dynamic process of updating and optimising it through time. This schedule is going to be used as a template for all future projects of this type. However, the executives for each new project ought to do the appropriate modifications before using it.

Based on the data collected during the monitoring of the above analysed projects the comparison analysis gave the following results:

- The first project used the initial work breakdown structure with 34 activities but during its execution 38 new activities were added to accommodate the project's needs. There was a 52.78% difference between initial and final number of activities.

- The second project used the updated schedule prototype having 66 activities and only 1 activity was added during its execution. There was a difference of 1.49% between initial and final number of activities.

In table 1 appear the relevant data about the two projects.

| Project | Number of initial activities | Number of final activities | Effectuated Changes (%) |
|---|---|---|---|
| First | 34 | 72 | 52.78 |
| Second | 66 | 67 | 1.49 |

**Table 1:** Initial and final number of activities in the two projects.

## 4. Conclusions – Further Research

The main points of the theoretical part concern the Corporate Memory use within an organisation in order to reengineer its projects schedules. The Case Study is used in order to give the practical appliance of the proposed method. The method presented in this paper aims to lead to effective schedule reengineering and optimisation through knowledge acquisition and corporate memory creation of project oriented companies. Schedule prototypes created by the proposed method can be accurate and optimise project management. As derived from the case study the use of an elaborated schedule prototype significantly reduced the difference between initial and final number of activities (refer to Table 1).

Taking into account the results of this research and the comments that we had from the project team, we came up with the finding that the corporate memory as an instrument for project schedule reengineering can essentially aid the project management procedure.

As a conclusion we strongly recommend project managers to lead their teams towards knowledge systems that can have a "high beneficial impact with also high probability of success".

It should be mentioned here that the use of project management software is of extreme importance for the success of this endeavor. Having such a software in place, the project oriented enterprise (such as those belonging to the construction sector) may gather all the appropriate data from the construction field and enrich its knowledge memory. As further research the authors are trying to apply the proposed approach to more complex and bigger in terms of budget projects.

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*AA040*

# PM-PEDIA: An Open-Learning, Expert-Based, Mind-Mapping Tool for Project Management Education

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## Abstract
Efficient and coherent education in PM needs to couple the standards incorporated in systematic yet concise methodologies (such as the ICB® or the PMBOK®), with elaborated documentation, examples and evaluation tools, in order to corroborate the learning material. A challenge in this attempt is that PM an inter-disciplinary field and as such, the existing literature is vast and dispersed in various media (books, articles, internet, etc.) Bringing the knowledge elements from standards (which are mostly guidebooks) and textbooks together in a form acceptable by learners and teachers, by maintaining the completeness and integrity of scientific concepts, is a challenging task.

## Keywords
Project Management, Mind Mapping, E-learning

## 1. Introduction

The primary purpose of this article is to present all the necessary elements for the development of an online e-learning tool, and to correlate them in an effective way in order to increase its adoption for educational purposes. E-learning is an essential element in the majority of modern management teaching methods, so it could not be excluded by one of the most distinguished branches of administration, namely, project management.

The presented tool is an expert-based, adaptive and interactive online knowledge database. Its objectives are to facilitate the introduction of beginner learners on basic concepts of PM through the systematic formulation of process-oriented methods, and to offer a self-evaluation mechanism that enables the evolution of knowledge for the learner. The structure of the learning tool is much similar to the structure of the PMI®'s, PMBOK® Guide.

This article is structured as follows. In Section 2, we briefly review the literature and introduce basic concepts, we highlight the items necessary for the development of the tool and stress the importance of e-learning in modern education; the key differences between guidebooks and textbooks are also emphasized herein. Section 3 deals with the details of progressive development of the tool and the presentation of the specialized mind mapping software (Mindjet® Mind Manager 8). Finally, Section 4 illustrates the evolutionary characteristics of the model, stresses the expert-based and adaptive aspects of the development, and justifies the name *PM-Pedia* that we have given to the final product. The article culminates with conclusions, contributions and guidelines for future research.

# 2. Basic Concepts and Literature Review

## 2.1 Mind maps

A *mind map* is a diagram used to represent words, ideas, tasks or other items arranged and linked to a central key, word or idea (Wikipedia, 2009). The elements of the map (concepts) are usually enclosed in definite shapes of some type (nodes) attached to each other by drawn lines. Frequently, words on the lines referred to as linking words or linking phrases specify the density of the relationship between the two concepts. As mind maps are considered to be critical for the final outcome of the educational process, Jonassen (2000) indicates that the technique of conceptual mapping is an intermediary, learning tool that promotes the development of new knowledge, enhances interaction and involve people in cognitive processes for analysis and critical encounter of the content of teaching, as well as the organization and representation of knowledge, taking into account the social and cultural environment.
Conclusively, through this particular mind mapping feature, this study makes an attempt to embed mind maps in PM training. To achieve this, the PMBOK® Guide is decomposed as described in Section 3, in order to facilitate a deeper comprehension of its content for both the apprentice and the advanced user.

## 2.2 Electronic learning

The granted interactivity and efficiency in refreshing as well as enriching information, thus knowledge, in combination with the potential of global access and application from independent PCs everywhere in the world, have already transformed the market interest for creation and utilization of e-learning tools, into "*a survival skill for corporations and individuals"* (Cross, 1999). The most typical characteristics of e-learning remain the ease in accessibility and handling of information in a "*self-paced"* (Obringer, 2001) way, along with its applauded adaptability, bringing users one step closer to its learning objectives. In addition to that, "*the matching of content and delivery vehicle to a learner's style, amplifies retention and magnifies learning results",* as cited by Assumption University (2002). At present, e-learning appears highly attractive to all, especially to companies that want to reduce the cost of executives training hence the observed increase in relative web pages attendance. The existence of ample material in digital form has boosted the evolution of e-learning tools and practices. However, as Clark & Meyer (2002) point out: "*The technology that has lagged is the pedagogy and design thinking and strategies required to make all of this digital information reusable and targeted toward adding value*". The actual "trigger" in the development of the present e-learning tool is the creation of an open-ended knowledge database based on the structure of the PMBOK® Guide, while enriching it with scientific material, lessons learned and case studies from open sources provided by the members of the global PM community, thus creating a so-called *PM-pedia*.

## 2.3 Framework of PMBOK® Guide and its characteristics as compared to a Textbook

Although the basic principles and structure of the PMBOK® Guide are used in the development of this tool, supplementary learning elements enrich the structure of the guide. The architecture and concept of the PMBOK® Guide can elegantly be depicted on a mind map as it contains 42 processes grouped firstly in line with

***knowledge areas*** (in 9 PM processes) and secondly defined by the ***project life cycle*** (in 5 is product-oriented processes) (PMI®, 2008, p.37). The relationships between processes and their respective subtopics (inputs, outputs, tools & techniques) are portrayed in a mind-map by hyperlinks. Further information is provided in Section 3. Nevertheless, the PMBOK® Guide is a *guidebook*, not a textbook. In that sense, it enumerates the tools and techniques, inputs and outputs, step-by-step directions on processes, possibly some templates, but it hardly elaborates on the application of these techniques, not does it give any paradigm of application, a case study, or self-assessment opportunities; this is rather the purpose of a *textbook* or of supplementary software products.

The distinctive difference between the present e-learning tool and traditional textbooks and/or guidebooks for PM is thus that it unifies the positive characteristics of textbooks, guidebooks and self-assessment tools under one roof. Most important, however, is the fact that the developed tool is open, expert-based, interactive and adaptive and it enables distance learning, in non-real-time. The tool brings to the learner the combined benefits of formalistic thinking and open, elaborate, moderated information. While a guidebook demonstrates how to "Do the Right Things", which is greatly useful and practical in handling situations in a project, the developed tool is oriented towards "Doing the Things, Right".

## 3. Elaboration of E-learning Tool

### 3.1 Step-by-step modeling

The building of the e-learning tool is achieved with the use of the Mindjet® MindManager 8 specialized software. The procedure of modeling includes 4 steps:

Step 1
The ensemble of processes of PMBOK® Guide was recorded, documented and allocated in the nine knowledge areas (PMI, 2008, p.37), decomposed up to "activity" level. The main topic title is "PM-Pedia" followed by consecutive subtopics concerning the forty-two processes and their respective inputs, T&T (tools & techniques), outputs as dictated by PMI®. At the end of the map an extra chapter, relevant with training and certification information based on PM issues, was added.

Step 2
T&T are there to support managers by providing ways to plan execute and monitor the ensemble of PM processes, integrating scientific as well as expert-based knowledge. Step 2 deals with the attempt to transform this particular guidebook into a textbook, through the enhancement of suggested T&T with further scientific, learning data directly accessible through the Web. Nonetheless, while "Alternatives Analysis" technique (PMI, 2008, p.144) in the "Estimate Activity Resources" process of Time Mgmt (PMI, 2008, p.141) consists an acclaimed method of "*yielding options if there are other ways to accomplish the activity"* (Elyse, 2006) incorporating a wide variety of learning sources; "Expert Judgment" on the other hand is expressed in a more subjective way, because essential as it may be, it cannot be included in any type of bibliography. Out of a total 131 T&T proposed by the PMI®, 74 of them were subject to enrichment. The educational aspect of the tool is represented through the addition of learning-related questions and answers at the end of every knowledge area, that lead to evaluation of essential knowledge with a more apprenticing perspective, than a plain preparation for credential aquiring.

Step 3
Once the construction of the main body of the PM-Pedia has come to a mature level, the elements are conceptually correlated; that is, outputs of processes are fed as inputs to other processes. A typical example involves "Change Requests" which as an output of "Direct and Manage Project Execution" process (PMI, 2008, p.87), have to pass through "Monitor and Control Project Work" (PMI, 2008, p.92) and finally arrive at "Perform Integrated Change Control" process, as an input (PMI, 2008, p.97). Evidently, the operational structure of mind maps facilitates information feedback through simple hyperlinks, as it is clearly depicted in the final form of the model.

Step 4
Once the PM-Pedia is developed as a robust and rich mind map, it is exported in HTML format. The exported mind map is easy to use as a normal web page in a learning environment. The respective exhibits throughout the evolution of the model development are shown in the appendix.

## 3.2 Key features of the product

Digital illustration of the PM-Pedia

The structure of the model as a website and the near real-time data uploading through an administrator are the main features of the tool, which provides accessibility and availability among online users, and does not need extra portable storing means, as in the case of an e-book or a software package. This is because HTML applications have become the most widespread means of acquiring information, both in the business and the personal levels.

Mind maps and the structure of PMBOK® Guide

In reality, mind maps are considered to be a dignified characteristic of a webpage, but due to their suitability for PM education, they are even more important. Every PMBOK® Guide process consists of incoming elements (inputs) that are being processed with the necessary tools and techniques and conclude to results (outputs) that are viewed as inputs to other processes. The importance of information feedback during a project in association with the interactions between processes prompts for the use of hyperlinks as a means of item conjunction within an HTML application. Hyperlinks facilitate information gathering and accessing, hence the inclination to an HTML based website as the definitive version of the model.

Tools & Techniques Enrichment

The addition of online references in 74 out of 131, proposed by PMI®, T&T transforms the PMBOK® Guide from a Guidebook into a Textbook and generates a PM-Pedia. This transformation enables the user not only to consult the required pathways to appropriately manage situations, but also to deepen his knowledge and shape his administration style through a blending of online open-source tools. In other words, added entries and links, imported comments and expert-based reviews on the PM-Pedia elements, facilitates research, allows assessment and broadens the spectrum of knowledge.

Insertion of Questions & Answers

Self-assessment plays an important part in the conceived model. Questions and corresponding responses were thus added and grouped into 9 levels, according to the respective knowledge area. Questions relate to individual activities, processes, T&T and critical situation evaluation. The plan for the future use of the model requires that its content is operated under continuous renewal, holding the number of questionnaires at a high level, according to the latest advances in the PM field.

## 3.3 PM-Pedia

The term of **PM-Pedia** was coined in order to define the evaluated model as a free, web-based, open-source, PM e-learning tool and prompts to Project Management (PM-) and encyclopedia (-pedia). The attempt was inspired by Wikipedia, the online encyclopedia; however, instead of providing definitions and links to each tool on an encyclopedia basis, the tool contains several appropriate online references in the respective chapter and follows the structure of the PMBOK® Guide. As a result, PM education is based on a formalistic, process-oriented framework elaborated with practical methods and strategies that need to be followed in order to plan, execute and control the project throughout its various phases, and to deal with any critical or unexpected situations. The main concerns raised are:

- The evaluation and refining of received elements. A group of moderators should be available, that will screen and improve data and transform them in a way that makes them ready for publishing on the web pages.
- The need for a specialized administrator, responsible for the selection and renewal of data received, the publication of evaluated and refined text on the web pages (comments, reviews), and the handling of an online HTML-based e-learning tool. In short, this website needs to be converted from its present static form, to a refined, more dynamic form.
- The need for a website specialist and the requirement to host the dynamic website on an online server. This is even more crucial, as every received element has to be stored and at the same time made accessible to users.

## 4. Guidelines for the evolution of the e-learning tool

The main incentive for the development of the PM-Pedia is the realization that a guidebook, although useful it may be, does not facilitate learning in the mechanisms of tools and techniques, while most textbooks lack the formality of a guidebook. The first attempt to create the PM-Pedia initiated as part of the graduate dissertation of one of the authors. The developed "beta" model presently operates in an experimental fashion, and is practically evaluated on a daily basis by several undergraduate and graduate students. This gradually leads to the transformation of the model to an integrated, dynamic, e-learning website built upon the principles of PMBOK® Guide.

In the steady state, the required workforce should consist of the administrator, a group of evaluators-editors (moderators) specializing in one or more cognitive areas and other sub-moderators holding at least some basic PM knowledge. The roles and responsibilities of each of these entities lies in the gathering of received data and its classification in two main categories. During the first classification, they

diversify the content into the following categories: "Expert-based Reviews & Hints", "Case Studies", "Education & Credentials", and "Employment & Workplace". The second classification deals with the categorization according to PMI®'s nine "knowledge areas". Following the initial information filtering, data concerning "Expert-based Reviews & Hints" and "Case Studies" is posted to respective moderators (based on the knowledge area in which they specialize), that are responsible for a thorough evaluation, refining and editing appropriately the context. The administrator's duties are thus limited to receiving documented text from the moderators and posting it on the appropriate website domain. The separation of domains follows a two-level classification identical to the responsibilities of sub-moderators, after receiving users' data from the administrator.

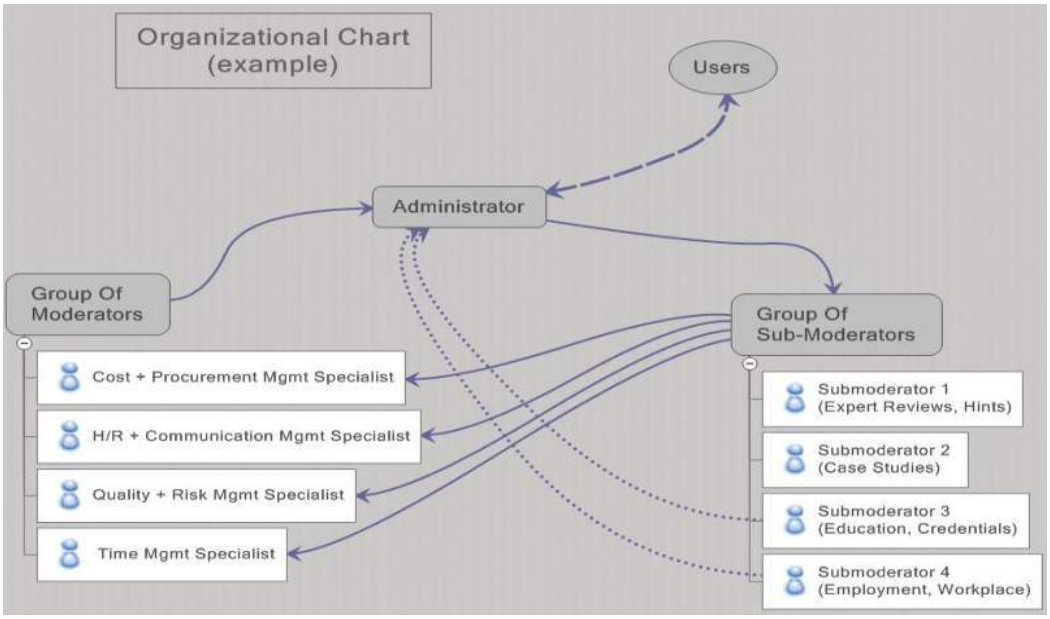


**Fig. 1:** Website's organizational structure. (Blue arrows represent received data, which is distributed by the administrator to sub-moderators, evaluated, processed by moderators-editors and finally recovered by the administrator, ready for posting in the appropriate domains of the website.)

## 5. Conclusions, Contributions and Guidelines for the Future

The present work has set the basis for an interactive, adaptive, knowledge-based, open e-learning tool, appropriate for apprentices, as well as PM experts. Learners may use this tool for both training and self-assessment, even for preparation towards a PMI® accreditation. The tool was developed using mind maps and the Mindjet® Mind Manager 8 software as the foundation to model the PMI® defined knowledge areas and processes and was then enriched in most of its elements. The model was also exported into web pages for ease of use.

Through a continuous improvement and enrichment path, the product is gradually being transformed to a PM-Pedia. The operation of the product requires the participation of people with distinct roles and responsibilities as described herein. The product is now on a broad evaluation phase in order to shape its final form. Future actions contain the further enrichment of the model, the addition of a scoring module, the inclusion of case studies, etc.

# 6. Appendix

## Step-by-step development of PM-Pedia mind map (Mindjet® MindManager)

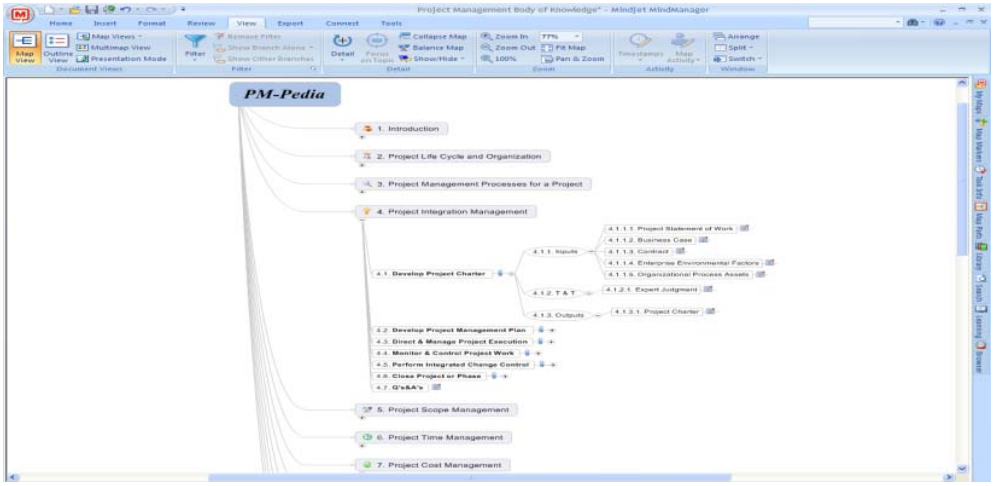


**Fig. 2:** Mapping of the PMBOK® Guide processes into mind maps. (Step 1)

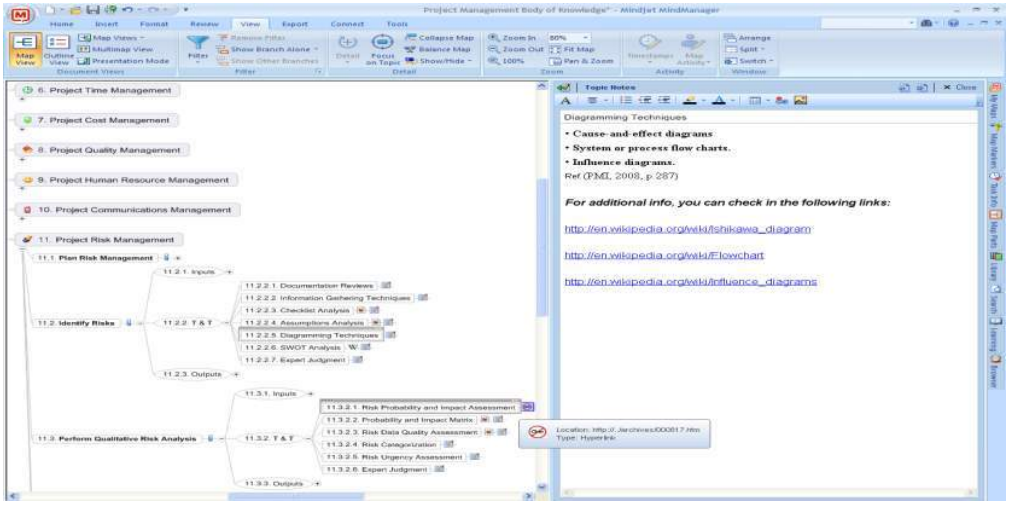


**Fig. 3:** T&T enrichment with online scientific and learning material. (Step 2)

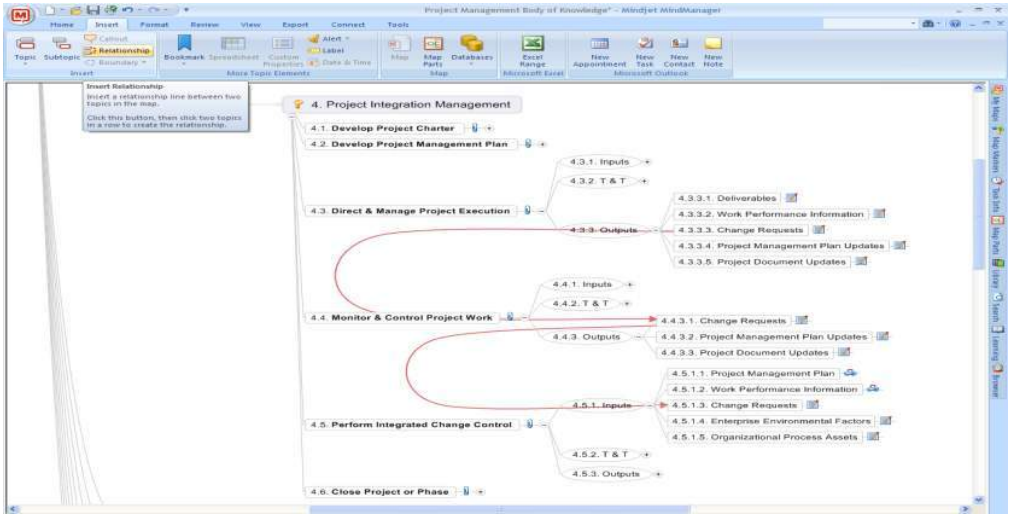


**Fig. 4:** Conceptual process correlation through hyperlinks, and addition of relationships in interrelated activities. (Step 3)

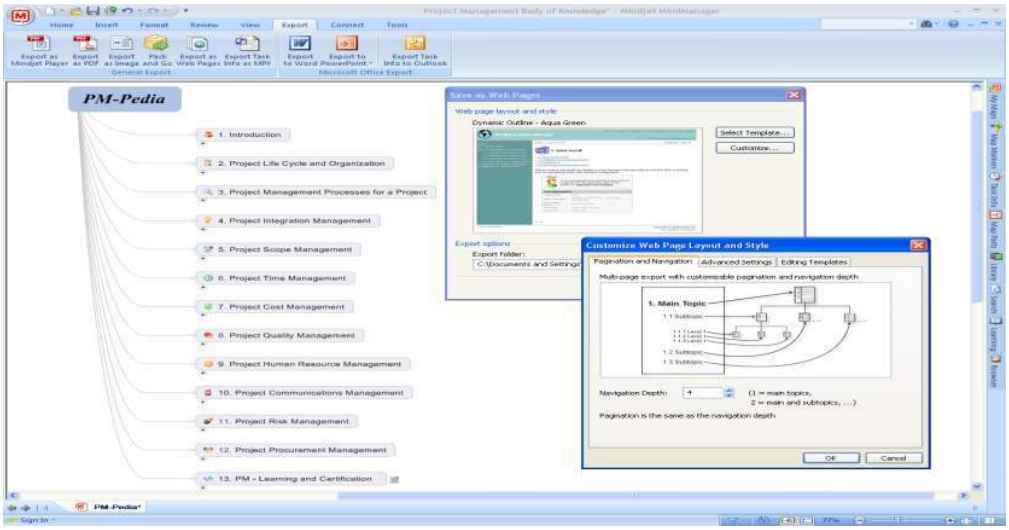


**Fig. 5:** Export of mind map into web pages and options parametrizing through the software menu (Step 4)

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*All figures were exported as images by* ***Mindjet® MindManager 8*** *(trial version).*

*SPM01*

# Lessons Learned from the Development of a Project Management Suite

Pavlos Laoutaris
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## Lessons learned from the development of a project management suite

Pavlos Laoutaris

*Task Force for the ESF projects co-ordinator*

MOU S.A.

## WHAT WAS THE NEED

- Participation in E.U. funded programs
- Massive drafting of technical application forms
- Monitoring reports and payment statements
- Interconnection of existing data bases
- Development of additional data bases and content

# THE ORGANIZATION

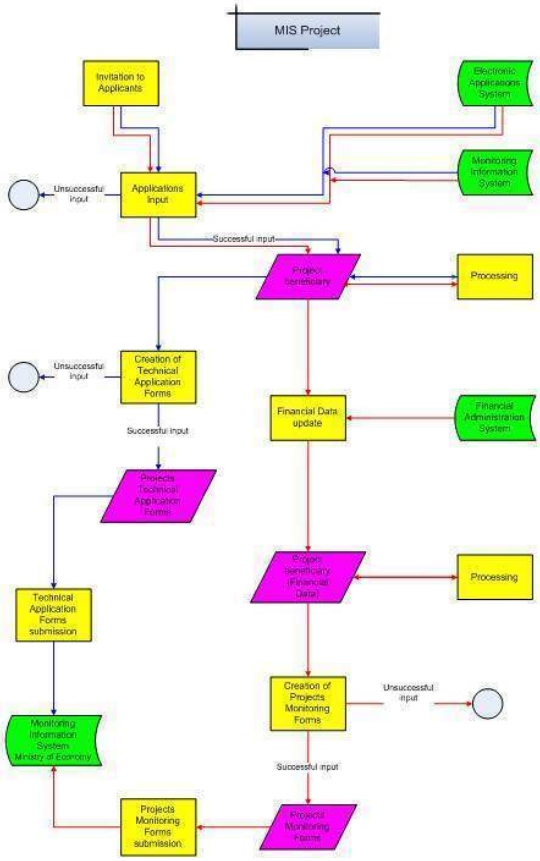
- Large – traditional – public
- Mainly routine business processes
- Typical influence project organization
- No clarified project roles

# THE EXISTING SYSTEMS

- Electronic Applications System
- Monitoring Information System
- The Financial Administration System
- The NSRF data base (MIS) in the Ministry

# THE PRODUCT

- Converting suite
- Content development
- Analytics
- Transmission tool



# DEPARTMENTS INVOLVED

- General Manager
- Operations Department
- External Relations Department
- IT Department
- Financial Department

# PUBLIC SERVICES INVOLVED

- Managing Authority of the Operational Program
- Coordinating Authority of ESF
- Managing Authority of NSRF
- Managing Authority of Monitoring Information System (Ministry of Economy)

## EXTERNAL CONSULTANTS INOLVED

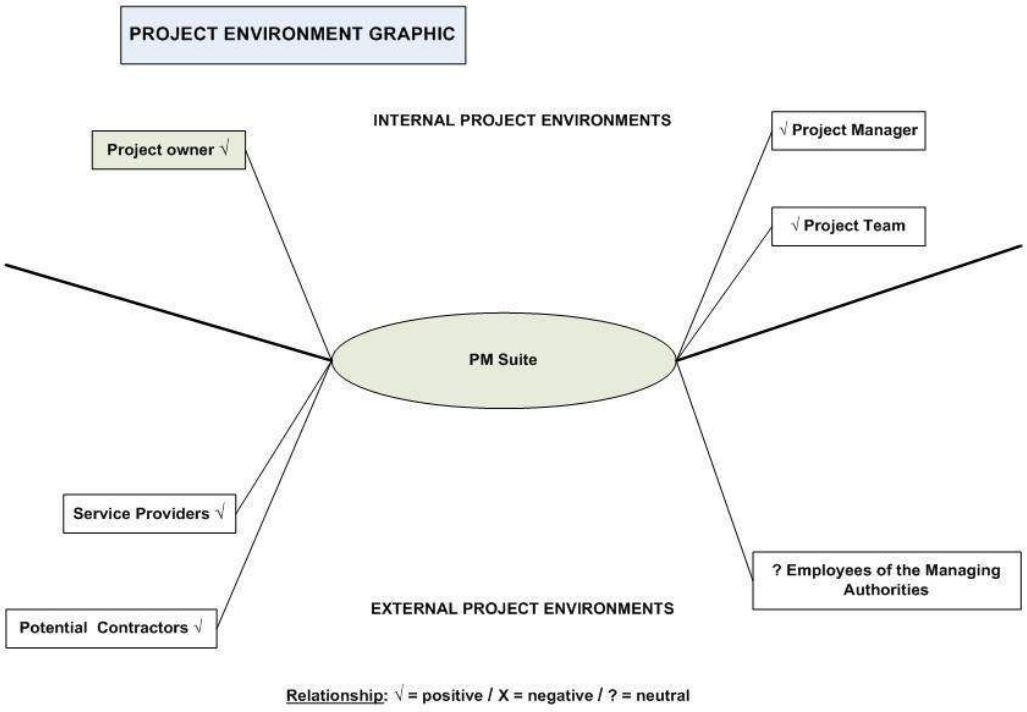
- Service Provider Monitoring Information System
- Service Provider Financial Administration System
- Contractor of the Project
- Task Force for ESF Projects

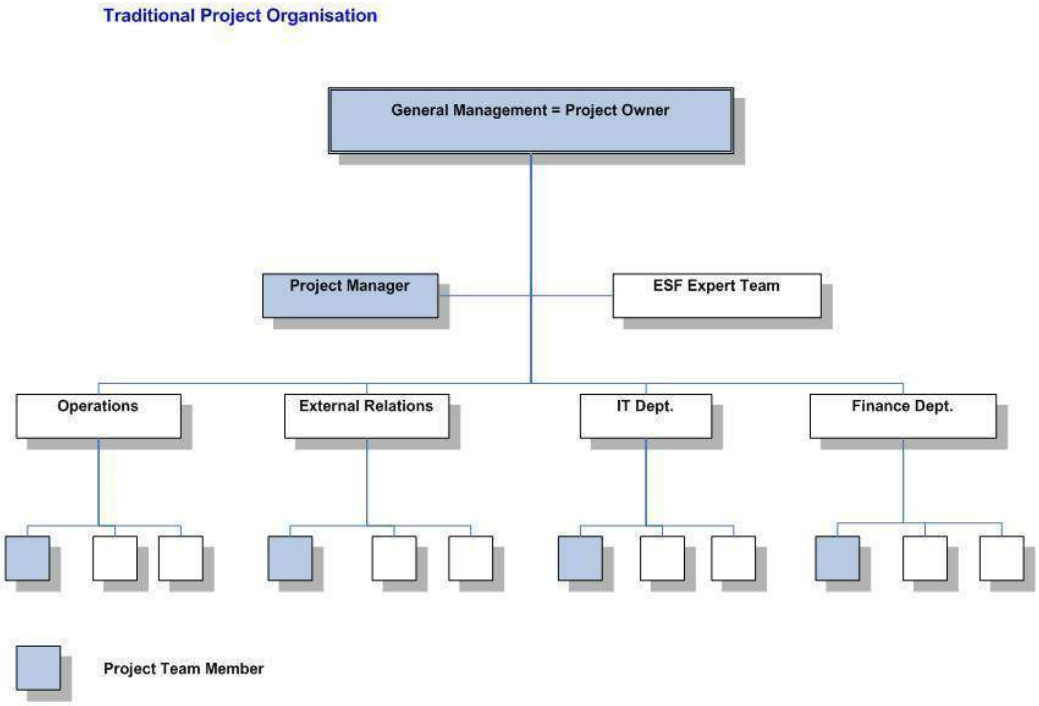
## INTERNAL ENVIRONMENT

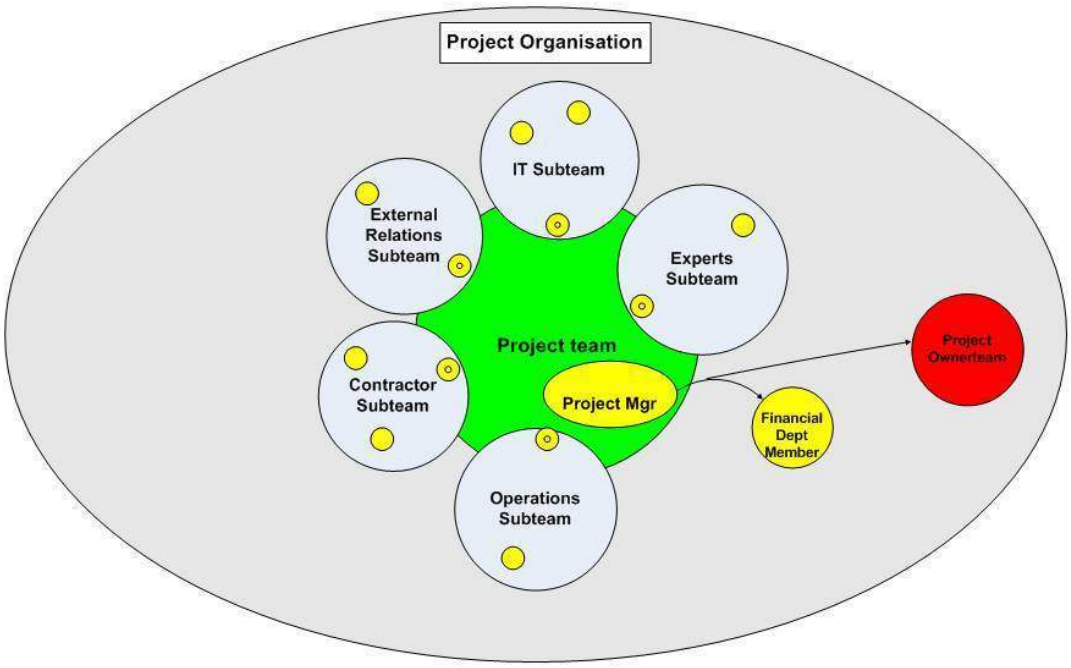
- The Project Owner Team
- The Project Manager
- The Project Team

# EXTERNAL ENVIRONMENT

- The Service Providers
- The potential Contractors
- The employees of the managing Authorities

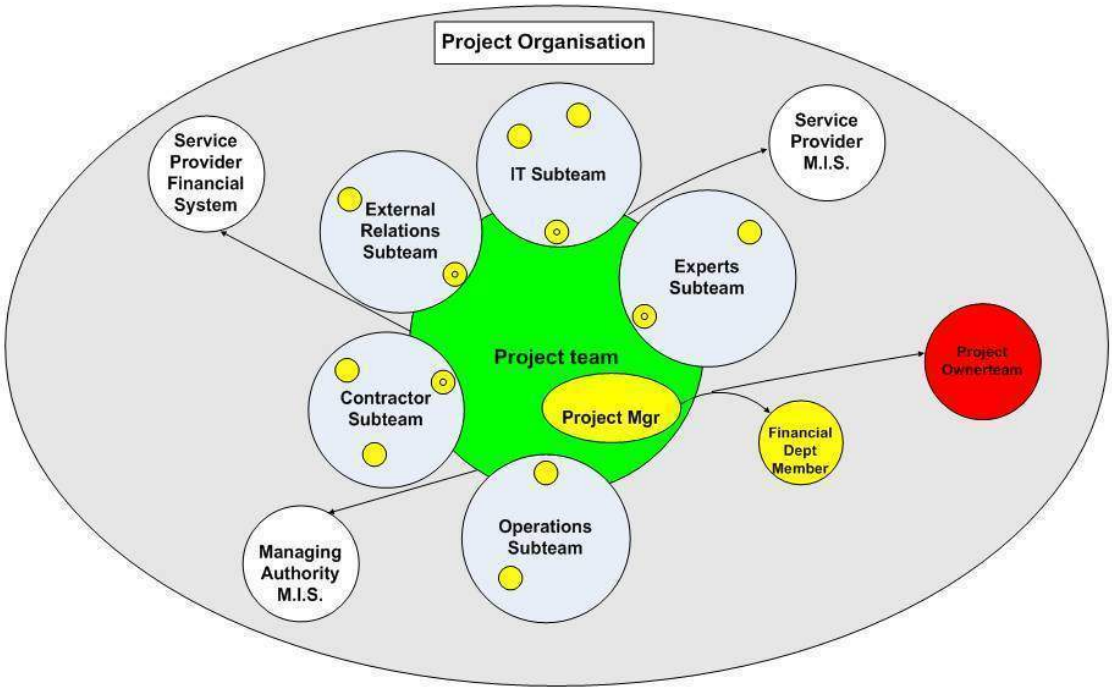



Traditional Project Organisation
General Management = Project Owner
Project Manager
ESF Expert Team
Operations
External Relations
IT Dept.
Finance Dept.
Project Team Member


Project Organisation
IT Subteam
External Relations Subteam
Experts Subteam
Project team
Contractor Subteam
Project Mgr
Financial Dept Member
Project Ownerteam
Operations Subteam

# PROJECT START

- Business case analysis
- Formal project assignment
- Definitions of roles
- Development of project culture
- Risk analysis
- Project start workshop



# PROJECT COORDINATION

- Communication with project owner
- Communication with team members and contributors
- Communication with relevant environments
- To do lists
- Meeting minutes
- Acceptance certificates

# PROJECT CONTROLLING

- Constructing a common project reality
- Updating the project plans
- Changes in the objectives and scope
- Resolving of minor project discontinuities

# PROJECT CLOSE DOWN

- Completion of remaining packages – MIS reporting
- Final project marketing event
- Planning of the post project phase
- Official Report

# LESSONS LEARNED

- Project owner actively involved
- Constructor skilled and experienced
- Achievable approach
- Agreed measures of success (CSF)

# LESSONS LEARNED

- PM had responsibility but not authority
- Key stakeholders not included in the project team
- Not secured a common understanding and agreement of stakeholder requirements
- No risk analysis
- Not skilled project team with clearly defined roles

# Thank you for your attention!

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*AA054*

# Comparative evaluation of project management standards

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## Abstract
The increasing number and complexity of engineering projects require the implementation of systematic management procedures for effective project execution. Among existing project management standards, PMBOK and PRINCE2 have prevailed. PRINCE2 appears more suitable for disciplined environments with strong leadership while PMBOK may be more appropriate for organisations not emphasizing on a strong hierarchy. Such standards can be effective in large or well structured organisations but not so effective in organisations without experience, ability or motivation to invest much in project management. A guide that may be used to assist organisations in developing a project management method internally is presented. The guide is structured upon a detailed questionnaire that aims to reveal the general directions for developing a management method that meets the organisation needs, to suggest practical implementation plans and actions, to help organising the management documentation, and to provide incentives for further investigation and development. The proposed guide is flexible, directly applicable, adapted to the organisation needs, and promotes people creativity and participation.

## Keywords
Project management, Standards, PMI, PMBoK, Prince2

## 1. Introduction

The current need for building more, larger and of increased complexity projects is being affected by technological advancement, globalisation, shortening of product life cycle and increasing competition over depleting resources. An important success factor of projects, in terms of both the quality of the deliverable and the production time and cost, is their systematic management. In this direction, several management methods and standards have been developed over the last decades and used in many production lines and projects. Two of the standards that have prevailed, based on their penetration, geographical spread and de facto or de jure dominance, are PMBoK (Project Management Institute-PMI (2009)) and PRINCE2 (Office of Government Commerce-OGC (2009)).

The literature includes several references and case studies from around the world about the two standards. However, it seems that there are no enough studies about how these standards interrelate and which are the optimal conditions for their successful deployment. Moreover, there has not been any attractive alternative for organisations without the experience or motivation to apply such robust standards but still willing to incorporate simple project management procedures.

The objectives of this paper are:

- to perform a comparative evaluation of the two standards (similarities, differences and extras) and to determine the conditions under which each standard is more effective,
- to present a practical and flexible guide that may assist organisations without previous experience, ability or enthusiasm to use existing standards in developing a project management method that can better fit to the needs of the organisation.

## 2. Comparative evaluation of PMBoK and PRINCE2

### 2.1 History, aims and structure

PMBoK has been developed by PMI (an independent non-profit organisation aiming to enhance project management) and it is the USA official standard (ANSI) for project management. PRINCE2 has been developed by OGC (a British Government Office aiming to successful execution of primarily government projects) and it is the "de facto" standard in UK and other countries. Both standards have originated in the late 80's and have gone through four major revisions since then apart from various improving editions. They have both developed a project manager certification procedure and user support system and are now worldwide established counting more than 250,000 certified practitioners each.

Both standards provide a general framework for project management and describe analytically a large number of management procedures, their inputs and outputs and tools utilised. The specific procedures and the extent that they are applied in each project are determined by the project team and/or the project executing organisation.

PMBoK is structured following particular management knowledge areas incorporated to it. PRINCE2 instead follows a project management phase structure. Despite differences in their structure, both standards point out the fact that project management is an iterative process rather than a linear one, meaning that most management activities are executed more than once during a project. They also both acknowledge that project management is a constitutive element of the project life cycle trying to optimally allocate organisation resources into operational work.

### 2.2 Comparison of Standards

An in-depth comparative evaluation of PMBoK and PRINCE2 has been performed in Loukas (2008). The results of the evaluation are summarised in Table 1. It can be seen that the two standards bear more similarities than differences. Their differences can be attributed to their historic evolution and their goals. In particular, whereas PMBoK is supported by an independent organisation and aims at knowledge advancement, PRINCE2 is managed by the British Government and is mainly directed to managing governmental projects.

| | **PMBoK** | **PRINCE2** |
|---|---|---|
| **Similarities** | Both standards are bulky (presenting a lot of procedures, their interdependencies and tools), generic, independent of specific industry and other standards (e.g. ISO). | |
| | They have been developed at the same time period, cover virtually the same needs and they are enhanced by a user certification and support system. | |
| | They coincide in principals, concept and roles although utilise somehow different terminology. | |
| | They are generally in agreement regarding knowledge areas and procedures necessary for successful project management. | |
| | Both standards emphasise the need for further adjustments and adaptation to the characteristics of each specific project and project environment in order to be effectively applied. | |
| | **PMBoK** | **PRINCE2** |
| **Dissimilarities** | Structured according to the knowledge areas it covers. | Follows generally a project management phase structure. |
| | Places the centre of authority within the project team empowering thus the project manager. | Places the centre of authority outside the project team, in particular to the Executive, confining thus the project manager role to a day by day management. |
| | Allows the project team and the project manager to set roles and responsibilities. | Assumes strict and clear setting of roles and responsibilities beforehand. |
| | Emphasises on encouraging initiatives in order to maximise team participation and commitment. | Emphasises the adherence to hierarchy. |
| | Includes extra knowledge areas, such as Human Resources and Procurement Management. | Excludes these knowledge areas considering them of being out of scope. |
| | Includes extra project management tools (e.g. Earned Value Analysis). | Excludes these tools considering them as being widely known. |
| | **PMBoK** | **PRINCE2** |
| **Extras** | Considers additional knowledge areas (e.g. Human Resources and Procurement Management) and tools (e.g. Earned Value Analysis, three-point estimate). | Provides detailed check lists for roles, procedures and managerial deliverables. |
| | Emphasises on the prevention of deviation. | Focuses on controlling deviation. |

**Table 1**: Comparative evaluation of PMBoK and PRINCE2

The differences and extras can determine the standard efficacy considering the specific needs of projects and project environments. It seems that PRINCE2 may be somewhat more suitable for projects executed in a disciplined environment with a strong hierarchy centre while PMBoK may better accommodate projects in multicultural and flat environments which do not strictly adhere to hierarchy. To maximise benefits, one may consider using elements from both standards; PMBoK as a robust theoretical base and PRINCE2 as an effective practical guide. In all cases, tailoring of the project management method is fundamental to its success.

# 3. Proposed guide for internal PM method development

## 3.1 Need and objectives

The global recognition and popularity of the previous standards cannot eliminate the need for their successful customisation (sizing and tailoring) to every specific project and organisation. Because these standards are of a general nature, which is highly desirable and beneficial for their independence of a specific industry, their customisation to specific organisation or project characteristics (such as size, complexity, environment etc) is not easily or effectively achieved. Moreover, this customisation requires appropriate knowledge, training and experience that many organisations may not have or are unable to achieve within existing time and budget constraints. In addition, many organisations would prefer to develop management methods and procedures internally in order to better adapt to their needs. In this direction, a flexible guide that may assist organisations in developing a project management method internally is presented. The aim of the guide is to provide the general direction and a practical step by step approach for the project management method development using simple and well-known tools without the need to refer to existing standards.

## 3.2 Tools and structure

The guide is structured upon a detailed questionnaire that aims to assist a step by step project management method development. There are 280 questions consisting five chapters (development phases) which intend to reveal the general directions for developing an internal project management method that meets the organisation needs, to suggest practical implementation plans and actions, to help organising the project management method documentation, and to provide incentives for further investigation and development. The employment of a questionnaire (instead of a list of suggestions) bears several advantages, such as:

- it assists the participants to better discover the special characteristics of the organisation structure, the projects and the project environments,
- it allows the participants to better understand the important project management parameters and procedures,
- it stimulates participant creativity,
- it helps in increasing participation and commitment.

Simple and extensively used tools are proposed throughout the guide in selected points to further support the management method development:

- SWOT Analysis (Korres et al. (2003)) as an awareness tool to recognise areas that can be utilised or strengthened.
- Cost – Benefit Analysis (Korres and Chassiakos (2003)) as a decision making tool for future decisions or as a post-evaluation tool of previous decisions.
- Probability Impact Matrix (PIM) (PMI, 2009) as a means to systematically recognise, quantify and treat uncertain events, such as risks and opportunities.
- 5W/H (Who, What, Where, When, Why, and How) as a way to identify and document all the necessary information.

The guide suggests a five-step development as indicated in Table 2. The Table briefly presents the topics (content), objectives and indicative suggestions within each phase. Some sample questions for each phase are further presented to provide a better view of the guide content and its expected results.

| Nr | PHASE (chapter) | TOPICS (sections) | OBJECTIVES | EXAMPLES |
|---|---|---|---|---|
| 1 | Analysis of the need for a PM method | Collection and evaluation of data about:<br>▪ Organisation<br>▪ Projects<br>▪ Customers<br>▪ Suppliers<br>▪ Subcontractors<br>▪ Competition<br>▪ Environment<br>▪ Human Resources<br>▪ Quality<br>▪ Risk | To better understand and document the business need for a PM method (type, size, cost benefit analysis etc) and the desirable characteristics of the PM method. | A big construction company engaged in new road or railway projects has different needs from a small company which is mainly focused on building homes. While the first one needs an extensive PM method, the second one can probably speed up the development and condense the method. |
| Sample questions:<br>✓ What is the project impact on the financial results, the brand image and the strategic goals of the organisation?<br>✓ What are the strengths and weaknesses (SWOT Analysis) of the organisation personnel involved in projects?<br>✓ Are there any stakeholders that may oppose to the new method (5W/H) and how are they going to be dealt with? | | | | |
| 2 | Development of the PM method | Decision making about:<br>▪ Basic characteristics of the method<br>▪ Procedures<br>▪ Templates<br>▪ Tools<br>▪ Documentation<br>▪ Approvals<br>▪ Side effects of PM method<br>▪ Pilot application planning<br>▪ Requirements for pilot application | To develop a method that meets the business needs without disturbing the existing operation framework of the organisation and to plan a pilot application for prompt evaluation of method effectiveness. | Public sector projects require stiff approval procedures and formal documentation, while private sector projects could be more flexible in these aspects.<br><br>Some organisations are mature enough to use demanding tools (such as Earned Value Analysis that calls for extensive follow up) while others cannot do so and should start up with basic tools (such as three-point estimate). |
| Sample questions:<br>✓ What will be the contents of the "Project Management Plan" for every project and how is this going to be developed (5W/H)?<br>✓ What are the risks of the pilot application of the PM method (PIM)?<br>✓ What is the predicted cost of the pilot application (Cost – Benefit Analysis)? | | | | |
| 3 | Pilot application of PM method | Application and evaluation of PM method:<br>▪ Application of PM method in selected projects | To assess the method effectiveness and determine areas of improvement. | Best case scenario is to execute similar and representative projects with and without the new PM method so that the results of the method can be tracked and shown. |

| | | | | |
|---|---|---|---|---|
| | | ▪ Results evaluation | | |
| Sample questions:<br>✓ Are the technical skills and other prerequisites of a successful pilot project implementation in place so that the results of the method can be isolated and stay unaffected by other drawbacks?<br>✓ Are the results of the method gathered as planned and free of any subjective judgement and/or mistake in measuring?<br>✓ Are there any side effects of the method that have not been predicted? | | | | |
| 4 | PM method refinement | Adjustments in PM method according to pilot application findings:<br>▪ Improvement approval<br>▪ Deployment of improvements<br>▪ Check for side effects, if any<br>▪ Preparation for the operation phase | To appropriately refine the PM method and ensure that all prerequisites for the PM method full application have been addressed. | Every method, no matter how well designed, will fail if it is deployed without all the supporting tools in place (e.g. management information systems). |
| Sample questions:<br>✓ What are the expected side effects and the Cost – Benefit analysis of the proposed necessary or desired changes to the method?<br>✓ Is there a need for further testing of the method as a whole or partially after the refinement?<br>✓ Who will be in charge of monitoring operation and support of the method (5W/H)? | | | | |
| 5 | Operation and support phase | Operational phase:<br>▪ Monitor and control of method application<br>▪ Data collection and periodical evaluation | To make sure that the method is properly used, evaluate its results and propose further (long-term) improvements. | Continuous and strong management support is a key success factor.<br><br>Data gathering and periodical evaluation of the method are also important. |
| Sample questions:<br>✓ Is there sufficient and timely communication within the organisation about the method application and data gathering?<br>✓ Are the projects managed according to the method, its tools and templates?<br>✓ Is there a reason for immediate action before the scheduled evaluation and/or change of the method due to negative effects? | | | | |

**Table 2**: Structure of the proposed guide

At the beginning of each chapter, its objectives are defined, important guidelines (hints and tips) for a successful performance are outlined and there is a short yet necessary business need validation section according to previous sections findings. Finally, prerequisites to a good start and execution of the section are described. At the chapter end, results must be analytically documented and an executive

summary report is created and officially approved. If there are management comments, parts of the phase can be re-done before the results are finally approved.

## 3.3 Benefits and shortcomings

Although the guide has been based on existing standards, it is designed to be applied independently from them. The proposed guide is of general application, analytical and structured, yet simple, short and easy to use even by organisations with no extensive knowledge or previous experience in project management methods. Developing a project management method internally offers a number of benefits:

- the method is adapted to the organisation needs from the beginning,
- the personnel is vitally engaged throughout the development process and, therefore, committed to its success,
- there is limited need for external support since the method is build step by step,
- the development promotes continuity, adaptability and extensibility.

On the other hand, certain shortcomings and difficulties are associated with the proposed method development such as:

- the initiation momentum for the method development may be low,
- existing knowledge and experience from other organisations may not be adequately utilized,
- the progressively acquired experience may be narrowed to the executed activities,
- the method may be accidentally or on purpose misled by the developing team since it is not benchmarked against an existing, widely recognised framework.

# 4. Conclusions

The increasing number and complexity of engineering projects require the implementation of systematic and standardized project management techniques for effective project execution. Among existing project management standards, PMBOK and PRINCE2 have been globally used in such direction. However, their use may be effective only in large or well structured companies and organisations. The objectives of this work are (a) to perform a comparative evaluation of these standards and (b) to propose a guide that may assist organisations in developing a project management method internally, which may be more flexible in application and more adapted to the needs of each organisation.

The evaluation of the two standards shows that they bear more similarities than differences. Both standards are bulky (presenting a lot of procedures, their interdependencies and tools), generic, independent of specific industry and other standards (e.g. ISO). They coincide in principals, concepts, roles and procedures necessary for successful project management. They both recognize the need for further adjustments and adaptation to the characteristics of each specific project and project environment in order to be effectively applied. In terms of differences, PMBok is structured according to the knowledge areas it covers, places the centre of authority within the project team, allows the project team and the project manager to set roles and responsibilities, and emphasises on encouraging initiatives with the aim of maximizing team participation and commitment. On the other hand, PRINCE2 follows generally a project management phase structure, places the

centre of authority on the Executive, confining thus the project manager role to a day by day management, assumes strict and clear setting of roles and responsibilities beforehand, and emphasises the adherence to hierarchy. In conclusion, it can be said that they both standards can be effective depending on the environment they are applied and on the success of adaptation to it. PRINCE2 appears somewhat more suitable for more disciplined environments with a strong leadership while PMBOK may be more appropriate for organisations not emphasizing on a strong hierarchy. The maximum benefit may probably result from the combination of PMBOK as a theoretical base and PRINCE2 as a practical tool.

The proposed guide considers the difficulties in application of robust standards by organisations without experience, ability or motivation to invest much in this direction. The guide is structured upon a detailed questionnaire that aims to assist a step by step project management method development. There are 280 questions consisting five chapters (development phases) which intend to reveal the general directions for developing an internal project management method that meets the organisation needs, to suggest practical implementation plans and actions, to help organising the project management method documentation, and to provide incentives for further investigation and development. The proposed guide is flexible, directly applicable and has minimal requirements for external support. Moreover, the fact that the organisation develops the project management method internally results in sufficient adaptation to the needs of the organisation, wider and direct people creativity and participation as well as extensibility potential based on internal needs and regardless of the improvements in "commercial" standards.

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*AA067*

# Construction Productivity: From measurement to improvement

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## Abstract
The subject of productivity is one of the broadest, most complicated, and therefore vague subjects related with constructions. Much research has been done for creating techniques which can efficiently measure productivity, and even more suggestions for its improvement can now be found in related literature. This paper aims to introduce current techniques and methods for measuring construction productivity along with their critique, and potential ways to improve their use. In order for the present work to be completed, people with great experience from construction industry and academia were interviewed and an extended literature review has been conducted. The data analysis reveals some unique issues that can lead to productivity loss, and also provide engineers with the current industry and academia trends on improving productivity in constructions. The results of that research can help the engineering community understand the seriousness of the construction productivity problem, and provide engineers with techniques and recommendations to face that problem.

## Keywords
Construction Productivity, Productivity Loss, Productivity Measurement, Improvement Techniques

## 1. Introduction

Construction people have to improve their productivity in order to survive in the highly competitive environment of the industry. Hence, productivity has been generating significant interest in both the construction industry and academia (Park et al., 2005). Although through the years many suggestions and efforts for measuring and improving productivity have been made (Borcherding, 2008, Liberta et al., 2003, Oglesby et al., 1989) the advancement of that task is relatively slow because of the various factors that affect it and the uncertainty of how to effectively measure it with the most efficient way (CII, 2000). Moreover, the amount of existing techniques globally used for measuring productivity is extremely extended and there are many uncertainties around the accuracy and applicability of many methods. Finally, not all of the proposed measurement and improvement techniques are broadly applied to real construction projects while many are theoretically developed and evaluated. The previously mentioned reason makes it difficult to form an actual list of the widely used techniques, their advantages and disadvantages and to present more suggestions on their applicability or usage for productivity improvement. The purpose of this report is to present a summary of the most widely used productivity measurement techniques and productivity improvement methods. In addition an effort is made to explore the limitations and uncertainties on those methods, and also make some suggestions about productivity improvement.

## 2. Background

According to various researchers, no universally accepted productivity measurement standard exists (CII, 2000, Park et al., 2005), something which is considered to be the main reason for the existence of so many measurement methods. The amount of existing techniques used for measuring productivity extends from time-lapse photography and video analysis in combination with statistics (Oglesby et al., 1989), to models using historical data (Song and AbouRizk, 2008), Neural Networks (Chao and Skibniewski, 1994, Ezeldin and Sharara, 2006), and techniques from other industries like manufacturing (Lean Construction Institute, 2010, Alarcon et al., 2003). Related literature reveals that some of the techniques used are designed to measure the productivity of specific crafts at different kinds of construction work (Song et al., 2003), while others measure productivity at firm or site level and include every participant involved in construction (Alarcon and Calderon, 2003). Additionally, construction productivity is affected by many factors which when not handled properly can cause great productivity loss. According to the related literature construction productivity loss is mostly related with situations like worker low motivation and dissatisfaction, poor worker skills, insufficient equipment and tools, excessive overtime and material handling, rework and worker fatigue, inadequate planning, poor construction management, and many more (Borcherding et al., 1972, Borcherding and Garner, 1981, Fosberg and Saukkoriipi 2007, Ofori 2005). In order to maintain adequate productivity standards, construction firms should track the main causes of productivity loss and work towards a method for controlling them for improving construction productivity and performance (Borcherding, 2008). Except from the traditional productivity improvement techniques construction productivity can be boosted with the use of information technology advancements which enable project participants to collect and share important field data in a timely and accurate manner (Chao and Skibniewski, 1994, LeMenager, 1992, Hewage and Ruwanpura, 2009). Examples of such technology applications are mobile computing, 3D Laser Scanning, digital close-range photogrametry, GPS, sensors, and wireless communication (Eldin and Egger, 1990, LeMenager, 1992, Song et al., 2004). Moreover, many researchers (Alarcon and Calderon, 2003, Forsberg and Saukkoriipi, 2007, Salem et al., 2006) are trying to utilize methods from other industries to improve productivity. Lean construction seems to be the most popular of that kind of methods. Despite the fact that many lean construction tools and elements are still in an embryonic state, lean construction techniques (Last Planner, Six Sigma) are gaining popularity because they can affect the bottom line of projects.

## 3. Methodology

For completing that report, the first step of the method followed was that of an extensive bibliographic research, and after establishing a solid background of the academic efforts on construction productivity measurement and improvement a series of interviews followed to explore the existing construction industry trends. More than 50 experienced engineers working from small to multinational level construction firms, experienced project managers, construction directors, and faculty of academic and research institutes were interviewed. Most of them are employed in the US, and European construction industries, while others are appointed as University faculty members at construction engineering departments.

The participants were asked questions about how do they perceive productivity terms, the importance of productivity knowledge, the ways and frequency of measuring construction productivity, critique of the measurement techniques they use, the causes of low productivity and the ways to improve it. Because of the complexity and vagueness of the subject of productivity the data collection method preferred was of personal interviews with open ended questions, instead of asking the survey participants to complete a questionnaire. It was considered to be more practical, and ethical to leave the participants free to express their views and not to direct their options (and consequently the results) by asking for answers at multiple choice questionnaires. Respondents were mostly conducted physically by telephone and face-to-face interviews, with a very small number of people (less than 10%) being interviewed through e-mails. Because of the absence of numeric data in the responses, the basic theory of statistics was used for output data analysis. After the interviews concluded, various responses were counted and the most acceptable and broadly used measurement techniques were selected and analyzed. Furthermore, recommendations for improving construction productivity starting from its measuring were introduced along with the analysis of issues that can cause productivity loss and a discussion on recommendations for facing that problem.

## 4. Construction productivity measurement techniques

The methods and techniques presented are, according to the interviews, the most widely used in an effort to measure, and evaluate productivity in a construction site or at the firm level. Some of those methods are experience-based while others are applied with the use of mathematical and statistical models, technological tools, and computer-based applications. By recording industry trends in measuring construction productivity it was observed that the majority of independent engineering companies, and smaller construction firms tend to use experience-based models for conducting measurements, or they do not even track productivity at all, while large firms, companies and construction organizations (mostly in the US) tend to measure productivity by using more complex, computer-based models and work sampling with the help of technology tools. Moreover, for the same activity, productivity may be measured by different people in different ways, and so the resulting productivity values may not be directly comparable.

### 4.1 Input/ Output

Input/output ratio (for example work hours per square feet of wall painted), is mostly used for measuring productivity at an activity level (labor productivity), and its lower values indicate better labor productivity-performance. Furthermore, when measured by that method labor productivity often depicts how efficiently labor is combined with other factors of production, a clue which can be very useful for activity planning and scheduling. Therefore, if productivity is reported as work hours per unit, the cost engineer can easily determine project costs by multiplying productivity times the estimated quantity and the wage rate. The present form of measurement has the disadvantage of being very simplistic, and it cannot depict the real on-site situation by not taking into account any of the factors affecting site activities. That model could be helpful for having an estimation of labor productivity, but the same could not be claimed for the productivity of organizational and off-site staff, management staff (whose works' input and output cannot easily be defined), nor for productivity at a firm level.

## 4.2 Experience-based models

Probably the first attempts to measure and understand productivity in the construction industry were totally based on the experience of engineers and constructors in general. In the times where advanced technology and measurement techniques were not available, the actual productivity in a construction site was perceived and evaluated by experience-based estimations based on daily observations on the job site. Despite the industry's technological advancement and the numerous measuring techniques now existing, surveys revealed that more than 20% of contractors still rely on estimators' experience and notions for the majority of their estimates. Obviously, the accuracy and reliability of this approach are influenced by personal prejudice and can be highly subjective. When using models and techniques highly related on experience, the most reliable estimate can be made by combining that experience with past project data. However, such empirical practices do not guarantee a consistent estimate due to the lack of an efficient binding mechanism that could relate the present case to past patterns.

## 4.3 Measuring productivity using project milestones

Another broadly used method is measuring productivity by using project milestones. At the beginning of a project, construction managers and other administrative personnel of a project's general contractor, define some project milestones, which need to be completed by specific deadlines. By the end of a pre-defined time spam (one or two weeks), staff meetings are held in order to review the work progress and discuss about the completion percentage of the milestones. During those meetings, an evaluation of the general work progress plan takes place and the productivity of the whole project is defined by examining the completion percentages of project tasks usually with the help of a project planning software. Despite being easy to follow, the milestone method does not provide any outcomes that could help defining the root of a possible productivity loss. Furthermore, it is not useful for defining on-site productivity and it does not give any numerical results which could enable construction managers to compare each week's productivity with previously recorded data. It can be claimed that this method is more a broadly used, experience-based technique than a broadly accepted scientific method which can generate safe and accurate outcomes.

## 4.4 Activity model (Work sampling)

A number of labor productivity models based on work-study concepts have been proposed during years of research and applications. Those models can be arranged in three broad classifications: delay, activity, and task models. According to the conducted interviews activity models were considered the most accepted and widely used work-study models. Activity models are based on work sampling, a method that employs statistical sampling theory to measure the utilization of labor, measured in time. Work sampling is based on probability theory. The ratio of the number of observations of a given activity to the total number of observations of all activities approximates the percentage of time that the work process spends on that activity. If the number of random observations from a large group of craft activities on a project is large enough, the percentage of time found by work sampling spent on an activity will differ little from the actual time spent on that activity in the work process developed on the project site. The needed data can be collected with ways varying from observation tours, to the use of video-recording,

time lapse photography, and others. It is important that sampling is conducted randomly, and without bias by trained construction or maintenance analysts. Covering the entire labor workforce on-site, each worker is counted as one sampling observation. Usually, most data is recorded in three categories: Direct work, support work, and delays. Work sampling provides the researcher with ratio estimates (waiting/total) which are a very convenient way to measure productivity. Furthermore, the method is easy to administer and fairly cheap and in the same time collects useful facts during project execution that are not normally collected by other methods, while it has no, or minimal, interference with the worker's normal activities. On the other hand, some major disadvantages are the human errors that may occur, and the possible limited accuracy of results. Furthermore, work sampling does not differentiate rework from original work and is frequently reviewed with great suspicion by craftsmen and foremen.

## 4.5 Factor models

Factor models are multi-variant approaches to modeling the productivity of a crew rather than of an individual, based on the factors that affect it. The quantification of factors involves the statistical analysis of crew productivity and related factors (Thomas and Yiakoumis, 1987). Their applicability and accuracy makes them valuable tools for measuring and predicting productivity at site level. The many factor models now existing have implemented many mathematical and statistical methods and software in order to generate more accurate results and simultaneously take under consideration many factors. On the other hand, and according to the conducted literature review and interviews, the key limitation of those models is that despite their applicability for measuring the site-level productivity of a specific project, they do not address interactions across multiple projects and hence it is difficult to be applied at a firm level.

## 4.6 Cost reporting method

Many construction companies, which do not use any statistical or mathematical techniques and software, try to make estimations about their productivity rates by monitoring and comparing project costs. The method they follow for productivity estimation is usually based on the simplistic approach that when the cost is increased, work is unproductive. In order to have the ability to compare costs of similar projects, a database containing historical data of costs for materials, wages, and others is needed. Such data can be collected from previous projects and are used not only for measuring productivity of a specific project but also for predicting future productivity trends. This kind of method has the advantage of being very simple and easy to use. On the other hand, it does not pinpoint the root of possible low productivity, and data collection may become a costly and time consuming procedure, with high possibilities for human errors in estimating input and output, when compared to other available techniques for measuring productivity.

# 5. Productivity loss and trends on improvement

Construction industry experts tend to relate construction productivity loss mostly with on-site activities and situations like worker low motivation and dissatisfaction, poor worker skills, insufficient equipment, excessive overtime and material handling, rework and worker fatigue. In addition, more than seventy five per cent of the people interviewed seemed to be highly aware of the importance of administrative, and support staff skills, indicating as very important factors for

productivity loss the low planning level, the poor pre-planning, the lack of leadership and skills in management team, and the poor on-site management. As for improving construction productivity, interviews have shown that the majority of the industry professionals (more than eight out of ten) continue to show some preference on traditional productivity improvement techniques like craft productivity measurements and motivation enhancement programs, extensive project pre-planning, cost control, and the selection of better equipment. Furthermore, a very popular notion among engineering professionals is productivity improvement through advanced technology use. Many construction firms try to promote the use of hardware technologies, such as optical scanning, optical mark recognition, bar coding, video and camcorders which with the help of software can analyze the data collected and give recommendations for productivity improvement.

## 6. Discussion

It is quite obvious that not every measurement method can efficiently be applied to any project's situation, and that the use of each method/technique has advantages and disadvantages. The use of an unsuitable measurement method may not only cause productivity loss, but also falsely indicate such a situation. For the above reasons, and in order to improve the use of measurement techniques, construction managers first need to carefully evaluate the available methods and find the most applicable to their project and needs. Furthermore, people handling the selected measurement tool should be well trained, have knowledge of measurement analysis, vision to relate measurements with the on-site reality, and decisiveness to take actions towards productivity improvements. For improving the broadly used methods the industry should probably rely more on those that give numerical data for productivity, not only because those methods are outcomes of scientific research, but also because they help firms keep a history record of productivity data.

Moreover, as the literature review revealed, numerous productivity measurement methods exist. Some are still on experimental level while others have been used for several years. In addition, method selection is frequently based on the size and economic power of the construction firm. Consequently, small firms which depend on individuals with low budgets, tend to use methods based on personal experience and not on proved scientific research. Those experience-based techniques may prove to be very efficient, but they have the disadvantage that their efficiency cannot be easily measured, and the firm's productivity trends cannot be easily recorded because of the absence of productivity numerical values.

As for the industry trends in improving construction productivity the literature review has shown that the industry tends to move forward by following the advancement of technology. Most of the new methods proposed are based on the use of IT, computer-based systems and software. The question is if small construction firms struggling to survive through today's world economic crisis can afford the use of such applications. The trend of such firms is not to generally measure productivity by using any particular technique, but to have an overview of it through the use of a cost reporting method. That trend in combination with the unwillingness of small firms to make investments in new tools make productivity measurement and improvement a very challenging task for the majority of the industry members. In order to face that challenge, construction community needs to motivate individuals to measure and improve productivity of their firms and

companies, and also motivate researchers to create inexpensive and easy to operate scientific tools, as for everyone to have the ability to effectively measure construction productivity.

## 7. Conclusions

Construction is a constantly evolving industry, heavily affected by the rapid evolution of technology which makes situations change dramatically from one day to the other. People involved in constructions have diverse opinions on the subject of productivity measurement, mostly because the term "productivity" is not easily defined and understood. Furthermore, causes of productivity loss are not always predictable and easy to track. It usually requires much effort to define those causes and much more effort to adequately face them. Research also showed that there is a difference in the way of productivity measurement between large and small-independent firms which do not frequently measure or record productivity of their projects, and thus have difficulties in improving performance. Moreover, the majority of techniques/ tools used for measuring productivity have key limitations, something that should alert industry participants before deciding the selection of a specific tool. In addition, technology use as a measure for boosting productivity is usually a privilege of firms with great economical power, a situation that needs to be faced with much attention.

In order to expand the conducted research, further interviews on a larger scale and with diverse background participants should be conducted. Some of those participants should be key people working for developers and manufacturers of software and hardware used for productivity measurement and analysis, mostly because they can reveal the conceptual background behind the development of a measurement tool and the industry's needs and wills for such tools. Further research and mostly more interviews and surveys must be conducted in order to create a complete catalogue of measurement techniques used, and the ways to improve them. Finally, the correlation between recorder productivity loss and the technique/tool used to define that loss should be re-examined, and with the help of industry experts and researchers shape the path leading from productivity measurement to productivity improvement.

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# Student Difficulties in Conducting PhD Level Research The Aristotle University of Thessaloniki Case Study

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## Abstract
The Greek academic community seems to be well informed about the problems surrounding undergraduate level studies but the unique situation of graduate programs still remains quite unknown. This paper aims to make the first step towards a valuable discussion about the unique situation of the Greek University PhD programs, and explore the quality, feasibility and general philosophy which surrounds research at the PhD level. In order to extract conclusions about the research situation in Greece, a statistical survey was conducted among doctoral students of the Aristotle University of Thessaloniki. Students were asked to express their views on the research difficulties they face, by answering multiple choice questions and also by making text comments. The data analysis reveals some unique problems in conducting doctoral research, and also illustrates the need to transform the current PhD research philosophy into an educational method more applicable to the current academic needs of Greek Universities.

## Keywords
PhD research, Graduate Students, Research Problems, PhD difficulties, Statistical Survey

## 1. Introduction

There are many, and complex interests and motivations an individual can have for undertaking a PhD (Barnacle and Usher, 2003, Leonard et al., 2004), and even more possible problems that can arise during this process. The academic community seems to be well informed about the difficulties surrounding doctoral studies. Many researchers have explored the challenges of conducting PhD level research along with the relevant views of students and faculty members (supervisors) (Welsh, 1980, Russell, 1996, Golde and Gallagher, 1999). In addition, many members of the academia have proposed solutions to problems of doctoral research, and recommendations to make doctoral studies an easier procedure for faculty and future candidates (Salmon, 1992, Donald et al., 1995, Phillips and Pugh, 2000, Boud at al., 2006). Despite the above mentioned novel efforts, knowledge about the actual PhD process is still considered to be limited. The uniqueness of each academic institute and the constantly evolving global economic conditions, along with the different personality of each one involved in doctoral studies, differentiate the PhD process for each individual. For the above reasons, the academic community should be well aware of the problems people can have in conducting doctoral research as well as of the problems of each different academic system in order to make generalizations which will lead to the re-evaluation and improvement of the PhD process. The purpose of this article is to reveal and demonstrate problems PhD students, of Greek Universities, have when conducting research by focusing on the case of the Aristotle University of Thessaloniki (AUTH), the largest academic unit of Greece with more than 60000 enrolled students. Furthermore, there was made an effort to indicate the major concerns and

obstacles doctoral students have, and to depict the situation under which research at AUTH is conducted.

## 2. PhD Research in Greece

According to the Greek Scientific Association of Doctoral Candidates and the Greek Ministry of National Education there are more than 18,000 PhD students enrolled in the graduate programs of public Universities, a fact that reveals the intense interest Greek students show at doctoral studies. Despite that fact, most of the PhD level research programs in Greece lack sufficient funding and consequently doctoral students cannot be employed by Universities as researchers while working on their doctoral degree. In every department only a few funded research programs exist, rarely connected with PhD research projects. For the above reasons most of the Greek doctoral students have to personally fund their studies or find someone to provide them with the money needed to cover their living expenses. According to the National Statistical Service of Greece, only 225 scholarships (of 470 Euro/month) are provided each year by the State Scholarships Foundation, and 60 more are provided by other Foundations, Institutions and individuals. Most of those scholarships are not capable of covering the living expenses of graduate students. On the other hand, Greek graduate studies are free for the enrolled students and do not require any tuition or fee payments. Furthermore, statistics of the National Statistical Service of Greece reveal that more than 33% of the currently enrolled PhD students are older than thirty three years old, something that shows great delays on the degree completion and consequently leads many candidates to drop their degrees. The main reason for those delays is probably the fact that most of the PhD students have to work during they studies because the Universities' incapability of offering adequate funding to support them.

## 3. Method

To collect the needed data for exploring the student difficulties in conducting PhD level research, a survey was conducted during the academic year 2009-2010. The participants were more than 60 active PhD students (out of the almost 110 asked to participate, with a response rate of 57%) studying at various departments of AUTH. The method of survey with multiple-choice questions was considered to be the most appropriate to use, mostly because it provides the surveyors with accurate data along with a relatively easy circulation of the questionnaires which can be achieved among many participants and with many ways. Questionnaires were given to survey participants personally, by mass e-mails to PhD student organizations of various AUTH schools, and by phone interviews. The survey asked for multiple-choice answers to questions, but also permitted many text comments in order to help the individuals describe their unique situation without being confined by standardized answers. Students were asked to express their views about methodological, ethical, organizational, educational and other research issues and demonstrate the major difficulties they face during their studies and research. They were asked to characterize the situations-difficulties they face while studying at AUTH by using relative terms (e.g. "excellent", "good", "adequate", "fair", "bad" and others) and also asked open ended questions on subjects where a more detailed opinion was considered to be more helpful. After data collection, the survey findings were analyzed with the use of the basic theory of statistics, in order to have a clearer picture about PhD research in Greece from the scope of students/researchers. The major findings of the conducted research are presented below followed by a discussion on their analysis.

As for the demographics of the survey, most of the survey participants were between twenty four and twenty eight years old (47%), followed by students with ages between twenty nine and thirty two (28%), and students older than thirty two years old (25%). The schools and departments where they were doing their research were mostly technical (engineering) and science ones. Furthermore, their research experience at a PhD level was less than two and a half years at a percentage of almost 60%, between two and a half and five years at a percentage of 27%, while almost 13% of the participants have more than five years experience. Around 65% of the survey participants has up to two years of work experience at a job related to their research subject, while more that 59% had obtained a Masters degree before been enrolled at the PhD program. Furthermore one out of four students participating in the survey had an educational experience in a country other than Greece. The funding sources of the people questioned vary, with more than six out of ten having as their main funding source a non-university job, while the 34% of the participants are funded by parent and family funds, 8% by a scholarship and 9% by University funds. In addition, the 62% of the participants work in the private sector together with their PhD research. Finally, 66% of the people questioned feel that a PhD degree is a substantial, and probably the most important, step towards the career they would like to follow.

## 4. Presentation of the major survey findings

### 4.1 The funding problem

The major problem indicated by almost every survey participant is insufficient research funding. According to the survey, research and academic programs do not receive adequate governmental funding, something that results to part-time PhD studies for most of the students, because of their need to cover living expenses. This is illustrated by the fact that more than 65% of the participants responded that they are supported by their family, working at the private factor full-time, or they are having evening part-time jobs together with their doctoral research commitments, and only 16% of them is studying on a scholarship or is employed by the University as a Research Assistant (Fig. 1).

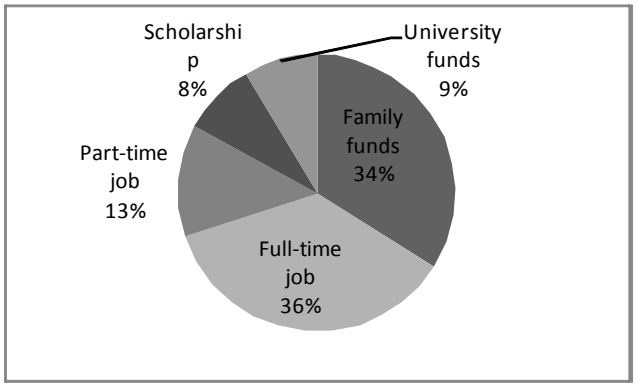


**Fig 1:** Funding sources of AUTH PhD students

Furthermore, survey answers indicate that very little funding is provided by AUTH to PhD students for covering other research needs like book and educational material purchasing, conference registration fees and subscriptions to scientific

organizations. Almost six out of ten respondents claim that they "frequently" use personal funds to cover the above mentioned expenses which are usually very high.

## 4.2 Facilities and infrastructure

Another important difficulty, according to the survey participants, is the one caused by University facilities, student offices, laboratories, and available equipment. Many students indicated the problem of the unavailability of a designated space for doctoral students (student offices) in many AUTH departments. From the people surveyed, only one out of four indicated that research facilities, labs and equipment are "adequate", with the rest 75% considering facilities and infrastructure as "average" or "poor". Furthermore, despite the fact that more than eight out of ten have no problems with finding the bibliography needed for their research, only one out of two is satisfied with the bibliographic updating of the AUTH library system. Finally, and in the question "Do you believe that AUTH provides its PhD students all the required "tools" to complete their research" a percentage close to 80% replied in negative manner.

## 4.3 Research Supervision

On the research and thesis supervision issue, 65% of the answers indicate that the main supervisor of a PhD research (and thesis) can easily be found, but on the other hand more than seven out of ten respondents state that they have important difficulties on defining the main subject of their doctoral research. Many AUTH students believe that their supervisors-advisors do not provide them with the needed mentoring and guidance. In addition, one out of five people surveyed indicated personal problems with their supervisor, and almost 45% said that they have problems with the supervisor's availability for meetings. Finally, almost half of the respondents replied that except from their main supervisor their research progress gains little attention from the rest of their supervising committee, with 23% saying that the rest of their committee is generally not available, and 18% claiming that they have no relationships at all with them. A summary of the main supervising problem sources is illustrated at the Figure 2 below.

In the questions regarding AUTH faculty training and scientific qualifications more than seven out of ten participants answered that the quality of faculty is "high" or "excellent". Another interesting survey finding is that almost 67% of those considering the faculty's scientific qualifications as "average" had some educational or research experience at a country other than Greece, and 30% have personal problems with their supervisor. Moreover, almost 90% of those considering the faculty's scientific qualifications as "average" have problems (or no relationships at all) with their supervising committee.

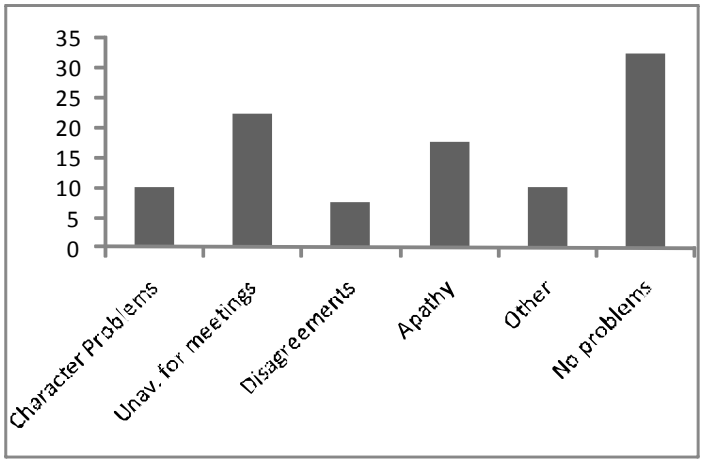


**Fig 2:** Sources of supervising problems

## 4.4 Motivation

Furthermore, motivational issues are considered to cause great upsets and difficulties while conducting PhD level research. Almost 34% of the people questioned feel less motivated from the time when they started doing their research, while the motivation of four out of ten surveyed has "remained stable".

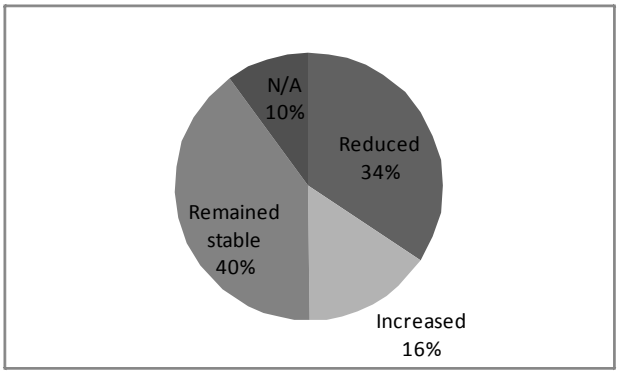


**Fig 3:** Advancement of motivation for PhD research

Finally, it is indicated that from the students who have personal or cooperation problems with their supervisors almost 67% have lost their motivation for research.

## 5. Discussion on the research findings

By analyzing the survey findings, conclusions could be drawn about the difficulties PhD students in AUTH have and recommendations could be made in order to refine graduate work at a doctoral level. As it was previously indicated, the major problem illustrated by doctoral students was that of research funding and the fact that very few students are getting any economic boost from the University. More than half of the participants working together with their research stated that their motivation, time and courage to conduct research have been diminished because of the psychological pressure, fatigue and lack of time cased by the conflict of their research and work duties. The majority of students who participate in research

programs funded by the University, the Greek Government, the European Union Research Committee or other private institutions and organizations are receiving some kind of salary from the programs' funds, but most of the times the subject of that research program has nothing to do with the subject of the students' PhD thesis. The above can create time-management problems to doctoral students who have to balance their everyday workload between the research program and their own individual research. Consequently, it is easily understandable that lack of funding can seriously affect some students' research, and result in serious concerns and their deep frustration (Holdaway et al., 1995).

The ideal situation for PhD students could be that of a regular University pay-roll by being appointed as research assistants and teaching assistants or by receiving more scholarships for conducting research. Furthermore, students should be relieved from scientific expenses like subscriptions to scientific organizations and federations, conference participation, the purchasing of research-related books and others. It is sad to consider those costly actions needed at times when the world economic crisis has caused so many difficulties in the economy of the European Union and particularly in Greece. Despite the above, education is considered to be one of the stepping stones of our society and ways to economically support it should always be found. It is obvious that much work towards the direction of the University research economic boosting should be done, and further measures should be taken in order to overcome the funding difficulties which PhD research at AUTH faces.

Furthermore, facilities and infrastructure of the Aristotle University are considered by its students to be "poor" or "average" at a percentage of almost 75%. In addition, it was stated that the number of laboratories, and facilities designated for experimental research is quite limited when compared to the number of researchers who have to use them. Consequently, laboratories are not always available something which defers PhD research projects and University progress in general. Moreover, one out of two students participated in the research were not satisfied with the bibliographical updating of the University's library system. According to the participants' statements, most of the departmental libraries do not have adequate collections of scientific books and journals. In addition to the above mentioned facility problems, many PhD students indicated a problem of space in their department facilities, with more than the one third of the people questioned state that there is no space for PhD student offices. The above mentioned issues are probably the main reasons why the 80% of the participants think that AUTH does not provide them with all the needed "tools" for successfully completing their research. There are few actions that can be done for facing the infrastructure and facility difficulties PhD students have indicated. It is true that buildings and facilities of the AUTH campus have problems and can be rebuild, laboratories can be expanded and modernized, and collaborations with other institutes can be formed. All the above need an extensive amount of time, and more important much funds to be spent from the Greek Government, funds which are difficult to be found.

Starting a research degree marks a transition in the lives of students (Phillips and Pugh, 2000), and in order for this transition to be successful, a good morale and strong motivation are demanded. From the doctoral students questioned, almost 34% stated that they face motivational problems. Additionally, the fact that the 67% of the students having "low" or "stable" motivation also have problems with their supervisors illustrates how important supervising is for completing a successful doctoral research. It is also a fact that many AUTH doctoral students can

be considered to be on a part-time status and as other researches state: "Part-time doctoral students have a range of support needs and these are often complex and interwoven with their 'other' roles beyond that of student" (Watts, 2008). For the above reasons, it is a very intense need to effectively face supervising problems and also improve student mentoring and advising, in order to always keep doctoral students motivated. It is probably a fact that most students undertake a doctorate as an education rather as a training (Leonard et al., 2004), and for covering their needs, and in the same time promoting the educational function of research it is important for supervisors to expand their repertoire of skills as educators and leaders (Pearson and Brew, 2000).

## 6. Conclusions

Education and research are two extremely important aspects of modern society. Though, world economic problems and unique difficulties of each institution have created difficulties mostly in conducting academic and PhD level research. The difficulties doctoral students face in Greek Universities vary, and can be unique for each individual, but it can be claimed that the problems this research revealed are a reality for the majority of PhD students mostly because they are caused by organizational problems, poor funding and inadequate facilities, problems which are a reality for the Greek academic system as a whole. In an attempt to highlight the major findings of the conducted survey, it can be stated that insufficient funding for PhD research, facilities and infrastructure problems, and low motivation for doctoral research are the difficulties indicated by most participants. Furthermore, actions should be taken for improving AUTH infrastructure, motivating University students and faculty, and finding a way to include the majority of doctoral students in a regular pay-roll in order to promote research in Greek Universities. In addition, due to uniqueness of the Greek educational system, it is very difficult to use models from other countries for improving the current conditions under which PhD research is conducted. The most applicable solution for facing the difficulties mentioned in this paper seems to be the initiation of a new three way dialogue between PhD students, members of the academia, and the Greek Government. This dialogue should have as its main subject the research in Greek Universities at a PhD, experimental and productive level. Key improvements can be introduced and a whole new research framework can be proposed in order to promote knowledge and education, and improve the conditions under which PhD research in Greece is conducted.

In order to expand the conducted survey and to have a more holistic approach of the PhD research difficulties of doctoral candidates, a new survey which would also examine the faculty views is proposed to be conducted. The present paper has as its limitation that it extracted conclusions only by considering students' options and not taking under consideration faculty views. Thereby, the conclusions drawn were only from students' perspective. By conducting a survey among PhD research supervisors and combining the results of those two different surveys, the academic community could track different opinions which could lead to safer conclusions about the difficulties Greek Universities face, and the actions that need to be taken for materializing students' and supervisors' ideal research projects. Moreover, and having in mind that there are more than 18,000 PhD students enrolled in Greek Universities, the results of the present paper need to be validated by a survey which could cover the biggest part of the doctoral student body of Greece and could though generate safer, and more detailed results.

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*W06*

# The difficulty of introducing the main subject of a PhD research

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## Abstract
It is widely accepted that the definition and selection of a PhD research project is a very important and complex procedure. Particularly in Greece, where PhD studies are mostly supported by private (student) funds, doctoral studies have become not only a difficult but also a very expensive process. This paper examines the Aristotle University of Thessaloniki case study in order to explore the difficulties a doctoral student has to overcome for defining and organizing a PhD research project. To extract conclusions, a survey among active doctoral students was conducted. The generated results can help us find the roots of the problem of designing and defining the subject of a PhD research. The data analysis provides findings which try to answer questions about communication issues between PhD student and supervisors, the difficulty of organizing and designing PhD research projects, and the feasibility of making one's ideal research come to life.

## Keywords
PhD research, Subject definition, Research organizing, Communication, Survey

## 1. Introduction

It is common knowledge that conducting a PhD research is a difficult procedure with many obstacles that need to be faced for concluding it. Probably the most important of the obstacles a PhD candidate has to overcome is that of introducing and defining the main topic of the doctoral research (Kane, 1985). That topic definition is of such importance because it will follow the student until the completion of the PhD degree, and also because the selected topic should be capable of helping the student make an original contribution to the chosen field and attain the necessary experience to continue to do so (Council of Graduate Schools, 1990, p. 1).

Except from the students' difficulties it is also challenging for the supervising committee to provide guidance and a well defined methodology to the candidates for conducting their doctoral research (Hughes, 1994). Much research has been done on that student-supervisor relationship (Phillips and Pugh, 2000), and recommendations on managing PhD research projects have been proposed (Howard and Sharp, 1983). In addition, many researchers support that for finding and establishing a working relationship with a supervisor, the student has to master knowledge and reconcile conflicting methods before placing the research in the context of literature and originality (Golde and Gallagher, 1999, Haksever and Manisali, 2000). The above mentioned reasons clarify that introducing a PhD research topic is not an easy task. The present paper aims to examine the Aristotle University of Thessaloniki (AUTH) case study in order to explore the difficulties students enrolled at Greek Universities have for organizing a PhD research project and for finding the needed supervision. The findings' analysis illustrates the difficulty of organizing a PhD research along with communication issues, difficulties

for defining a research topic, and the feasibility of making one's ideal research come to life.

## 2. Method

To collect the needed data for exploring the difficulties of defining and organizing a PhD research project, a survey was conducted during the academic year 2009-2010. The participants were more than 60 active PhD students studying at various departments of AUTH. The survey asked for multiple-choice answers to questions, but also permitted many text comments in order to help the individuals describe their unique situation without being confined from standardized answers. After the collection of data, the survey findings were analyzed in order to have a clearer picture about PhD research in Greece from the scope of students/researchers. The major findings of the conducted research are presented below followed by a discussion on their analysis.

## 3. Demographics of research

Most of the PhD students who participated at the survey were between twenty four and twenty eight years old (47%), followed by students with ages between twenty nine and thirty two (28%), and students older than thirty two years old (25%). The schools and departments where they were doing their research were mostly technical (engineering) and science ones. Moreover, their research experience at a PhD level was less than two and a half years at a percentage of almost 60%, between two and a half and five years at a percentage of 27% and almost 13% of more than five year experience at doctoral research. As for their work experience, a percentage around 65% of the survey participants has up to two years of work experience at a job related to their research subject, while more that 59% has obtained a Masters degree before been enrolled at the PhD program. Furthermore one out of four students participating in the survey had an educational experience (Masters or Bachelor degree) in a country other than Greece before starting their doctoral research. The funding sources of the people questioned vary, with more than six out of ten having as their main funding source a non-university job, while the 34% of the participants are funded by parent and family funds, 8% by a scholarship and 9% by University funds. In addition, the 62% of the participants work in the private sector together with their PhD research. Finally, 66% of the people questioned feel that a PhD degree is a substantial, and probably the most important, step towards the career they would like to follow.

## 4. Survey findings

### 4.1 Subject initiation difficulties

Survey participants indicated that defining the main subject of their PhD research is one of the most important difficulties they face during their studies. Specifically, 72% of the questioned students answered that the selection of their PhD research subject was a "difficult" or "very difficult" procedure, and indicated as the most important of their concerns the "originality" of the selected subject. Despite the above fact only 35% had difficulties in finding a faculty member who could act as supervisor for their doctoral research project and thesis writing, while from the rest who found supervisors with no particular difficulties, around 68% found it "difficult" or "very difficult" to introduce their research subject. Furthermore, one out of three

PhD students surveyed selected their subject after their supervisor's urging, while almost 60% defined their subject after having a specific research interest and in cooperation with their supervisor. Moreover, a 22% of the PhD candidates had difficulties in finding bibliographic references for writing their research proposal, and almost half of the survey participants are not satisfied with the bibliographic updating (journals, papers, books, electronic resources) of the University library system.

## 4.2 The effect of students' background

The doctoral students' qualifications seem to play an important role in the selection of the main PhD research subject. Nine out of ten respondents with no working experience in an area relevant with their PhD research found "difficult" or "very difficult" the subject selection in contrast with those who had years of working experience and did not met such difficulties. Furthermore, more than half of the respondents who did not have a Masters degree when enrolled at the PhD program had difficulties in introducing the main subject of their research.

People with an interest in a specific research area had important difficulties in defining and organizing their PhD research project. More than half of them had problems with introducing the subject, while two out of three had also difficulties in finding a supervisor for the research they would like to do. There were also some doctoral students who are pursuing their PhD degree only for boosting their curriculum in order to find better job at the private sector and not because of a particular academic or research interest. Those people neither met any important difficulties in finding a supervisor, nor in finding a research topic, nor in organizing their research project.

## 4.3 Organizational and supervising difficulties

Finally, by answering questions about the difficulties of organizing and materializing a PhD research project, students indicated some very important issues. The supervisor's unavailability for frequent meetings seems to be one of the most important difficulties doctoral students meet. It was also stated by many students that communication problems between them and their supervisors were making the research project initiation an even harder process, and consequently organizational difficulties were coming up. Additionally, almost 10% indicated that the professional relationship between them and the research supervisor is "not satisfying" while another 10% described that relationship as "neutral". Almost half of the respondents stated that they have communication problems with their supervisors, or they could not get in contact with them when needed. Respondents with such problems indicated their need for more step-by-step guidance from their supervisor in order to form a methodological basis for their research. The above in combination with the incapability of some academic departments to conduct heavy experimental research are making the implementation of some kinds of PhD research unfeasible, and the materialization of some students' initial ideas unattainable.

# 5. Discussion on the research findings

It was clearly illustrated at the survey findings that the initiation of a doctoral research subject is considered (at a very high percentage) to be a very challenging and difficult procedure, but the clear definition of a PhD research project is an

essential prerequisite for success (Hughes, 1994). By asking them to detect the most important difficulty in that subject definition, most of the respondents answered the "originality" of the subject. In order for PhD students to make an original contribution to their chosen field, a unique and original research must be conducted, and this could be very difficult without proper supervising and guidance which could shape and change the scientific personality of a student (Golde and Gallagher, 1999).

Furthermore, students with difficulties finding a supervisor did not meet many difficulties in finding a research subject in contrast with the 68% of doctoral candidates who had problems with project initiation but not with finding a research supervisor. The above reveals that, at least in AUTH, the effort needed to define a doctoral research subject and the supervisor selection are two issues that are not directly and completely related. Survey data support the notion that many PhD students select thesis subjects which are not connected with their research interests, just because they can be involved in a funded research project, or because their supervisor's interests urge them to select specific research subjects. In addition, only a few funded research programs exist in Greek Universities' departments and schools, programs which are rarely connected with PhD research projects. The above can create time-management problems to doctoral students who have to balance their everyday work-load between the supervisor's research program and their own individual research. For the above reasons it is very common for Greek doctoral students to personally fund their studies or find someone to provide them with the money needed to cover their living expenses. It is claimed that around 90% of the Greek Universities PhD candidates are self-funded, or funded by their family and parents. That situation is not common in other countries like the United Kingdom, USA and Switzerland where PhD students are funded by the Universities' scholarships, or are under a salary from the research programs' funds. Consequently, doctoral students at many other countries do not face particular problems in defining their PhD research subject because they are not the ones who select it. By participating in a funded research or by being funded by their supervisor's research funds they are usually being assigned a PhD research subject that could not be easily changed or modified, in contrast to Greek institutions where candidates usually select their research subjects by themselves and with some minor support from the University faculty.

Another important issue illustrated by the collected data is that of student difficulties in finding bibliographic references for writing a research proposal. Many PhD candidates have to submit a research proposal to their future advisors before being officially enrolled at the PhD program. This proposal has to be accompanied with related references and bibliography which is difficult to be found if access in the library system and it e-resources is not granted to not officially enrolled students. For that reason, it could be recommended that PhD students should be asked to submit a research proposal only after they are officially admitted at the PhD program. In a different case it is recommended that a not enrolled student should be granted temporary access to the University's library systems in an effort to promote the reception of the required scientific knowledge.

The combination of students' professional qualifications with their answers on difficulties of subject introduction generated some very interesting findings. Survey results reveal that professional experience works in favour of the subject selection. Only 40% of doctoral students with professional experience had problems with finding a subject for their thesis while that percentage rises to 90% for students

with no such experience. Furthermore, having a Masters degree before starting PhD research probably has the opposite results of having professional experience. It can be noted that doctoral students with a Masters degree tend to find more difficult the introduction of a PhD main subject compared to candidates without such a qualification. It could be claimed that the specialization offered by a Masters degree makes candidates narrow their research interests and options and consequently the selection of a research supervisor or a PhD subject a more difficult procedure. Though, the above conclusion is thought to be very risky because it is depended upon a very small statistical sample which can often generate conflicting results.

Moreover, a contrast between students with pure research interests and those who selected a subject only for enhancing their professional qualifications is quite obvious. It is reported that a doctoral candidate with little research and scientific interest is more comfortable with making recessions for finding a supervisor and also for selecting a subject which would not probably apt directly to the initial research idea he/she had in mind. As stated before, the PhD research subject selection is a very important decision, having as one of its most critical aspects the existence of a pure interest from the students-researchers for the conducting research in order to be motivated and timely conclude with their doctoral studies. On the other hand, it could be advocated that other motives except research interest can urge doctoral students to effectively work on their research, with some of those motives being professional incentives, a better salary or a qualification which could enhance their prospects of employment or promotion, and more (Leonard et al., 2004, and 2005). In Greece though, it is a fact that (according to the Greek Scientific Association of Doctoral Candidates and the National Statistical Service of Greece) professionals with a PhD degree only receive approximately 14% higher salaries than professionals with only a Masters degree. In addition, it is very common for PhD holders to work in sectors irrelevant with their doctoral research subject mostly because of the Greece high percentage of unemployment, and the existence of limited opportunities for working in research institutes and for University appointments almost in every scientific area. It is also widely accepted that despite the intense interest of students to pursue a PhD degree, the faculty position openings in Greek Universities are generally very limited when compared with other European countries, something which results in the existence of more PhD holders than those demanded to cover the possible Greek academic system needs.

As for the organizational difficulties a doctoral student can meet, the advisor's unavailability for meetings seems to be the most concerning one. That difficulty in setting up meetings could make PhD students think that the advisor may be indifferent, and consequently demoralize them and cause research organization problems. Furthermore, communication difficulties along with professional relationship problems can disrupt the harmony between students and supervisors and cause personal disharmony which can lead to an early termination of the supervision process (Russell, 1996, Li and Seale, 2007). PhD students can easily lose their motivation for studying or conducting research and for that reason the appropriate step-by-step guidance and advising is needed from the supervisors' side.

Additionally, researchers have indicated, that one of the most serious worries of students is the case of bad supervision (Haksever et al., 1994). For avoiding such a case supervisors should be communicative, approachable and understanding, and also have the experience, knowledge and familiarity with the processes of PhD

research (Hughes, 1994). Finally, students should effectively manage their professional learning, discuss their expectations with the supervisor, report their difficulties, and cooperate with their supervisors on organizing, defining and materializing their PhD research project (Hughes, 1994, Phillips and Pugh, 2000).

## 6. Conclusions

Introducing the main subject of a PhD research could be a very challenging and complex procedure, and according to some doctoral students probably one of the most complex problems they would have to solve during their student life. In order to face such a difficulty, a strong collaboration between the candidate and the supervisor has to be supported by effective and intense guidance, advising and mentoring. Probable communication and professional relationship problems should be solved before they become reasons for demoralization and thus for early termination of research projects and collaborations. Consequently, there is a very intense need to effectively face supervising problems and also to improve student mentoring and advising, for always keeping doctoral students motivated. Furthermore, and in order to minimize supervisors' unavailability for meetings, motivating University faculty is also needed along with an improvement of the University's facilities and laboratories. Moreover, the formation of affiliations with other Universities and research institutes could be very helpful in order for the University to be able to conduct heavy experimental research and so give PhD candidates more options when trying to define their research subject.

In addition, students' background may have an important role in the easiness with which someone can define and organize a PhD research. The research has shown that having related work experience before entering doctoral studies could help the candidates initiate the subject of their research and also make them understand the importance of the subject selection procedure. It is though recommended that working experience and academic qualifications of PhD candidates should be seriously considered for their acceptance at the University's PhD programs.

While concluding this research paper, it has to be stated that it is probably "unfair" for the University faculty and staff to extract conclusions by taking under consideration only the student's views on the subject. The opinion of academic supervisors (which were not included in the present paper) could indicate more and different difficulties than those indicated by the PhD students. For the above reason and in order to have a more holistic approach of the PhD research subject introduction difficulties, a new survey which would examine the faculty views is proposed to be conducted. Thereby, by combining the results of two different surveys, the academic community could track the different opinions which could lead to safer conclusions about the difficulties Greek Universities face, and the actions that need to be taken for materializing students' and supervisors' ideal research projects.

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*AA020*

# Assessing The Procurement Process In Greece's Construction Projects

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## Abstract
The aim of this research is to assess the application of recent Legislation towards sustainable procurement in Greece with special attention to the construction industry. A questionnaire survey of twenty seven experts (construction managers, industrial and academics) was carried out in order to investigate the awareness level and the constraints of sustainable procurement practices, and to record the procurement practices implemented in the Greek construction industry. The findings indicate that although sustainability criteria are recognised as essential their use is limited.

## Keywords
Construction industry, sustainability, procurement practices, questionnaire survey

## 1. Introduction

Sustainability means meeting the needs of today without compromising the ability of future generations to meet their needs (Brundtland report, 1987). Sustainable Construction is a building methodology that promotes the attainment of goals associated with the next "quadruple bottom line". In achieving these goals to improvement and enhancement of the procurement and project delivery systems employed by private owners and government clients is considered necessary. Recent public awareness brought in to attention laws and regulations in Greece according to sustainability goals. Specifically, in conformance with recent laws and regulations and in achieving the required high performance standards for sustainable construction the procurement process is considered the key point in all the stages of life cycle i.e. the process that spans the whole life cycle, from identification of needs, through to the end of the useful life of an asset

The fundamental principles generally applied in the field of public procurement in Greece, include those laid down in the EC Treaty, and relevant secondary Community legislation (public procurement Directives). Among those are the principles of equal treatment, non-discrimination, transparency, proportionality and mutual recognition.
The following Community Directives on public procurement have been implemented in the Greek legal system:

- Supplies Co-ordination Directive 93/36/EEC which is actually amended by European Parliament and Council Directive 97/52/EC and Commission Directive 2001/78/EC
- Works Co-ordination Directive 93/37/EEC amended by European Parliament and Council Directive 97/52/EC and Commission Directive 2001/78/EC

- Services Directive 92/50/EEC amended by European Parliament and Council Directive 92/57/EC and Commission Directive 2001/78/EC
- Sectoral Directive 93/38/EEC amended by Directive 98/4/EC of the European Parliament and of the Council
- Remedies Directive 89/665/EEC and Sectoral Legal Remedies Directive 92/13/EEC

Public procurement Directives have been implemented in Greek legislation by Presidential Decrees 370/95, 105/2000 334/2000 and 336/2002, 346/1998, 18/2000, 101/2003 and 2854/2000
In the Greek legislation there are also specific laws regulating works and design contracts below the threshold of Council Directives 93/37/EEC and 92/50/EEC. The main legislation in question is:

- For works: Law 1418/1984 as amended by Law 2229/1994, and Presidential Decree 609/85
- For design contracts: Law 716/1977.
- For design contracts and relevant consulting services: Law 3164/2003

In cases of contracts below thresholds of the Directives and where there is no other particular law provision, the framework set in the Directives is implemented in substance..

## 1.1 Institutional framework

The institutional framework for public procurement in Greece consists of three Ministries each one responsible for one sector according to the division of the classical Directives:

- Ministry of Economy and Finance which is responsible for public procurement of services (Directive 92/50/EEC), and Ministry of Environment, Physical Planning and PublicWorks which is responsible especially for design studies services;
- Ministry of Development which is responsible for public procurement of supplies (Directive 93/36/EEC);
- Ministry of Environment, Physical Planning and Public Works for public procurement of works and construction contracts (Directive 93/37/EEC);

For the utilities sector (Directive 93/38/EEC), again the above competent Ministries are responsible depending upon the sector of responsibility of ach Ministry.
The above mentioned Ministries co-ordinate their action for the government of procurement policy and for the preparation of the legislative framework as well as the incorporation of Community legislation in the Greek legal system.

## 1.2 Sustainable procurement

Recent awareness for the scarcity of resources in Greece has emerged the adoption of green products and Sustainable Procurement services Sustainability as a concept is most widely known in relation to sustainable development.
Sustainability is important for every sector of industry but merely in the construction industry because the facilities we construct have a huge impact on the environment. These facilities make use of natural resources during the construction stage and leave man-made footprints in the ecological environment and they are also our interface to the natural environment, protecting us from the elements and meeting the needs of humanity for shelter, status, and other functions.
As a result there is a pressure in order to make these facilities more sustainable, through sustainable construction, is the demand to meet the needs of society without compromising the needs of others or jeopardizing the future survival of humanity on earth.

Sustainable construction is defined as (Chan et al 2001)'the set of processes by which a profitable and competitive industry delivers built assets: building structures, supporting infrastructure and their immediate surroundings, which:
- Enhance the quality of life and offer customer satisfaction,
- Offer flexibility and the potential to cater for user changes in the future,
- Provide and support desirable natural and social environments,
- Maximize the efficient use of resources while minimizing wastage'.

Sustainable construction comprises construction procurement (i.e. new construction, refurbishment work and maintenance), operation and demolition of constructed work. It encircles such matters as tendering, site planning and organization, material selection, recycling and waste minimization (Chan et al 2001)

The general framework for implementing sustainability in construction has to deal with the procurement selection with respect to materials and services. It is claimed that the correct choice of a construction project delivery method will lead to the success of the project and as a result selecting an appropriate procurement system is an essential step in any construction project process (Love et al 1998). A construction project may be regarded as successful if it fulfils the following requirements: it is delivered at the right time, at the appropriate price and quality standards, and provides the client with a high level of satisfaction. The most important influence on the above requirements is the type of procurement method implemented which determines the overall framework and structure of responsibilities and authorities for participants within the whole construction process. The selection of the most suitable procurement method consequently is critical for both clients and project participants, and is becoming an important issue within the construction industry Watuka and Aligula (2003).

## 1.3 Comprehensive approaches to Sustainable Procurement at national level

In Greece national legislation on procurement refers only to public procurement compatible with Community law. The existing legislative framework offers possibilities to integrate environmental considerations into public purchases, notably when defining the technical specifications, the selection criteria and the award criteria of a contract (e.g. Directive 93/96-14-4-1993 and Presidential Decree 370/1995, Presidential Decree 394/1996) (Karanastasis 1998).

A questionnaire survey of twenty seven experts (construction managers, industrial and academics) was carried out in order to investigate the awareness level and the constraints of sustainable procurement practices, and to record the procurement practices implemented in the Greek construction industry.

The paper is organised as follows. In the next section issues of sustainable procurement are presented followed by the stages of the procurement process are outlined. In the following section the methodological framework concerning the preparation of a questionnaire survey in developing procurement selection criteria in the case of Greek construction industry is presented. The results are presented in the next section. The final section draws the conclusions of the paper.

## 2. Background

The procurement process is viewing as a cycle (IDALG, 2003) in order to emphasise the development of a business case. The stages of the procurement cycle are (IDALG, 2003).
- Identifying needs
- Development of business case
- Definition of procurement approach
- Supplier selection
- Tender evaluation
- Award and implementation of contract
- Management of contract
- Closure/lessons learned

The first stage of the procurement cycle is to identify needs. Identifying needs has to do with the alternative options for satisfying the needs of a user group which can be significantly different from the current solution. The business case deals with the identification and appraisal of alternative options and the establishment of value for money. The business case can be summarised as: achieving strategic objectives; complying with environmental law; controlling costs; managing risk and reputation; creating markets; ensuring security of supply; ensuring maximum community benefits. The definition of procurement approach comprises the specification of requirements and the update of the business case. The supplier selection has as outcome the short-list of suppliers, though tender evaluation comprises bids evaluation, confirmation of successful supplier and updating of the business case. The stage of award and implement contract includes the preparation of service delivery. Management of contract deals with the serviced delivered, benefits achieved and, value for money maintained. The final stage (Closure/lessons learned) deals with the preparation for future arrangement and review and updating of the business case.

### 2.1 Challenges for green procurement

Challenges for green procurement have emerged as a result of the international and national The challenges for green procurement selected for consideration are presented in Table 1 (IDALG, 2003).

#### 2.1.1 Price

Green products are deemed to be more expensive than conventional alternatives, which is true in some cases, particularly where development costs are reflected in the price. However, very often there is no significant difference between green products and conventional alternatives because a green product may have a higher up-front purchase price, but will cost less over its lifetime.

#### 2.1.2 Lack of corporate commitment

The implementation of a green procurement programme, requires commitment from all levels of an organization, including senior management and purchasing agents.

### 2.1.3 Insufficient knowledge

It is essential for an organization to have an understanding of concepts and relevant terms.

### 2.1.4 Availability

Delays in obtaining green products may occur because distributors do not stock them or else they stock only small quantities of them due to low market demand.

### 2.1.5 No acceptable alternative

Lack of acceptable alternatives to a present product can be a barrier. construction industry's response to sustainable construction.

### 2.1.6 No specifications

On one hand purchasers must clearly define their needs and requirements, though on the other hand suppliers must be asked to provide the environmental specifications of their products.

### 2.1.7 Purchasing habits

Purchasing habits have to do with change management, which is important in order to overcome existing relationships between purchasers and suppliers that make it difficult to switch to alternatives and change the purchasing process.

### 2.8 Strategy development

It is essential in order to implement a green procurement programme and aims to identifying changes, suitable products and services, and evaluating the environmental performance of suppliers.

## 3. RESEARCH METHODOLOGY

### 3.1 Research Design

Survey research adopted for this paper in order to obtain information on procurement practices in Greece by asking people (i.e. persons employed in firms, organizations/authorities) about their perceptions. The target population in survey was 27 firms and their distribution is presented in Table1.

| Type of Firm | Number |
|---|---|
| Industrial | 7 |
| Educational | 4 |
| Construction | 16 |
| Total | 27 |

Table 1. Participants

The response rate was 66 %, i.e. 18 questionnaires were returned, representing and these were used in the analysis presented in the following section.

## 3.2 Development of the questionnaire

The questionnaire refers to the challenges for green procurement that have emerged as a result of the international and national construction industry's response to sustainable construction. The challenges for green procurement selected for consideration are those presented above.

Persons employed in target population (Table 1) were asked to answer the following questions:
**Question 1.** Do you think that green products are more expensive than conventional alternatives? (Yes, No)
**Question 2.** Do you think that the knowledge in a use of a green product is sufficient? (Yes, No)
**Question 3.** Can you purchage green products easilly as for instance local distributors or you face delays in purchaging green products Easily_ difficulties_
**Question 4.** Did you find lack of acceptable green product alternatives to the present products? (Yes, No)
**Question 5.** Do the suppliers provide the environmental specifications of the products they are offering? (Yes, No)
**Question 6.** Do you think that purchasing habits and relationships between purchasers and suppliers that make it difficult to switch to alternative green products? (Yes, No)
**Question 7.** Is it in your business goals a systematic review of the green procurement programme to be carried out? (Yes, No)
**Question 8.** Where do you find more difficulties in implementing green products procurement? Select one of the following:
1. Organizational support (Implementing a green procurement programme means changing policies and procedures).
2. Self-evaluation: An important step in implementing green procurement is conducting an evaluation of present purchasing practices
3. Set goals: A broad policy should be established, and specific priorities and targets set.
4. Develop a strategy: It is now to time to identify and implement changes, both short and long-term, identify suitable products and services, and evaluate the environmental performance of suppliers.
5. Assignment of accountability, plan addressing employees, customers, investors, suppliers and the public.

## 4. Results

All the participants think that green products are more expensive than conventional alternatives. A percentage of 66.6% think that the knowledge in a use of a green product is sufficient. Only 27% think that green products easily can be purchase from local distributors while the rest 78% think that purchasing is having difficulties. A percentage of 61% find lack of acceptable green product alternatives to the present products all the participants say that suppliers provide the environmental specifications of their products they are offering. A percentage of 78% think that purchasing habits and relationships between purchasers and suppliers that make it difficult to switch to alternative green products.
Difficulties in implementing green products procurement are ranked as follows:
1. Develop a strategy
2. Set goals.
3. Organizational support

4. Self-evaluation
5. Assignment of accountability, plan addressing employees, customers, investors, suppliers and the public.

## 5. Conclusions

In order to investigate the awareness level and the constraints of sustainable procurement practices, and record the procurement practices implemented in the Greek construction industry a questionnaire survey of eighteen experts, mainly consultants and contractors, was carried out in order to obtain experience of the above issues concerning procurement practices in the Greek construction industry. The findings indicate that although there is a sufficient knowledge in the use of green products associated with sustainable procurement practices implemented in the Greek construction industry the use of green products is limited due to barriers such as product price, purchasing habits and relationships between purchasers and suppliers.
The results of this research indicate that the most important factors concerning the implementation of procurement practices in the Greek construction industry were strategy development, goal setting and organizational support.
Based on the findings of this paper, a number of measures could contribute in initiating the process of entrenching green procurement in the Greek construction industry. These measures can be classified into two broad categories related to general or specific policy (i.e. construction policy): a) General policy measures and b) Construction policy measures
The general policy measures should focus on the development of existing legislative framework for integrating environmental considerations into public procurement.
Construction policy measures should include an appropriate legislative framework regarding sustainability in construction. The legislative framework regarding sustainability in construction should be revised in order to encourage the use of green products supporting not only the procurement process but all the stages of the whole procedure towards sustainability.
We conclude that future research should be conducted using the same or other more extended questionnaires and should involve a comparison of the results with those of other methodological approaches. Alternative methodological approaches for identifying the above factors towards green procurement would be the Delphi technique and/or the analytical hierarchical method using pairwise comparison.

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# A multi-faceted approach to construction scheduling research

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## Abstract
Although extensive research has been conducted for the development of an algorithmic project scheduling methodology allowing optimal resource allocation and cost control, it has been realized that in real-life situations a pure analytical approach may not be enough. In the current complex and multi-cultural project execution environment behavioural and contextual issues should also been taken into account. As such, issues relating to the organizational structure, personnel training, negotiation skills and the legal, financial and political context may affect project scheduling beyond the modelling abilities of pure algorithmic approaches. To this extent, the aim of this paper is to review the effectiveness of various research methods in the construction project scheduling process. In particular, the adequacy of quantitative and qualitative research methods in issues pertaining the algorithmic formulation, behavioural issues and contextual aspects of construction scheduling is examined. Special attention is paid to the differences between the analytical formulation of the problem and human factors in the project context. It is concluded that a multi-faceted methodological approach is required consisting of both quantitative elements and qualitative ones based upon the fundamentals of social and economic sciences.

## Keywords
Construction Project Scheduling, Quantitative Research, Qualitative Research

## 1. Introduction

### 1.1 Methodological debate in construction management research

The debate for finding the most appropriate research methodology in construction management has occupied the academic community for many years. At the heart of this debate lie two opposing philosophies: that of rationalism and of interpretivism. The research community in the construction industry is dominated by methodological assumptions of the rationalist paradigm, which draws a distinction between subjective experience and objective reality. At the other end, the interpretative approach refers to understanding another's point of view, rather than a pure causal understanding which is the aim of the rationalist approach (Seymour and Rooke (1995)). Therefore, quantitative research methods which emerge from rationalism gather factual data and study the mathematical relation between facts. However, qualitative methods, which emerge from interpretivism, focus on the

quality of the phenomena being investigated rather than numerous measurements (Sutrisna (2009)).

## 1.2 The need for methodological pluralism

The use of methodological pluralism in construction management research is suggested as an alternative to strictly adhering to a single research philosophy. Raftery et al. (1997) advocate that researchers in the construction field should conduct research by defining the problem and then applying the most appropriate method chosen from an unconstrained and wide range of available approaches. Triangulation and multi paradigmatic approaches should be used in construction management research since the field is too wide and diverse to allow the adoption of the simple mono-method approach. Wing et al. (1998) argue that construction management problems (which encompass economic issues) are multi – faceted. Therefore, it is difficult to accept that a single research method is appropriate to all research problems. The fundamental problem concerning construction management is that of explaining and predicting human behaviour. The way forward is through methodological pluralism and paradigm diversity. It is clear that all established research methods and approaches in both the quantitative and qualitative fields have a contribution to make at various points in the process, depending upon the existing body of knowledge in the specific area under study, the objectives and perspectives of the research and the quality of available data. More recently, Dainty (2008) addressed the issue of multimethodological pluralism in construction management research. He suggests the move of consideration to multimethodology rather than the more usual triangulation aspects. By studying papers published in the journal "Construction Management and Economics" he shows the predominance of quantitative methods, and discusses the implications of such uniformity before moving on to address methodological pluralism and the use of techniques from different paradigms. He concludes that construction management researchers must show courage in breaking out of single paradigm intransigence.

## 1.3 Construction scheduling

Construction scheduling is one of the many aspects of construction management. Effective construction scheduling combined with optimal resource allocation and cost control is of utmost importance in the implementation of projects in the built environment. The completion of projects within budget and on time is always a primary objective for project managers. For many decades the research methods and techniques pertaining to this issue have primarily followed an analytical – algorithmic approach. Taking into account the multi–faceted characteristics of the issue at hand, this paper seeks to find the best approach to conducting research in construction project scheduling. To this extent, the effectiveness of various research techniques in the construction project scheduling process is reviewed.

# 2. Overview of the construction scheduling process

## 2.1 Scheduling tools

It must be acknowledged that the body of knowledge in construction scheduling has come both from within and without of the field of construction management research. Clearly, scheduling tools and techniques may by used in projects of all types (aerospace, defence, information technology, marketing etc.). As such, today the major and mainstream scheduling tools can be summarized as follows:

a) Critical Path Method (CPM), which is a product of research efforts in the late 1950's in the U.S.A. to minimize construction cost and time (Kelley and Walker (1959)).
b) Program Evaluation and Review Technique (PERT), which stems from research efforts in 1958 in the U.S.A. that were aimed at minimizing the time and cost of the Polaris project of the US Navy (PERT (1958), Malcom et al. (1959)).
c) Linear and repetitive project scheduling tools which are applicable to specific types of projects (Harmelink and Rowings (1998), Harris and Ioannou (1998)).
d) Fuzzy project scheduling which originates from the application of Fuzzy Set Theory in scheduling (Chanas and Kamburowski (1981), Prade (1979)).
e) The Critical Chain scheduling method, which was formulated after the Theory of Constraints (Goldratt (1997)).

## 2.2 The construction scheduling cycle

Scheduling tools are important and they comprise the core of the construction scheduling cycle. However, it is important to define the construction scheduling cycle and frame the research problem in its entirety. Thus, it can be assumed that the construction scheduling cycle has three distinct phases:

a) *Estimation*: the primary scheduling variables and parameters such as activity completion time, labour and machinery productivity, resource availability are determined based on the experience of the construction manager and/or analytical calculations.
b) *Optimization*: the variables are processed with various algorithms, the critical path is identified, resource usage is levelled and costs are minimized.
c) *Implementation*: the results of the optimization processes are implemented in the organization/corporation that is responsible for executing the project.

## 2.3 Project context and behavioural issues

The construction scheduling cycle is performed in a specific project execution context with the following aspects: financial and political environment, legal framework, organizational structure, and corporate politics. The macro-economic environment has a huge effect on prices and the supply-demand relationship between clients and contractors. The correct structuring of contracts and their enforcement determines the commitment to attaining project goals. The role and power of the scheduling team in the organization is extremely important in regard to the ease or the barriers by which the results of scheduling tools can be implemented. Thus, there is a big difference between a scheduling team that has an advisory role and one that adopts a more pro-active approach. Also, taking into account resource availability and implementation difficulties in some contexts, near optimal solutions may be just as well suited as fully optimal solutions.

The construction scheduling cycle is performed by practitioners that have specific behavioural traits. The main behavioural elements of practitioners are personnel training, national culture, and negotiation skills. The theoretical and practical training (i.e. software) of personnel in scheduling is very important. National culture encompasses the individuals' commitment to punctuality, adherence to schedules, and meeting deadlines. The negotiation skills of practitioners in enforcing the scheduling requirement are also important. In addition, the perceived and actual benefits from scheduling implementation define the amount of corporate resources that are allocated in the estimation and optimization phases of the construction scheduling cycle. Quite frequently deviations from planned schedules

may lead to a negative preconception of scheduling tools and the limitation of corporate resources allocated to scheduling.

The combination of contextual and behavioural issues can create complex situations. Thus, in many cases the implementation of scheduling methods may be hindered by reasons such as: a) top management does not like the output of system and eye-pleasing reports are preferred instead of reality, b) people rely on instinct and trial and error instead of planning techniques c) there is not appropriate commitment to personnel training (software, project management principles), high information technology infrastructure and amount of staff and d) there are low corporate standards for WBS and planning (Kerzner (2003)).

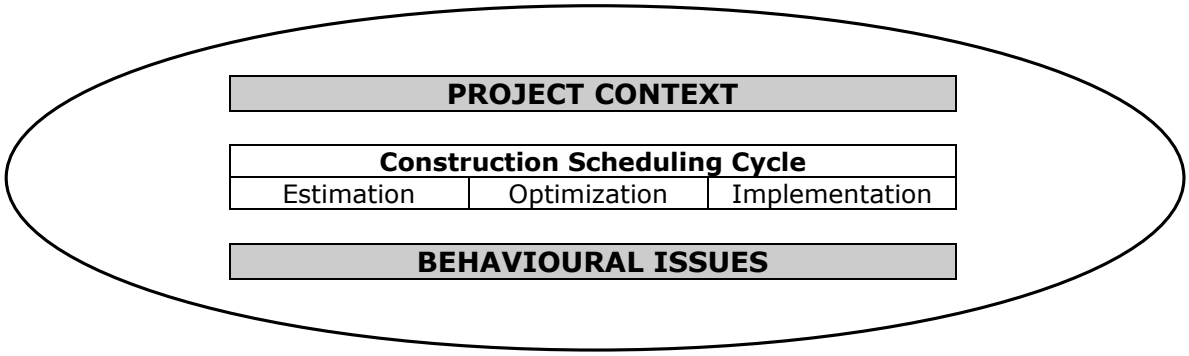


**Figure 1**: The construction scheduling process

Overall, the construction scheduling cycle consists of three phases: estimation, optimization and implementation. The construction scheduling process encompasses the construction scheduling cycle and its relation to contextual aspects and behavioural issues (Figure 1). This holistic framing of construction scheduling is fundamental in seeking the appropriate research methods.

## 2.4 Controllable and non-controllable risk

The effect of risks on the project is very crucial issue during the construction scheduling process. Examples of controllable risks (internal factors) are project characteristics, service providers influences and client organizational influences. Uncontrollable risks (external factors) can consist of socio-economic issues, unforeseen circumstances, economic and global dynamics, governmental/statutory controls (Mbachu and Nkado (2007)). In relation to the construction scheduling process non-controllable risks are crucial in terms of the project context and behavioural issues. Risks related to the project context are exchange rate volatility, inflation, a possible energy crisis, fiscal policies, building regulations, health and environment legislation. Risks related to behavioural issues are workers morale, labour union demands, and cultural influence. Since non-controllable risk may come from many different sources it is often difficult to provide contingencies from all possibilities. Overall, the management of non-controllable risks on construction schedules is a major challenge for project managers.

# 3. Research Methods in the Construction Scheduling Process

## 3.1 Trends in quantitative and qualitative approaches

In examining the state of applications of quantitative analysis techniques in construction management by studying publications in two top ranking journals (Construction Management and Economics, Journal of Construction Engineering and Management) there is a clear positive trend for papers that incorporate applied artificial intelligence techniques (Artificial Neural Networks and Genetic Algorithms, combined ANNs with GAs, fuzzy logic, knowledge based systems and expert systems), (Hua (2008)). In particular, recent developments in scheduling research aim at algorithmic advances by finding optimal solutions with the aid of probability, fuzzy set theory and advanced computational optimization techniques.

While a few truly interpretive studies exist in the field, there is a growing acceptance of qualitative research in construction management research (Chan and Littlemore (2009)). Qualitative methods have been considered capable of studying complex situations, particularly involving human beings and therefore yielding rich findings. This has resulted in the increase of their popularity, particularly in the built environment (Sutrisna (2009)). Examples of qualitative methods are structured interviews, questionnaires and postal surveys.

## 3.2 The effectiveness and limitations of each approach

### 3.2.1 Research methods and the construction scheduling cycle

The majority of research methods in the construction scheduling cycle stem from a pure quantitative approach to scheduling based on optimization and operations research techniques. Significant quantitative research has also been elaborated in the estimation of scheduling parameters. However, beyond these two "pillars" of the scheduling cycle, quantitative techniques present shortcomings in regard to implementation issues in scheduling. This is due to the limitations of quantitative techniques in dealing with non mathematical issues. In addition, it should be noted that the comparison of different algorithmic approaches may be erroneous if the project is not executed in the same context by practitioners with similar behavioural traits. Hence, the validity and reliability of a purely optimisation scheduling model is limited without considering the specific assumptions relating to the complete project scheduling process.

### 3.2.2 Research methods and the project context and behavioral issues

A special mention must be made about the advances attained by the application of fuzzy set theory and probability in scheduling. These approaches acknowledge the presence of uncertainty in the project execution environment, which they attempt to model through a purely mathematical approach. In cases where parameter estimations are purely statistical and computational the approach dwells purely in the rationalist domain. Otherwise, when the scheduling parameters originate from subjective and fuzzy estimations, such as practitioner assessments of best and worst case scenarios, the methods have an interpretative aspect. Even though the analysis is mathematical, it stems from an individuals perception of reality which

definitely has an interpretative element. This means that the trend of quantitative research is in the right direction, since these methods provide a connection between the construction scheduling cycle, the project context and behavioural issues. However, effort must be made in clarifying the process in which the perception of uncertainty is quantified since in many instance fuzzy estimates are a convolution of uncertainty from many distinct sources. Overall, probability theory and fuzzy set theory although quantitative increase the validity and reliability of research methods in scheduling because they provide a means of modelling contextual and behavioural issues.

A better defined relation of project context and behavioural traits to each element in the project cycle should be sought with qualitative techniques as well as fundamentals from the economic and social sciences. Undoubtedly, research techniques from economics can help us understand project developments in relation to the macro-economic environment. Methodologies from psychology and sociology can also be useful in comprehending the behaviour of practitioners in corporations. It is understood that although very interesting discoveries may be made through this approach, their generalization may in some cases prove to be somewhat difficult.

In conclusion, the construction scheduling cycle is performed in a specific context by people that have specific behavioural traits. Altogether the scheduling process is broader than the scheduling cycle and scheduling tools which are the main target point of academic research. Failure to comprehend this process means that the result of academic research may fall short of the true requirements of scheduling in the built environment.

## 4. The multi – faceted approach

Construction management and economics (CME) research as a multidisciplinary design science aims to produce multidisciplinary solution concepts that can be used in solving complex and relevant field problems in design, production and operation of the built environment. The output of CME research as a multidisciplinary design science consists of three types of solution concepts (Voordijk (2009)):

- Technological laws: empirical generalizations based on statistical data analysis
- Functional rules: concepts that specify what to do, if a certain result is to be attained under given circumstances
- Socio technological understanding: insights in the interrelationships between construction processes and social practice.

The correct framing of construction scheduling has proven to be extremely useful in assessing the effectiveness of various research methods. Clearly, the complexity of the nature of construction scheduling warrants a multi-faceted approach. Thus, in adopting a holistic stance in scheduling research, a multi-faceted approach to the construction scheduling process could have the following structure:

- Technological laws: scheduling tools for estimation and optimization.
- Functional rules: for schedule implementation, interaction of project context and scheduling cycle.
- Socio technological understanding: for a complete mapping of behavioural issues to the construction scheduling cycle.

The greatest foreseen challenge in this approach is the interaction and coordination of different research methods. Realistically, this can only be accomplished by the development of multi-disciplinary research groups. Researchers must understand the limitations of their knowledge and seek to establish cooperation with specialists from other fields. For example, such a group could be comprised of civil engineers, architects, economists, psychologists, mathematicians, lawyers and sociologists. In all cases the issue of complementarities of research findings must be addressed and multi-faceted solution concepts should not be antagonistic to each other. Also, innovative research techniques such as knowledge mining from many information sources (Palaneeswaran and Kumaraswamy (2003)) could prove to be very useful.

As noted by Hughes (1994) "In a new academic field it is necessary not only to undertake the research but also to invent a methodology". In this respect the multi-faceted approach is a new methodology which needs to be defined in greater detail and will require researchers to break out of their existing knowledge barriers. The greatest challenge in this approach is how the results of the different techniques from different paradigms will be combined and interpreted by the principal researcher.

## 5. Conclusions

The need for a multi-faceted approach to construction scheduling has been demonstrated by correctly framing the construction scheduling process. The scheduling cycle has been appropriately defined and well as its interaction with the relative project context and behavioural issues. The limitations of quantitative and qualitative techniques in various aspects of the scheduling process have been clearly laid out.

It is encouraging that the trends in quantitative research through probabilistic and especially fuzzy techniques achieve a mixture of rationalist and interpretative research philosophy and are a definite improvement over the outdated deterministic approach. At the same time there are plenty of issues pertaining to the project context, behavioural issues and schedule implementation that require qualitative analysis. The multi-faceted approach could be effective in mapping and providing contingencies from non-controllable project risks that come from many sources.

Multi-disciplinary research groups are proposed as a means to providing the best approach to this multi-faceted problem. The primary goal of this approach is to set technological rules, functional rules and enhance socioeconomic understanding. In this respect, let us envisage a scheduling handbook that also has a chapter or two on the fundamentals of the national economy as well as the basics of human psychology.

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# Uncertainty in Scheduling Multiple Projects

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## Abstract
Whereas there is ample research literature available on uncertainty in single projects, research on studying uncertainty in a multi-project environment is scarce. As such, this paper aims at establishing a framework for modelling uncertainty in scheduling multiple projects. The primary focus is determining the feasibility of the fuzzy set theory application in the modelling of scheduling uncertainty in the contemporary dynamic project execution environment. Issues such as duration uncertainty, resource availability and multiple project objectives are examined. It is concluded that the proposed methodology could be particularly useful in practical applications.

## Keywords
Fuzzy Project Scheduling, Multiple Project Management

## 1. Introduction

### 1.1 Uncertainty in the scheduling of single projects

The management of projects in an uncertain environment requires decisions that are based on inconsistent, vague and imprecise data. The shortcomings of traditional scheduling methods such as CPM and PERT, that employ a deterministic or a probabilistic view respectively, mandate the formulation of a new methodology to meet the real-world requirements. Probability theory and fuzzy set theory are two different approaches for the management of project uncertainty. Probability theory deals with random events by assigning probability distributions to the data that is necessary for making decisions. Alternatively, fuzzy set theory deals with the imprecision of data that must be processed in order to manage projects. Fuzzy Project Scheduling (FPS) is based on fuzzy set theory and is useful in dealing with circumstances that involve uncertainty, imprecision, vagueness and incomplete data.

In terms of Fuzzy Project Scheduling, Prade (1979) was the first researcher to propose the application of fuzzy set theory in scheduling problems. Chanas and

Kamburowski (1981) presented a fuzzy version of PERT which they named FPERT. Important research in Fuzzy Project Scheduling has been conducted by McCahon and Lee (1988), Hapke et al. (1996), Lorterapong and Moselhi (1996), Dubois et al. (2003), Bonnal et al. (2004). Overall there have been about 40 papers published in major international journals addressing various aspects of this new scheduling approach.

## 1.2 Multiple project management and scheduling

The management of a group of projects has significant differences from the management of a single project. Project orientation in an organization is the term used to describe the preference of managing by projects and the development of project management competence (ICB, (2006)). In this context, multiple projects are brought together for the sake of control, coordination and optimisation, so that their implementation achieves strategic goals and benefits for the organization. Today, project orientation and multi-project management is emerging as a predominant strategy in private-enterprise organizations (construction contractors) and government organizations (public works).

In the multi project environment single projects compete for organizational resources with other projects. Hence, significant effort is directed in resolving resource insufficiencies and conflicts. Engwall and Jerbrant (2003) argued that the allocation of resources to (and between) simultaneous and successive projects is a very complex process that is related to deeply embedded features of the organization. Also, special attention should be paid to project interdependencies and lack of resources, priority setting and resource allocation, competition between projects and short term problem solving. Blichfeldt and Eskerod (2008) discussed resource allocation difficulties in organizations managing portfolios of projects. Patanakul and Milosevic (2009) studied the effectiveness of management in multiple projects. They concluded that project assignment, resource allocation and organizational culture are important at the organizational level whereas project management processes and competencies of multiple project managers are critical at the operational level. Scheinberg and Stretton (1994) demonstrated an approach using a balancing method that improves the development, evaluation and making of planning decisions related to portfolios of projects by incorporating a wide range of business variables (indices) into the decision process.

As such, a generic framework with guidelines for the management/scheduling of multiple projects could consist of the following elements (ICB, (2006)):

1. List and prioritise programmes and projects inline with the organization's strategies and goals.
2. Allocate resources to the portfolio. Balance supply with demand.
3. Define standard processes, tools and reporting schemes to be used in all programmes/projects of the portfolio and establish support functions.
4. Continuously monitor and control the programmes/projects of the portfolio. Initiate corrective actions.
5. Delete programmes/projects from the portfolio when they are no longer relevant to the business strategy and ensure there is a feedback mechanism for lessons learnt.
6. Select and add new projects/programmes to the portfolio.

## 1.3 Uncertainty in multiple projects

In recent years the study of uncertainty in the scheduling of multiple projects has emerged as a dynamic research domain. Tong and Tam (2003) introduced a fuzzy optimization model for resource allocation with the use of genetic algorithms. Nozick et al. (2004) studied the relationship between resource requirements and the probability distributions of the durations of individual tasks. Thereafter, they proposed a non-linear mixed integer programming model with a heuristic solution procedure for optimizing resource allocations to individual tasks that minimize the weighted completion times of a collection of projects and the overuse of resources. East and Liu (2006) presented a model of the mobilization requirements of multiple crews performing a variety of different activities over a geographic space. A computer system called FIRS (Facility/Infrastructure Resource Schedule), was created to analyze multi–project resource plans with the utilization of a genetic algorithm in multi-project scheduling. The system identifies true mobilization costs of project priority and crew assignment decisions. Wu (2007) proposed a fuzzy linear programming approach for manpower allocation among projects within a matrix organization. Medaglia et al. (2007) proposed an evolutionary method for project selection problems under uncertainty with partially funded projects, multiple (stochastic) objectives, project interdependencies and a linear structure for resource constraints. Laslo and Goldberg (2008) studied the unavoidable resource conflicts that arise in organizations with matrix structures because project managers and functional mangers struggle for greater control over the allocation of organizational resources. They developed a simulation procedure to study the flow of resources in a multi-project setting under conditions of uncertainty as a means to examine the possibility of unnecessary and unrealistic conflicts.

## 2. Fundamentals of Fuzzy Set Theory

Fuzzy set theory is used to characterize and quantify uncertainty and imprecision in data and functional relationships. Fuzzy set theory permits the gradual assessment of the membership of elements in a set in the real unit interval [0, 1]. Hence, a fuzzy set A of a universe X is characterized by a membership function $\mu_A$: X[0,1] which associates with each element x of X a number $\mu_A(x)$ in the interval [0,1] representing the grade of membership of x in A. In fuzzy set theory the triangular membership function which is defined by three numbers a, b, c is encountered very often. At b membership is 1, while *a* and *c* are the limits between zero and partial membership. The triangular fuzzy number $\tilde{x} = \langle a, b, c \rangle$ has the following membership function:

$$\mu_A(x) = \begin{cases} 0 & x < a \\ (x-a)/(b-a) & a \le x \le b \\ (c-x)/(c-b) & b \le x \le c \\ 0 & x > c \end{cases} \quad (1)$$

With any fuzzy set A we can associate a collection of crisp sets known as α-cuts (alpha-cuts) or α-level sets. A α-cut is a crisp set consisting of elements of A which belong to the fuzzy set at least to a degree of α. Therefore, if A is a subset of a universe U, then an α-level set of A is a non-fuzzy set denoted by $A_\alpha$ which comprises all elements of U whose grade membership in A is greater than or equal to α (Zadeh, 1975). In symbols,

$$A_\alpha = \{u \mid \mu_A(u) \ge \alpha\} \quad (2)$$

where: *α* is a parameter in the range $0 < \alpha \le 1$ .

# 3. Multi project scheduling methodology

## 3.1 Mathematical formulation

Consider an organization that is responsible for a set of multiple project $P_1$, $P_2$,…, $P_n$. Every project has a set of activities $a_{p1}$, $a_{p2}$,…, $a_{pi}$ (p: project index, i: activity index). There is a common resource pool with resources $R_1$, $R_2$,…, $R_n$ that can be assigned to activities in separate projects. Individual projects can start at different points in time within the overall timeline. Their start time depends primarily on organizational strategy and may be modified due to resourcing conflicts. The objective of multi-project scheduling is to finish the projects in the shortest time while assuring the best utilization of the shared resources (Fig. 1).

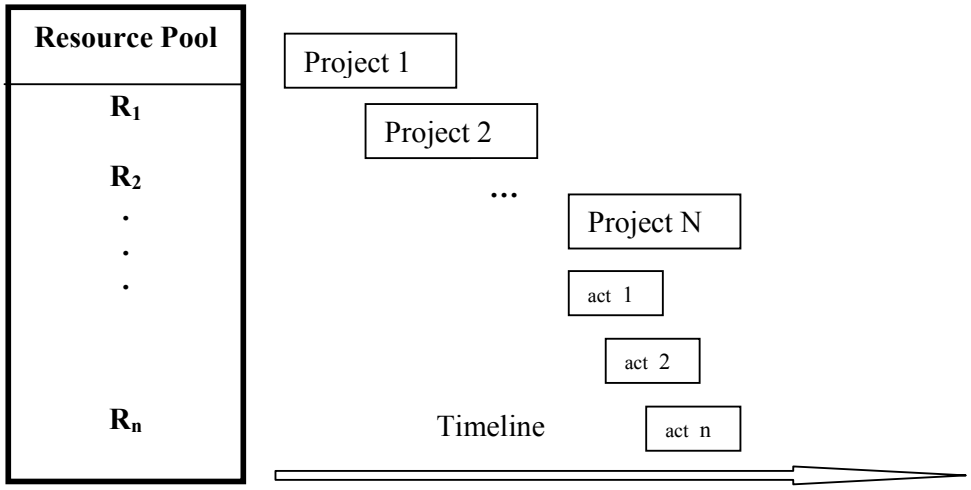



**Figure 1**: Scheduling of multiple projects

## 3.2 Fuzzy CPM

Initially, the most appropriate membership function for the duration of every activity is selected through a process called fuzzification. Thus, project activities can have durations that are fuzzy numbers instead of crisp numbers. Thereafter, the fuzzy project scheduling algorithm is applied to each individual project – meaning that the formula for the forward recursion is applied to the activities using fuzzy arithmetic. Essentially, the fuzzy formulation of the CPM algorithm is based on the forward pass of the data that is performed by calculating the early start and early finish.

$$\tilde{E}S_{start} = 0, \quad \tilde{E}F = \tilde{E}S(+)\tilde{d} \text{ and } \tilde{E}S = \max_{p \in P}(\tilde{E}F_p) \tag{3}$$

Where: p: is the preceding activity, P: is the set of preceding activities, $\tilde{E}S / \tilde{E}F$ : is the fuzzy early start/finish time, $\tilde{d}$ : is the fuzzy activity duration, $(+)$: is the fuzzy addition operator, $\max$ : is the fuzzy maximum operator.
Unlike CPM, FPS calculates the criticality of paths of the network instead of activities.

$$C_{P(i)} = \sup\left[ \mu_{T_{P(i)}}(x) \cap \mu_{T}(x) \right] \tag{4}$$

$$\tilde{T}_{P(i)} = \sum_{p \in P(i)} \tilde{d}_p \qquad (5)$$

Where:

$\sup$: is the largest value of a set, $P_{(i)}$: a path *i* from the first to last node of the network, $C_{P(i)}$: the degree of criticality of path *i*, $\tilde{T}_{P(i)}$: the fuzzy duration of path *i*, $\tilde{T}$: the fuzzy completion time of the project, $\mu$: the membership function of the path.

In other words, the degree of criticality of a path i, is equal to the maximum of the intersection of the membership function of the fuzzy duration of path *i* with the fuzzy duration of the project. The concept of critical activities is related to the assessment of path criticality. Thus activities that belong only to one path assume their criticality from that path. In the event that activities that are common to more than one path, the activity criticality takes the largest value of the paths that it belongs to (Lorterapong (1996)).

## 3.3 Resource allocation

The application of the FPS algorithm yields the fuzzy start and completion dates of the activities as well as the activity criticality degrees. In order to calculate the required usage/time of each resource it is necessary to divide the total amount of units assigned to each activity with its duration. However, the activity duration varies for different possibility measures and for optimistic and pessimistic scenarios. In the absolute best case ($\min D_\alpha$) the activity will start as early as possible and will last the minimum duration. In the absolute worst case ($\max D_\alpha$) the activity will start as late as possible and will last the maximum duration (Maravas and Pantouvakis (2010)). It is possible to calculate these intervals as follows:

$$\min D_\alpha = (\inf Start, \inf Start + \inf Duration)$$

$$\max D_\alpha = (\sup Start, \sup Start + \sup Duration)$$

where: $D_\alpha$: is the interval of minimum/maximum duration at the respective level α (α-cut), inf: infimum (least), sup: supremum (greatest).

The overall resource utilization profile is simply the sum of the unit/time usage of each resource per each activity from all projects. Because the resulting durations may not be integers they are rounded up/down accordingly. In this paper, it is assumed that the uncertainty in the duration of the activity and the amount of resource units are uncorrelated.

## 3.4 Visualization of Resource Allocation

The visualization of the resource allocation of activities with duration uncertainty is extremely important in evaluating the necessity for resource levelling. As an example consider two activities A, B whose durations are triangular fuzzy numbers as shown in Table 1. The fuzzy GANT chart is shown in Figure 2.

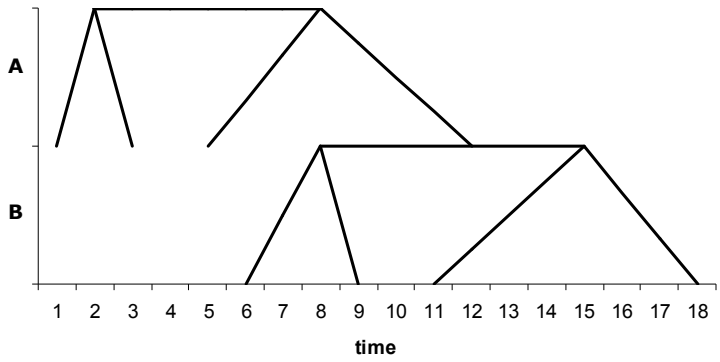
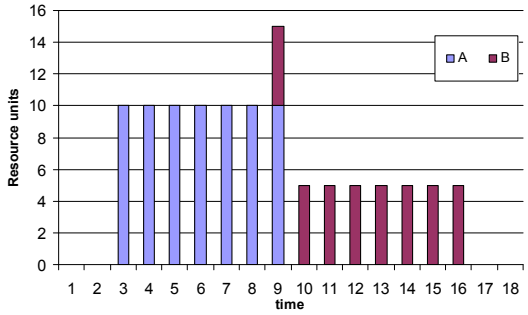


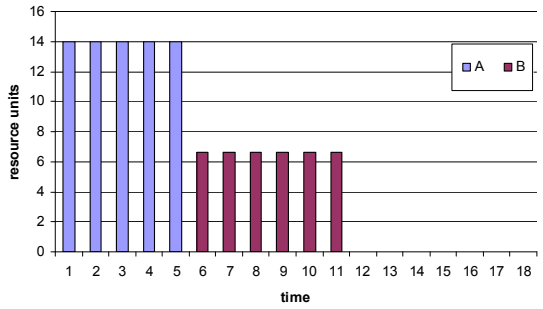

**Figure 2**: Fuzzy GANT chart of activities A, B.

| | Early Start | | | Duration | | | Early Finish | | |
|---|---|---|---|---|---|---|---|---|---|
| **A** | 1 | 2 | 3 | 4 | 6 | 9 | 5 | 8 | 12 |
| **B** | 6 | 8 | 9 | 5 | 7 | 9 | 11 | 15 | 18 |

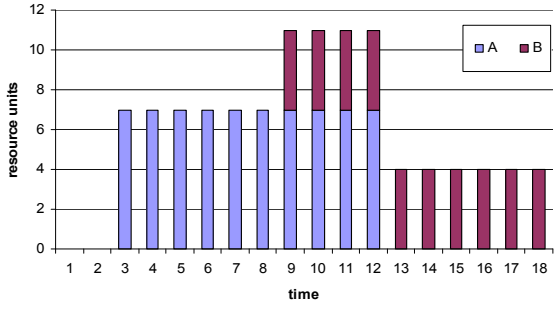
**Table 1.** Duration data of activities A and B.




(a) μ=1




(b) μ=0, optimistic




(c) μ=0, pessimistic

**Figure 3**: Resource usage for different cases.

Figure 3 depicts a stacked histogram of a resource $R_1$ that has 70 units assigned to activity A and 40 units to activity B. At μ=1 there is one peak resource demand at time period 9 (Fig. 3a). At the optimistic scenario at μ=0 there is a significant peak usage at time periods 1 to 5 (Fig. 3b). At the pessimistic scenario at μ=0 the peak period has a lower resource demand since the activities are spread out further in time (Fig. 3c). If the resource limit usage is 12 units per time period then there is a small problem in Fig. 3a, a significant problem in Fig. 3b and no problem at all in Fig. 3c.

With this simple example it is evident that resource allocation is not the same in different possibility levels and at optimistic and pessimistic scenarios. The use of a visualization tool can identify peak resource usage coming from many activities from several projects. In practice, the stacked resource usage histogram can be created for 11 possibility levels (0, 0.1, 0.2,…,1) which represent different risk levels. At μ=1 there is no risk at all. However, the risk level increases as μ moves towards 0.

## 3.5 Resource levelling

In multi-project project scheduling resource over-allocations can be resolved in two manners: i) by changing the amount of resource usage within activities of one project. In this case several resource levelling techniques exist in the literature. Some of these are based on setting priority heuristics based on scheduling parameters such as Early Start, Early Finish, Late Start Late Finish, etc. ii) by reassigning resources from one project to another. In the second case project priorities must be set so that preference is given to a particular project while resolving conflicts.

After the project fuzzy start and finish dates have been determined by the application of the fuzzy CPM algorithm and resource usage has been determined, resource levelling is applied with a heuristic algorithm that uses a priority list. Although priority heuristics yield near optimal and not pure optimal solutions they are still useful in scheduling practice. The following rules could be used:

1. Project priority (activities within a project are assigned the priority-level of the project)
2. Degree of activity criticality
3. Early start, early finish.

It is obvious that if all projects have the same priority then the problem reduces to that of resource levelling a single project. The use of the degree of criticality is important since it ensures that resources are allocated to activities that affect the project completion date.

## 4. Conclusions

This paper has succeeded in presenting a framework in which fuzzy project scheduling and resource levelling is utilized to deal with the uncertainty of scheduling multiple projects. The proposed methodology has succeeded in:

a) Providing a means to visualize the utilization and possible over-allocation of resources in different projects that have different strategic priority.

b) The ability to view resource utilization at different possibility levels (α-cuts) and at optimistic and pessimistic scenarios, from which it is discovered that resource conflicts do not exist at all risk levels.
c) Presenting an algorithm for resource levelling based on heuristics such as project priority and activity criticality.

Overall, there is a direct relation between the project managers perception of uncertainty in the duration and resource availability. Further research will be aimed at testing the methodology on a wider sample of schedules with many simulation runs. It is believed that the methodology could be a useful scheduling-tool for private-enterprise and government organizations that are engaged in multi-project management.

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*ITPM4*

# An Integrated Information System for Monitoring Construction Works

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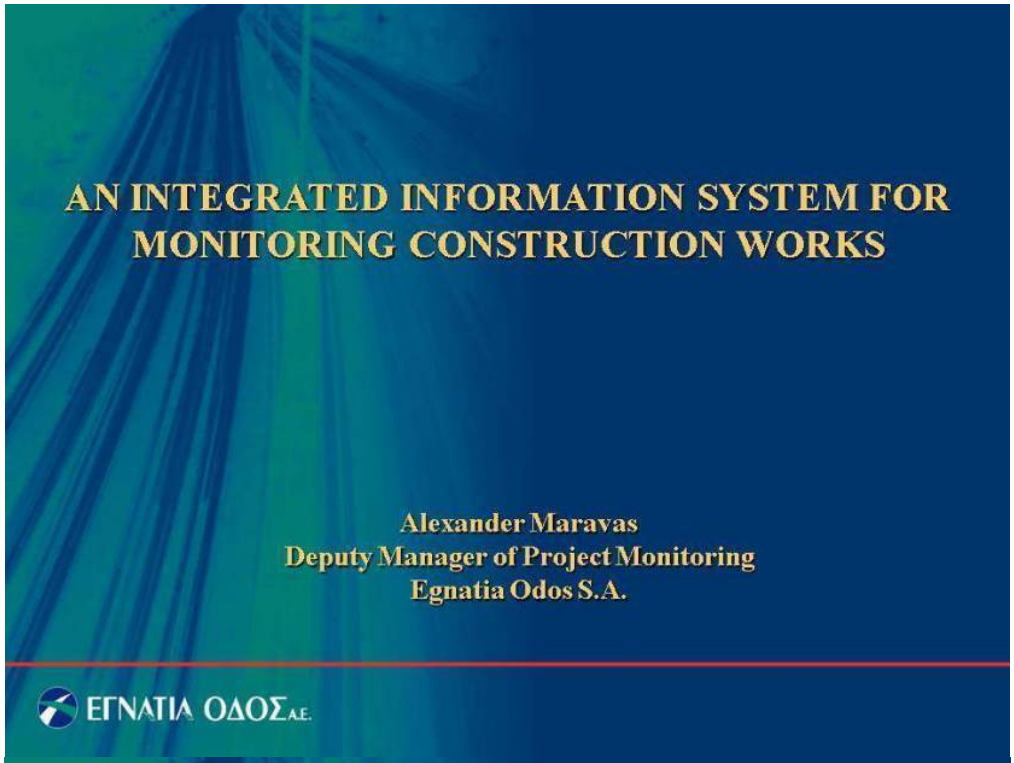


# 1.PROJECT MONITORING SCOPE

## 1.2 Necessity of Information Systems

- Construction budget
- Many contractors with great geographical dispersion
- Multiple contracts in some sections
- Contracts Tendered on Bill of Quantities with 900 work items
- Project WBS with many nodes
- Continuous modifications

ΕΓΝΑΤΙΑ ΟΔΟΣ Α.Ε.

# 1.PROJECT MONITORING SCOPE

## 1.3 Management Layers

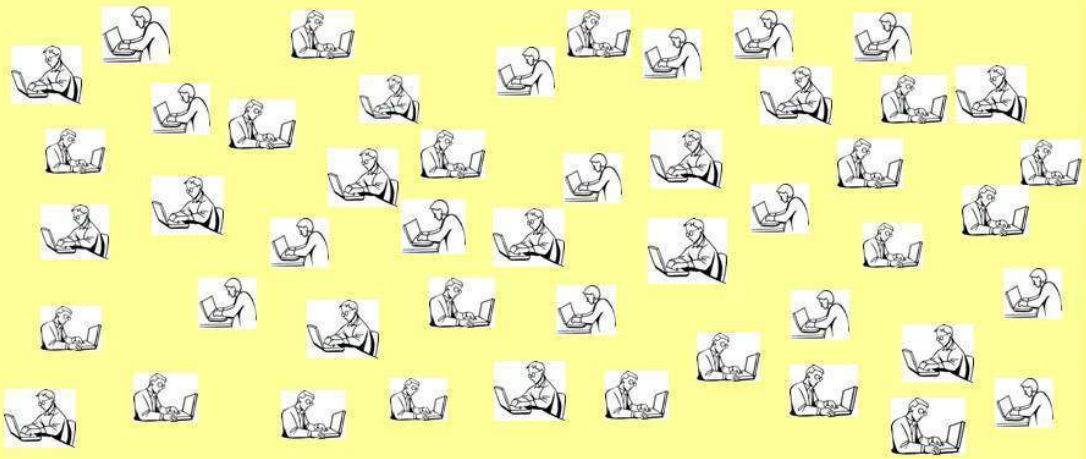
- Information must pass through many management levels
  - Quantity Surveyor,
  - Construction Supervisors,
  - Managing Service,
  - Superior Authority,
  - Board of Directors.

- Reporting must satisfy all layers:
  - Bills, Surveyed Quantities
  - Ministry of Environmental Planning and Public Works, European Union, Managing Authorities of CSF.

ΕΓΝΑΤΙΑ ΟΔΟΣ Α.Ε.

# 1.PROJECT MONITORING SCOPE

## 1.4 Data Management



Multiple Software – Different Coding and Methodologies

ΕΓΝΑΤΙΑ ΟΔΟΣ Α.Ε.

# 2. INTEGRATED SYSTEM

## 2.1 Advantages and Disadvantages of Centralized Project Control Systems

| ADVANTAGES | DISADVANTAGES |
|---|---|
| Data comparison across project | High system development and administration costs |
| Enhancement of horizontal and vertical communication | Advanced Information Technology Infrastructure |
| Fast and accurate data queries that minimize data transfer errors | Corporate reorganization to meet needs of system |
| Avoidance of work replication | |
| Accountability management | |

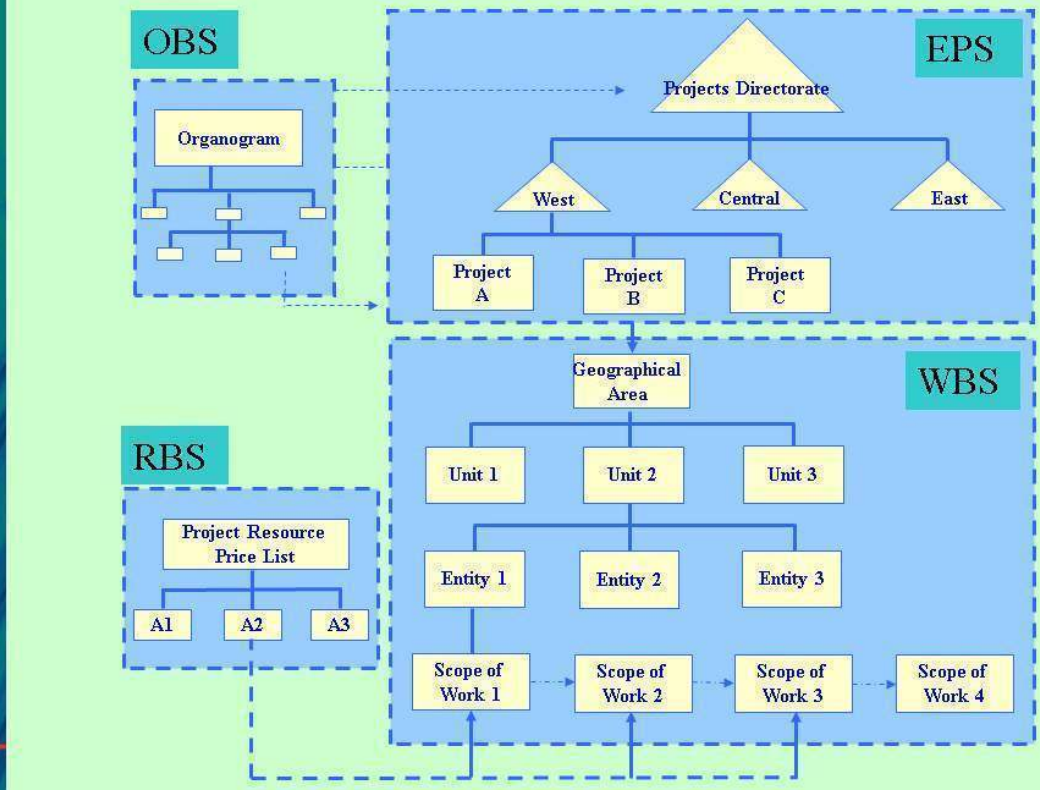
ΕΓΝΑΤΙΑ ΟΔΟΣ Α.Ε.

# 2. INTEGRATED SYSTEM

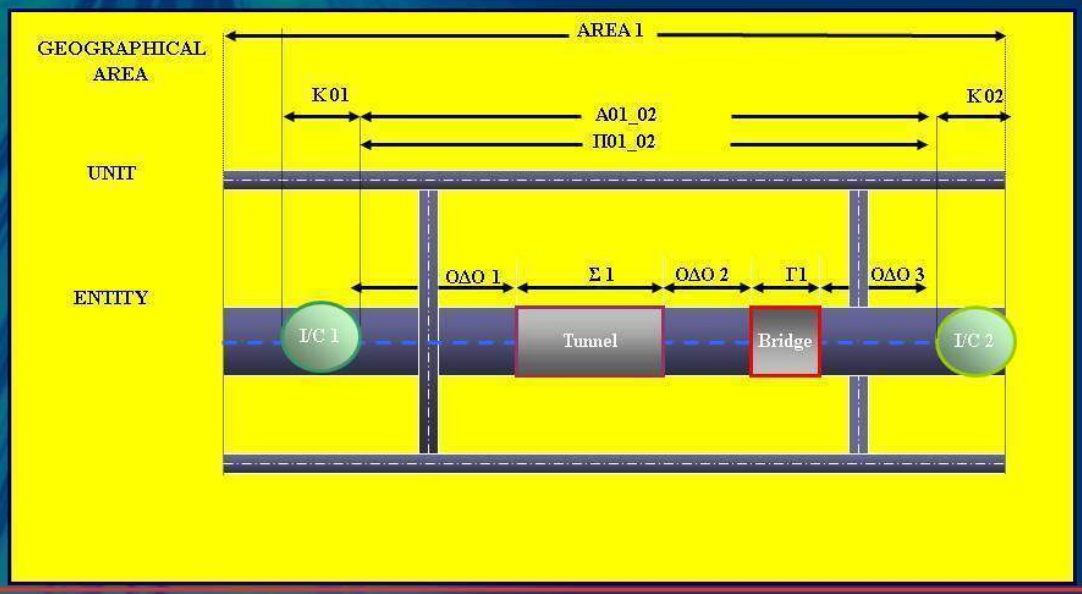
## 2.2 Analysis of Business Procedures

| BUSINESS FUNCTIONS | DATA STRUCTURES |
|---|---|
| Cost Control – Assignment of Work Items to technical objects. | Work Breakdown Structure (WBS) |
| Scheduling | Organizational Breakdown Structure (OBS) |
| Physical Progress Monitoring | Enterprise Project Structure (EPS) |
| Payment requisitions and surveyed quantities | Contract – work items (RBS) |
| Change Management | Project Funding |
| Budgeting – Cash Flow Predictions | Project time and cost data |
| Statistical Analysis of Historical Data | |

ΕΓΝΑΤΙΑ ΟΔΟΣ Α.Ε.



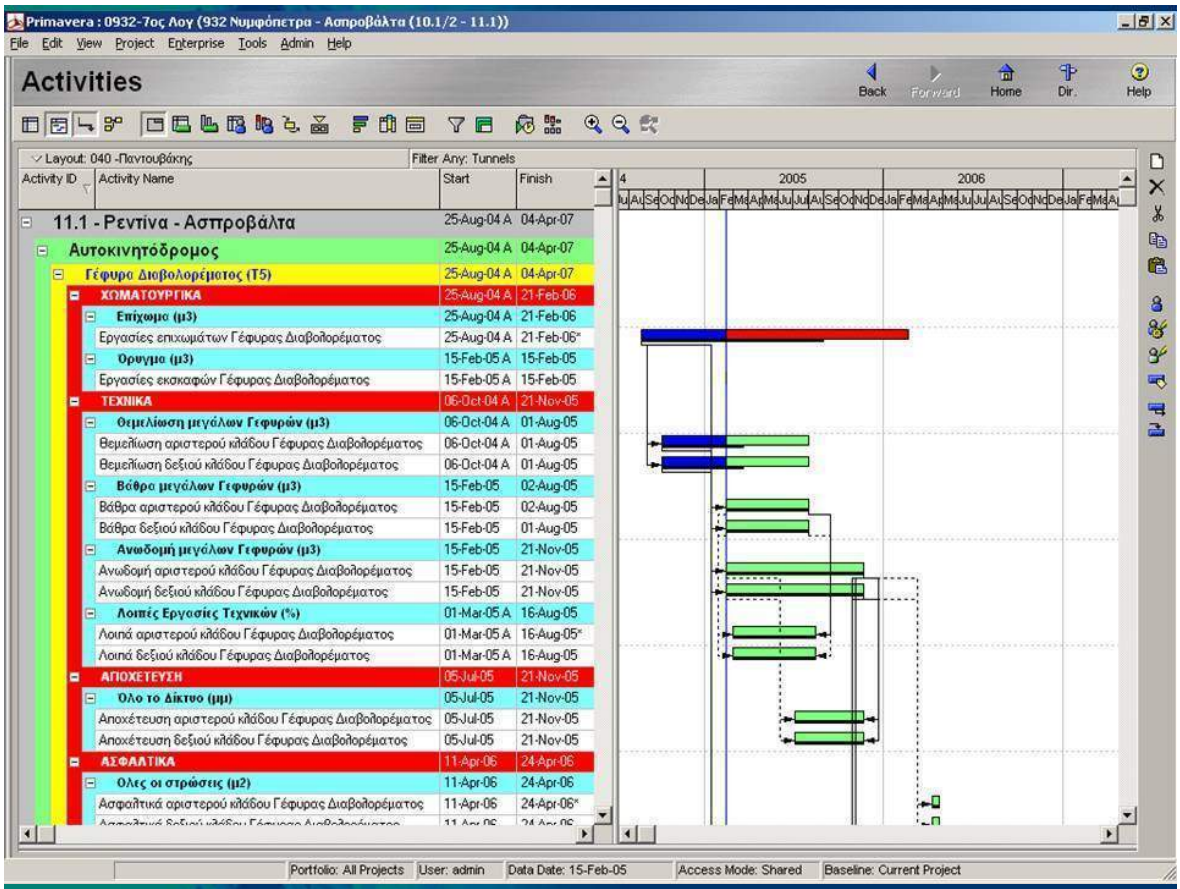
# 2. INTEGRATED SYSTEM
## 2.3 Work Breakdown Structure




ΕΓΝΑΤΙΑ ΟΔΟΣ Α.Ε.

# 2. INTEGRATED SYSTEM
## 2.4 Technical Scopes of Work

ΕΓΝΑΤΙΑ ΟΔΟΣ Α.Ε.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File Edit View Project Enterprise Tools Admin Help
Activities
Back Forward Home Dir. Help
Activity ID
Activity Name
Start
Finish
11.1 - Ρεντίνα - Ασπροβάλτα 25-Aug-04 A 04-Apr-07
Αυτοκινητόδρομος 25-Aug-04 A 04-Apr-07
Γέφυρα Διαβολορέματος (Τ5) 25-Aug-04 A 04-Apr-07
ΧΩΜΑΤΟΥΡΓΙΚΑ 25-Aug-04 A 21-Feb-06
Επίχωμα (μ3) 25-Aug-04 A 21-Feb-06
Εργασίες επιχωμάτων Γέφυρας Διαβολορέματος 25-Aug-04 A 21-Feb-06*
Ορυγμα (μ3) 15-Feb-05 A 15-Feb-05
Εργασίες εκσκαφών Γέφυρας Διαβολορέματος 15-Feb-05 A 15-Feb-05
ΤΕΧΝΙΚΑ 06-Oct-04 A 21-Nov-05
Θεμελίωση μεγάλων Γεφυρών (μ3) 06-Oct-04 A 01-Aug-05
Θεμελίωση αριστερού κλάδου Γέφυρας Διαβολορέματος 06-Oct-04 A 01-Aug-05
Θεμελίωση δεξιού κλάδου Γέφυρας Διαβολορέματος 06-Oct-04 A 01-Aug-05
Βάθρα μεγάλων Γεφυρών (μ3) 15-Feb-05 02-Aug-05
Βάθρα αριστερού κλάδου Γέφυρας Διαβολορέματος 15-Feb-05 02-Aug-05
Βάθρα δεξιού κλάδου Γέφυρας Διαβολορέματος 15-Feb-05 01-Aug-05
Ανωδομή μεγάλων Γεφυρών (μ3) 15-Feb-05 21-Nov-05
Ανωδομή αριστερού κλάδου Γέφυρας Διαβολορέματος 15-Feb-05 21-Nov-05
Ανωδομή δεξιού κλάδου Γέφυρας Διαβολορέματος 15-Feb-05 21-Nov-05
Λοιπές Εργασίες Τεχνικών (%) 01-Mar-05 A 16-Aug-05
Λοιπά αριστερού κλάδου Γέφυρας Διαβολορέματος 01-Mar-05 A 16-Aug-05*
Λοιπά δεξιού κλάδου Γέφυρας Διαβολορέματος 01-Mar-05 A 16-Aug-05
ΑΠΟΧΕΤΕΥΣΗ 05-Jul-05 21-Nov-05
Ολο το Δίκτυο (μμ) 05-Jul-05 21-Nov-05
Αποχέτευση αριστερού κλάδου Γέφυρας Διαβολορέματος 05-Jul-05 21-Nov-05
Αποχέτευση δεξιού κλάδου Γέφυρας Διαβολορέματος 05-Jul-05 21-Nov-05
ΑΣΦΑΛΤΙΚΑ 11-Apr-06 24-Apr-06
Ολες οι στρώσεις (μ2) 11-Apr-06 24-Apr-06
Ασφαλτικά αριστερού κλάδου Γέφυρας Διαβολορέματος 11-Apr-06 24-Apr-06*
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4
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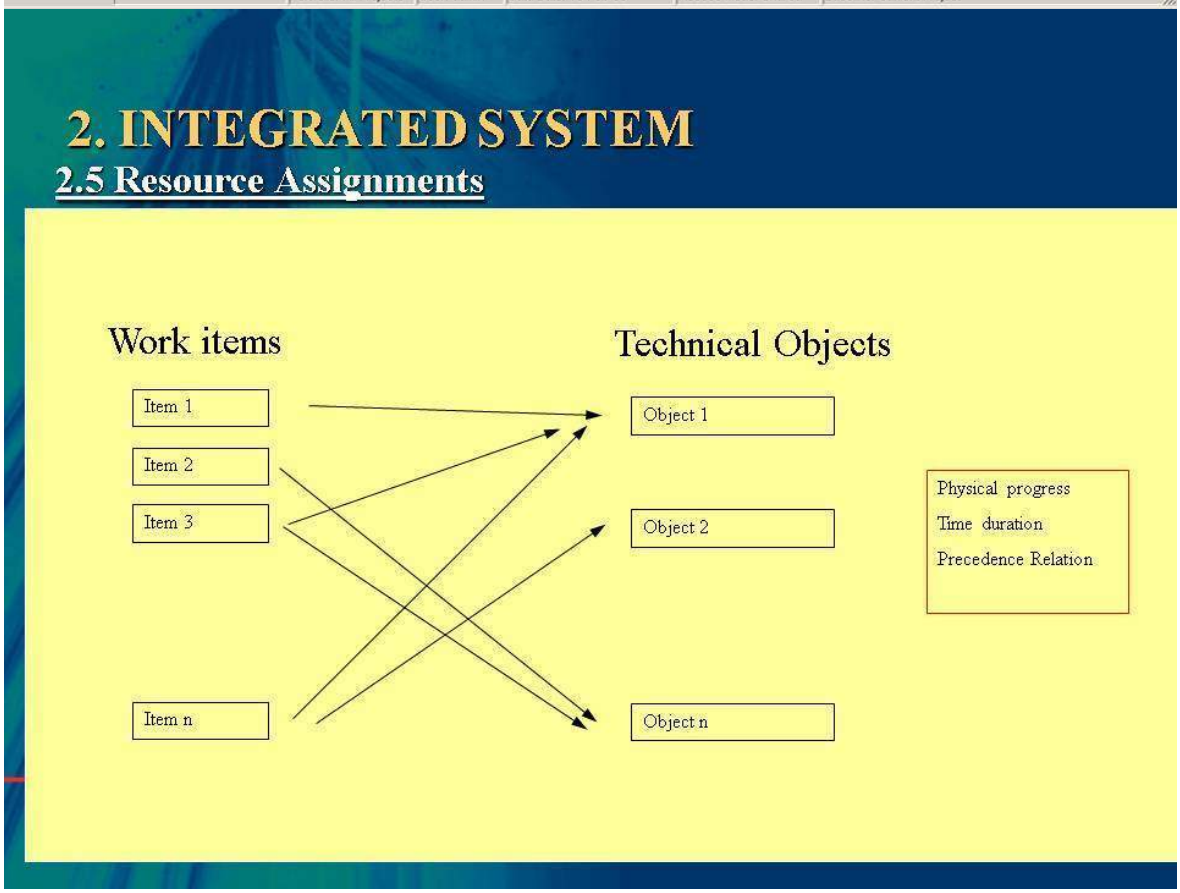
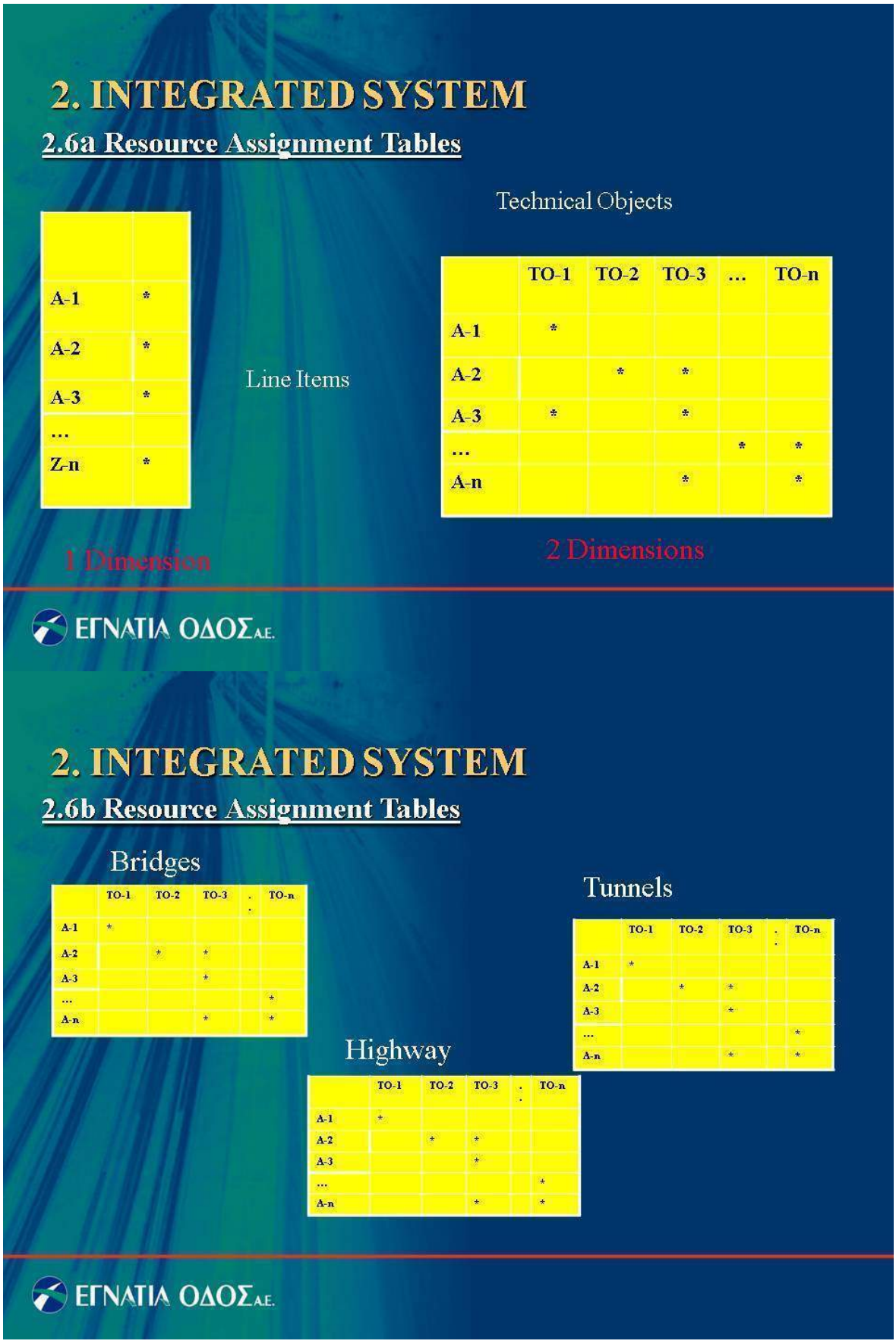
2006
Portfolio: All Projects
User: admin
Data Date: 15-Feb-05
Access Mode: Shared
Baseline: Current Project


2. INTEGRATED SYSTEM
2.5 Resource Assignments
Work items
Technical Objects
Item 1
Item 2
Item 3
Item n
Object 1
Object 2
Object n
Physical progress
Time duration
Precedence Relation




| | |
|---|---|
| A-1 | * |
| A-2 | * |
| A-3 | * |
| … | |
| Z-n | * |

| | TO-1 | TO-2 | TO-3 | … | TO-n |
|---|---|---|---|---|---|
| A-1 | * | | | | |
| A-2 | | * | * | | |
| A-3 | * | | * | | |
| … | | | | * | * |
| A-n | | | * | | * |

| | TO-1 | TO-2 | TO-3 | . . | TO-n |
|---|---|---|---|---|---|
| A-1 | * | | | | |
| A-2 | | * | * | | |
| A-3 | | | * | | |
| … | | | | | + |
| A-n | | | * | | + |

| | TO-1 | TO-2 | TO-3 | . . | TO-n |
|---|---|---|---|---|---|
| A-1 | * | | | | |
| A-2 | | * | * | | |
| A-3 | | | * | | |
| … | | | | | * |
| A-n | | | * | | * |

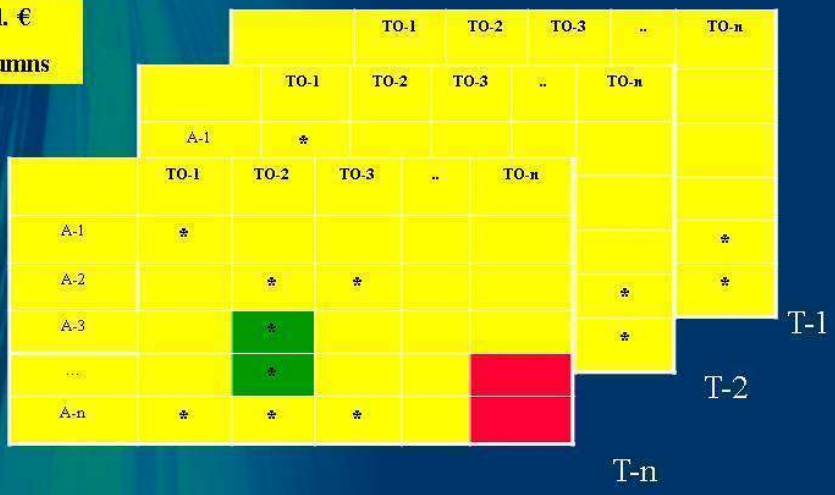
| | TO-1 | TO-2 | TO-3 | . . | TO-n |
|---|---|---|---|---|---|
| A-1 | * | | | | |
| A-2 | | * | * | | |
| A-3 | | | * | | |
| … | | | | | + |
| A-n | | | * | | + |

# 2. INTEGRATED SYSTEM

## 2.6c Resource Assignment Tables

**Contract ~ 100 mil. €**

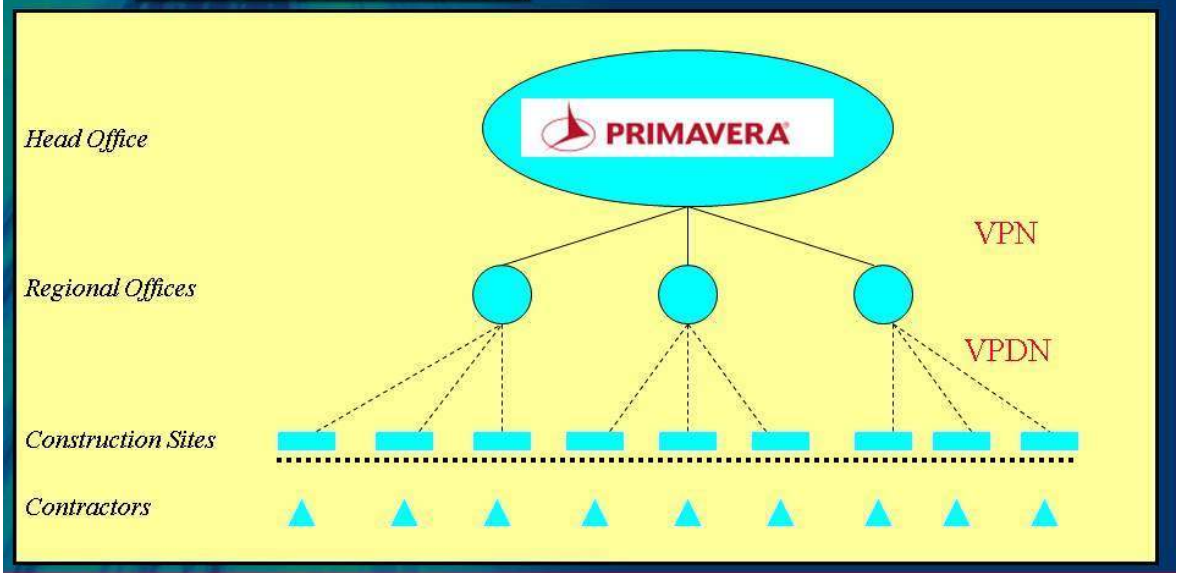
**250 rows* 400 columns**




ΕΓΝΑΤΙΑ ΟΔΟΣ Α.Ε.

# 2. INTEGRATED SYSTEM

## 2.7 Flow of Information

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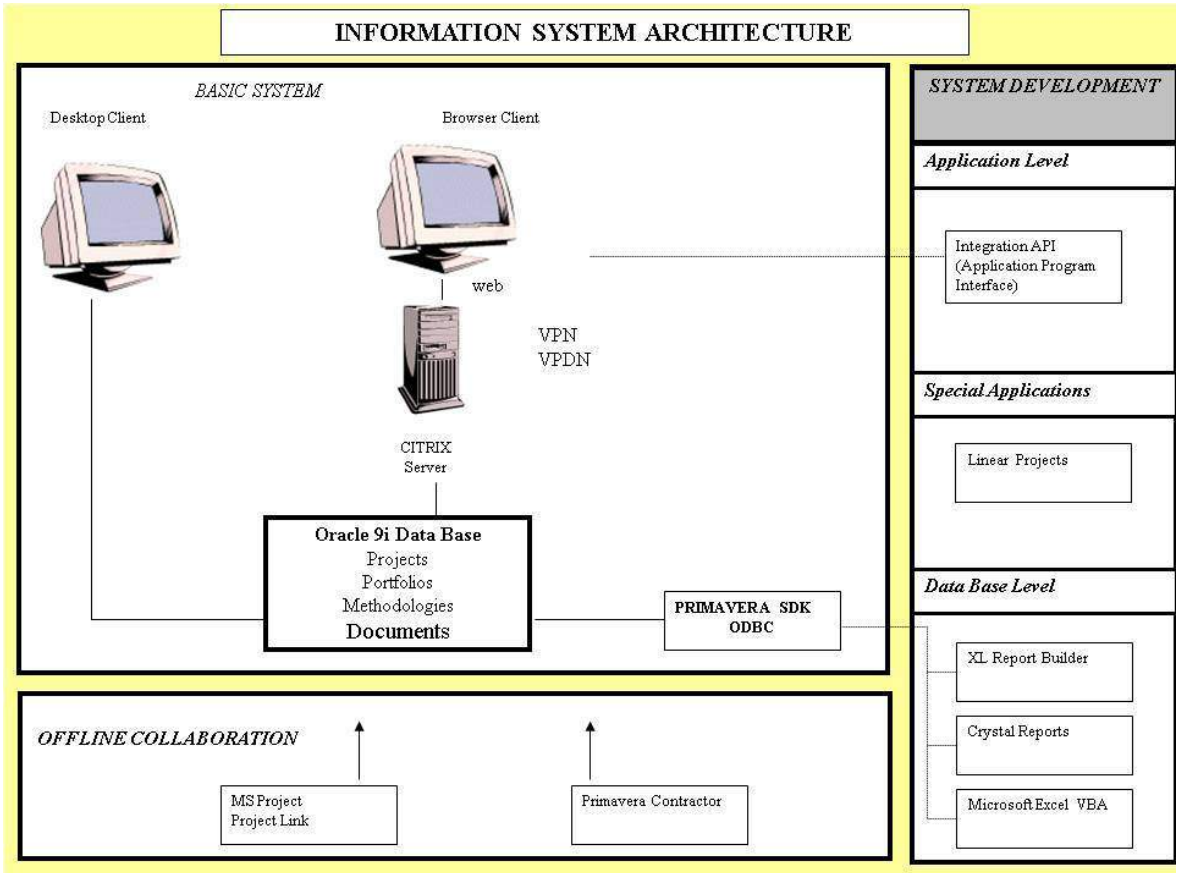
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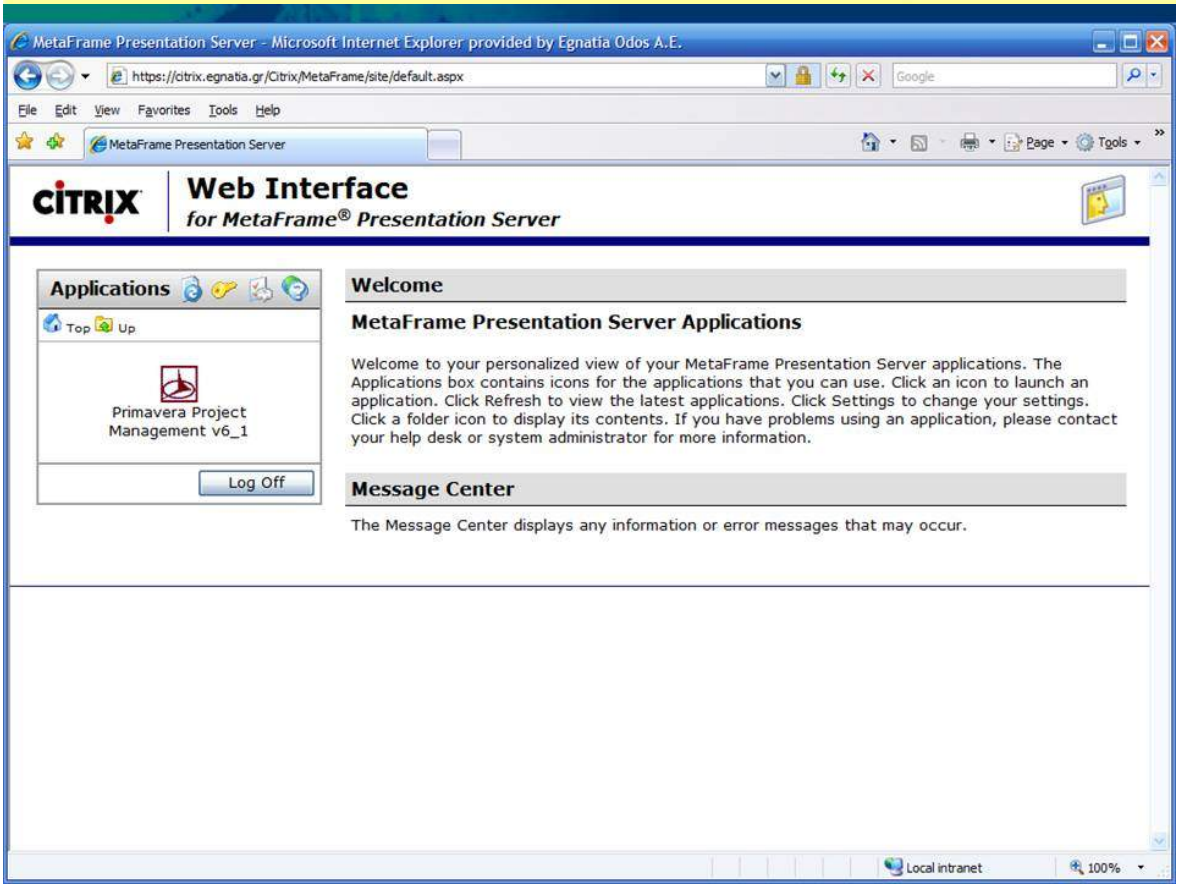
BASIC SYSTEM
Desktop Client
Browser Client
web
VPN
VPDN
CITRIX
Server
Oracle 9i Data Base
Projects
Portfolios
Methodologies
Documents
PRIMAVERA SDK
ODBC
OFFLINE COLLABORATION
MS Project
Project Link
Primavera Contractor
SYSTEM DEVELOPMENT
Application Level
Integration API
(Application Program
Interface)
Special Applications
Linear Projects
Data Base Level
XL Report Builder
Crystal Reports
Microsoft Excel VBA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https://citrix.egnatia.gr/Citrix/MetaFrame/site/default.aspx
File Edit View Favorites Tools Help
MetaFrame Presentation Server
CITRIX
Web Interface
for MetaFrame® Presentation Server
Applications
Top Up
Primavera Project
Management v6_1
Log Off
Welcome
MetaFrame Presentation Server Applications
Welcome to your personalized view of your MetaFrame Presentation Server applications. The Applications box contains icons for the applications that you can use. Click an icon to launch an application. Click Refresh to view the latest applications. Click Settings to change your settings. Click a folder icon to display its contents. If you have problems using an application, please contact your help desk or system administrator for more information.
Message Center
The Message Center displays any information or error messages that may occur.
Local intranet
100%

## 2. INTEGRATED SYSTEM

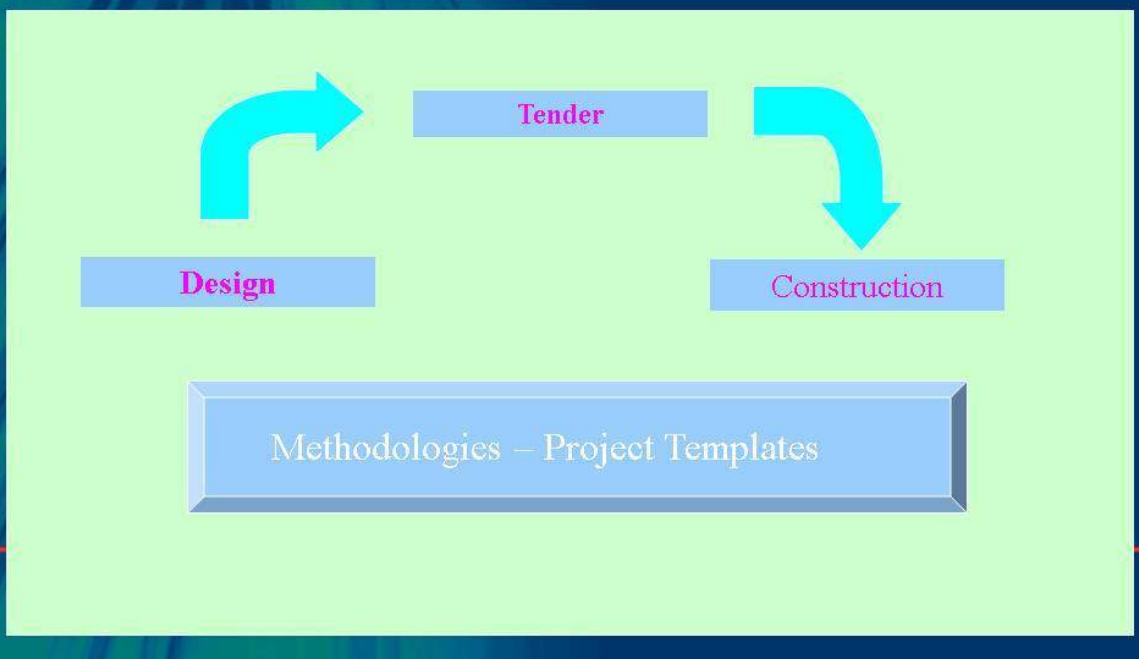
### 2.9 Administration Procedures

- Integration of System Implementation Procedures with ISO 9001 Quality Management System
- Internal reorganization with well defined responsibilities in the organization.
  - Project Managers
  - Construction Supervisors
  - Quantity Surveyors
  - Information Technology Department
  - Planning and Cost Control Unit
  - Resource Price-List Managers

ΕΓΝΑΤΙΑ ΟΔΟΣ Α.Ε.

## 2. INTEGRATED SYSTEM

### 2.10 Application in all project phases



# 2. INTEGRATED SYSTEM

## 2.11 Personnel

- Theoretical background in principles of project management
- Training in software
- "In – house" corporate seminars

Network of Construction Project Managers in Greece
(nCPM)

ΕΓΝΑΤΙΑ ΟΔΟΣ Α.Ε.

# 3. PROJECT PROGRESS

## 3.1 History

- System Analysis– OMEK Consulting Engineers
- Application of PRIMAVERA Software
- Information Technology Infrastructure (VPN and VPDN)
- Pilot Application (2004)

ΕΓΝΑΤΙΑ ΟΔΟΣ Α.Ε.

# 3. PROJECT PROGRESS

## 3.2 System Statistics from 2004 to 2010

- 80 contracts / users
- 3 bil. € construction works
- 13000 work items /activities
- 80000 resource assignments

- Over 3 mil. Resource assignments in historical part of database

ΕΓΝΑΤΙΑ ΟΔΟΣ Α.Ε.

# 4. CONCLUSIONS

## 4.1 Innovations

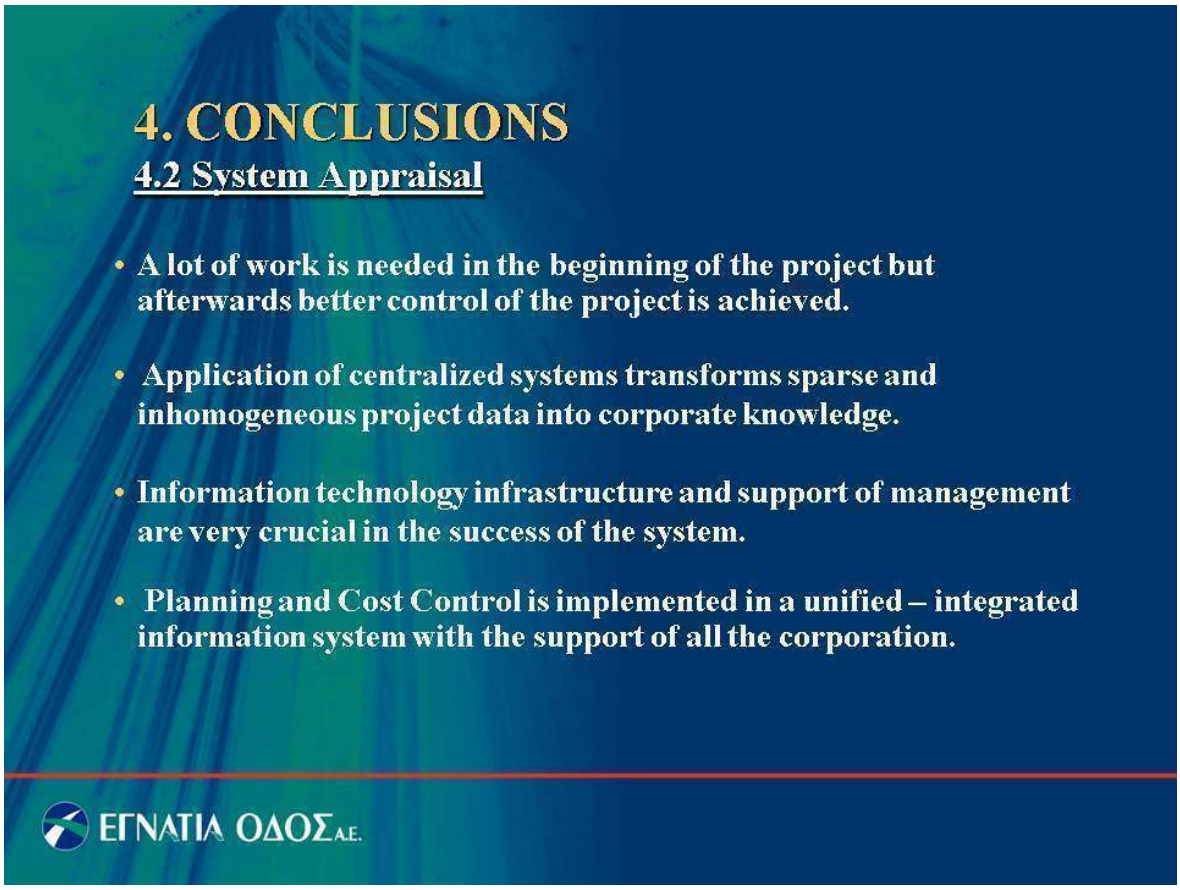
- Developed a WBS for highway projects

- Applied Enterprise Project Management System with live links from worksites to central offices.

- New methods of training corporate personnel

- Monitoring data can be used in Data Warehousing

ΕΓΝΑΤΙΑ ΟΔΟΣ Α.Ε.


4. CONCLUSIONS
4.2 System Appraisal
• A lot of work is needed in the beginning of the project but afterwards better control of the project is achieved.
• Application of centralized systems transforms sparse and inhomogeneous project data into corporate knowledge.
• Information technology infrastructure and support of management are very crucial in the success of the system.
• Planning and Cost Control is implemented in a unified – integrated information system with the support of all the corporation.
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# Prediction of earthmoving trucks deterioration using discriminant analysis

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## Abstract
Predicting the condition of construction equipment is a crucial matter for the building industry since it directly affects the company's investment planning thus resulting in considerable financial effects. Accurate predictions could be useful for the planning of future requirements concerning equipment maintenance, replacement or procurement as well as for ongoing earthmoving operations. Towards the above, this research implements a stochastic model based on discriminant analysis and evaluates its effectiveness. In particular, discriminant analysis is applied to data provided by two large Greek Construction Companies and attempts to classify the vehicles in several predefined condition levels, according to their characteristics of age, kilometers traveled to date and maintenance status. The results demonstrate that the performance of the prediction model is strongly dependent on the maintenance policy of the company, which forms the most substantial factor for further evaluation in the course of an effective total cost management.

## Keywords
Condition prediction, Earthmoving trucks, Maintenance, Discriminant Analysis

## 1. Introduction

Earthmoving equipment represents a major investment for the construction industry since its acquisition and maintenance involve a significant cost. Moreover, its continuous and intense use results in a high wear pace. The abovementioned facts justify the imperative need for effective policies concerning earthmoving equipment operation, maintenance and replacement. The capability to reliably predict the deterioration of equipment would significantly contribute to the achievement of the above.

This research focuses on the implementation of a deterioration prediction model to earthmoving wheel trucks. The analysis involves the fleet data and the equivalent

maintenance records of two large scale Greek construction companies and is based on the implementation of the statistical procedure of Discriminant Analysis.

## 2. Literature Survey

During the last decades, the increasing need for managing infrastructure resulted in the development of new models yielding a satisfactory prediction for their future condition.

Literature survey of the subject identifies numerous researches focusing on the prediction of bridges' and pavements' deterioration based on various models such as Markovian chains (Jiang and Sinha, 1994; Morcous and Lounis, 2006; Adedimila et al., 2009), Binary Probit Model (Bulusu and Sinha, 1997), Monte-Carlo simulation (Enright and Frangopol, 1998; Frangopol et al, 2001; Kong and Frangopol, 2004), Fuzzy Logic Techniques (Zhao and Chen, 2002), Linear Mixed Effects Model (Yu et al., 2007). Each of the aforementioned methods counts several advantages and disadvantages and most of them have been employed to Infrastructure Management Systems in U.S.A. Respective research has also been developed at the area of drainage systems with the employment of techniques such as the Ordered Probit Model (Baik et al., 2006) and the Neural Networks (Tran et al., 2007).

The research regarding vehicles' deterioration prediction is not equally extensive. The most relevant research refers to models that have been developed and applied to public transportation vehicles. Ludwig (1997) developed a wear prediction model for the bus fleet of the New Jersey Public Transportation Organization. This model was first applied to diesel engines and provides the wear pace of the vehicles in connection with its classification to a certain condition level. The model takes into account the fact that condition levels appertain to a discrete scale but it does not consider the effect of other factors such as vehicle mileage. Karlaftis and Sinha (1997) used data provided by the Organization of Urban Transportation of Indianapolis, USA in order to develop a prediction model for buses based on Ordered Probit methodology. This methodology not only recognizes the vehicle's condition levels as a scale of discrete numbers, but also links the vehicle's deterioration to a set of variables such as bus age, mileage, maintenance history and climate region. However, the methodology provides quantitative predictions related to the composition of a fleet as a whole and cannot be applied to a specific vehicle. Chang and Collura (1997) developed for the Armhest, Massachusetts Transportation System a model providing bus deterioration prediction, based on Ordered Probit Methodology and involving the age of the vehicle, the milage, its capacity, the engine's probable overhaul and the weather conditions. Karlaftis (1997) developed for the bus fleet of the Organization of Urban Transportations of Athens (OASA) a model that predicts the individual deterioration of each vehicle, using Discriminant Analysis methodology. An equivalent research presented by Sawicki and Zak (2009) addresses the classification of a fleet of vans as far as their technical condition is concerned, through the evaluation of particular characteristics (e.g. exhaust gas components, service break efficiency, condition of the body, mileage) using Rough Set Theory.

## 3. An introduction to Discriminant Analysis

Discriminant analysis is an analytical technique whereby a multivariate data set containing a total of n quantitative and/or categorical variables is separated into k pre-defined groups, using discriminant functions.

The number of discriminant functions f is equal to the minimum of the number of groups minus one and the number of variables; thus f=min (k-1, n).

Each discriminant function $D_j$, j=1…f, is a linear transformation of the n variables $x_i$, i=1…n, as shown in equation (1).

$$D_j=B_{j0}+B_{j1}*X_1+B_{j2}*X_2+...+B_{jn}*X_n \quad (1)$$

The constant $B_{j0}$ and the coefficients $B_{ji}$ are determined by maximizing the between-class variance relative to the within-class variance from sample data. The first discriminant function corresponds to the linear combination of variables that best separates the groups; the second is orthogonal to the first and is the next combination of variables and so on. Plotting the discriminant functions scores that emerge from applying the values of the variables locates the position of the respective observation in the f-dimensional space and thus, visualizes the discrimination of the groups. Figure 1 indicatively illustrates the case of three well-discriminated groups of observations.

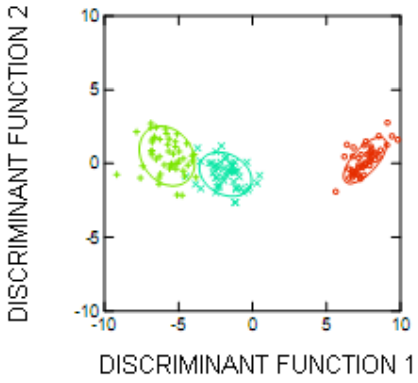


**Fig 1:** Example of well-discriminated groups

Another major purpose to apply discriminant analysis is the predictive classification of new cases. Once a model has been finalized and the discriminant functions have been derived, classification functions are calculated towards the determination of the group where a new case mostly belongs. The number of linear classification functions is equal to the number of groups as each one has its own classification function. The criterion of the classification is the score which is obtained through each function for employing the variables' values that correspond to the new case: The greatest score indicates the group that is the most representative for the case under examination.

The usage of the classification functions for the re-classification of the sample data is a direct and effective way to check the reliability of the method as a means of classification. It is obvious that a reliable tool is expected to classify the great majority of the observations in the class that they are actually known to appertain. An alternative way to check the consistency of the classification is the iterative "holdout method", whereby all data –with the exception of one case- is used to calculate the linear classification functions, which are then used to classify the omitted case either correctly or incorrectly.

## 4. Earthmoving truck deterioration prediction using discriminant analysis

Concerning this research, the original data set was provided by two Greek construction companies and includes the characteristics of 126 earthmoving trucks with regard to their capacity, age, kilometers traveled to date, and maintenance and condition levels. The objective is to employ discriminant analysis and find, amongst the available characteristics of the trucks (capacity, age, kilometers, maintenance class), those that best separate them as far as the different condition levels are concerned. Following this, the classification functions that the analysis defines, can be used for the assignment of any other truck of known respective characteristics, to the level condition that it appertains.

Concerning the condition level, the initially provided data set including ten levels ranging from 0.1 to 1, was transformed to a more flexible condition scale of 5 levels, each of which is represented by a discrete number from 0 to 4, according to the following description:

- Level 0: the vehicle's operation is impossible or involves high safety risk
- Level 1: the vehicle presents frequent failures requiring major unscheduled repairs
- Level 2: the vehicle presents frequent failures requiring minor unscheduled repairs or infrequent failures requiring major unscheduled repairs
- Level 3: the vehicle presents rare failures requiring minor unscheduled repairs
- Level 4: the vehicle presents no failures nor unscheduled repairs

As far as the maintenance level is concerned, the relevant policies of the companies result in the following classification:

- Class 1: The truck undergoes regular maintenance as scheduled
- Class 2: The truck undergoes extensive component replacement upon each project's completion.

The provided data are summarized in Table 1.

| **Variables** | **Condition Level** | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Age (years) | 10-16 | 10-32 | 9-31 | 11-31 |
| Kilometers | 474,832-510,886 | 24,520-600,662 | 3,113-877,847 | 3,296-295,324 |
| Capacity ($m^3$) | 13-15 | 14-22 | 9-26 | 11-20 |
| Maintenance | 1 | 1 | 1 & 2 | 2 |
| Number of trucks | 2 | 38 | 60 | 26 |

**Table 1**: Summary of sample data

The analysis, performed with the Statistical Package SYSTAT, yields the discrimination functions and the relevant illustration of the discriminant function scores as bivariate plots for various combinations of the discriminant functions (Figure 2). The plotting makes clear the fact that the discrimination of the different groups of trucks is not satisfactory and therefore the prediction of new trucks' condition level is not expected to be sufficiently reliable.

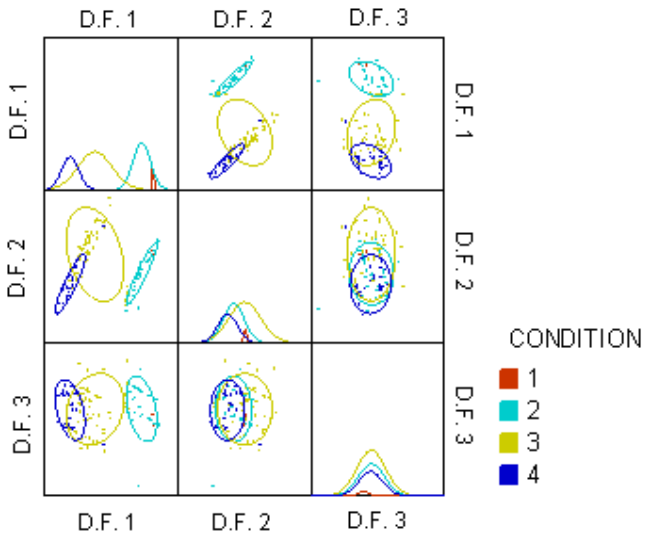


**Fig 2**: Plot of discriminant functions scores

Further to the above, discriminant analysis can yield the contribution of each variable to the groups' discrimination. The corresponding statistic index is the index "F-to remove", which particularly represents the relative importance of the variables included.

"F-to remove" index as presented in Table 2 demonstrates that the maintenance level has a far greater impact than the other variables. The above is also confirmed by the procedure of stepwise discriminant analysis which allows for stepwise omission of the variables that do not significantly contribute to the discrimination of the condition levels. Stepwise analysis yields the maintenance level as the major discriminative factor followed by the kilometers traveled.

| | Variable | F-to remove index |
|---|---|---|
| 1 | age | 0.286 |
| 2 | capacity | 0.695 |
| 3 | kilometers | 33.519 |
| 4 | maintenance | 99.113 |

**Table 2**: Relative importance of the variables of the model

The next phase of the analysis includes the determination of the classification functions and the re-classification of the sample data according to them. The Classification Table (Table 3) which indicates the actual condition level and the condition level calculated from the linear classification functions for each truck, demonstrates that the analysis failed to assign a significant percentage of the trucks of groups 2 and 3 to the correct group. Specifically, a 42% of the observations appertaining to group 2 were misclassified while the respective percentage for group 3 reached the 28%. Similarly reduced consistency is obtained by the aforementioned "hold-out" method.

| Condition level | | | | | % correct |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | |
| 1 | 2 | 0 | 0 | 0 | 100 |
| 2 | 16 | 22 | 0 | 0 | 58 |
| 3 | 0 | 10 | 43 | 7 | 72 |
| 4 | 0 | 0 | 1 | 25 | 96 |
| total | 18 | 32 | 44 | 32 | 73 |

**Table 3**: Classification Table for the sample data

## 5. Evaluation of the model's performance and significance

As it became apparent, the discrimination of the sample data for the used variables is not clear and consequently a reliable classification of new observations cannot be achieved. However, the said insufficiencies are strongly related to the determinant impact of maintenance and particularly to the fact that the maintenance policy involving frequent and extensive component replacement, eliminates the impact of factors such as the age and the kilometers traveled, that are normally expected to have a significant role on a vehicles' deterioration. In fact, such a maintenance policy directly defines the condition level and thus reduces the significance of a deterioration prediction model. Therefore, any kind of reliable equipment condition prediction strongly depends on the level of its maintenance and thus, the main objective of the effective operational cost management must be the evaluation of the maintenance policy applied, in correlation to the financial effects it involves. Towards this, the examination and comparison of actual cost data deriving from the implementation of substantially different maintenance policies to equivalent cases of equipment is advisable, provided that the company applies a consistent system for the monitoring of the equipment's performance and the collection of the necessary data.

Given the above, it would be advisable to attempt the discrimination of the trucks that are classified to the regular maintenance level so that the determinant impact of this factor is eliminated and the impact of the other factors is allowed to be observable and measurable: As illustrated in Figure 3, the models' discrimination ability for the trucks of maintenance level 1 has improved. The variable that most contributes to the discrimination is the kilometers traveled (F=22,846), while the age seems to have a significantly limited impact (F=3,184) and the trucks' capacity a rather negligible one (F=0,305).

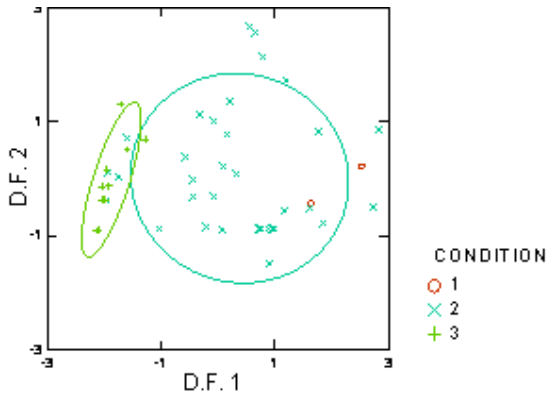


**Fig 3**: Plot of discriminant function scores for regular maintenance level

However, the classification functions thereafter calculated, still lead to misclassification of about 20% of the initial observations. This can be attributed to the fact that several data values significantly diverge from the pattern. However, such divergences are expected to occur up to a certain degree since site data involve significant uncertainty emerging from the human error or subjectivity, as well as other unpredictable factors.

## 6. Conclusions

This research aims at improving the management of earthmoving equipment; focuses on the implementation of a condition prediction model that has successfully been applied to means of Public Transportation. The model exploits data provided by two Greek construction companies and concern 126 earthmoving trucks. The first objective is to employ discriminant analysis to find amongst the available characteristics of the trucks (capacity, age, kilometers, maintenance level) those that best separate them as far as the different condition levels are concerned. The model recognizes by far the maintenance level as the most significant factor for the condition of the truck. However, this is mainly due to the considerably variable effectiveness of the different maintenance policies applied to the sample trucks: according to the one of the policies, the truck undergoes extensive component replacement upon each project's completion. This eliminates the impact of the other characteristics (capacity, age, kilometers) and thus prevents their correlation with the trucks' condition. Therefore, the model is not allowed to provide a sufficiently reliable classification of new trucks. The model's performance improves under the consideration of a common maintenance level, verifying the fact that its importance and effectiveness is strongly dependent on the maintenance policy applied.

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*SPM02*

# An Integrated Approach to Monitoring/Performance Assessment of Operational Programmes Co-financed by the European Union

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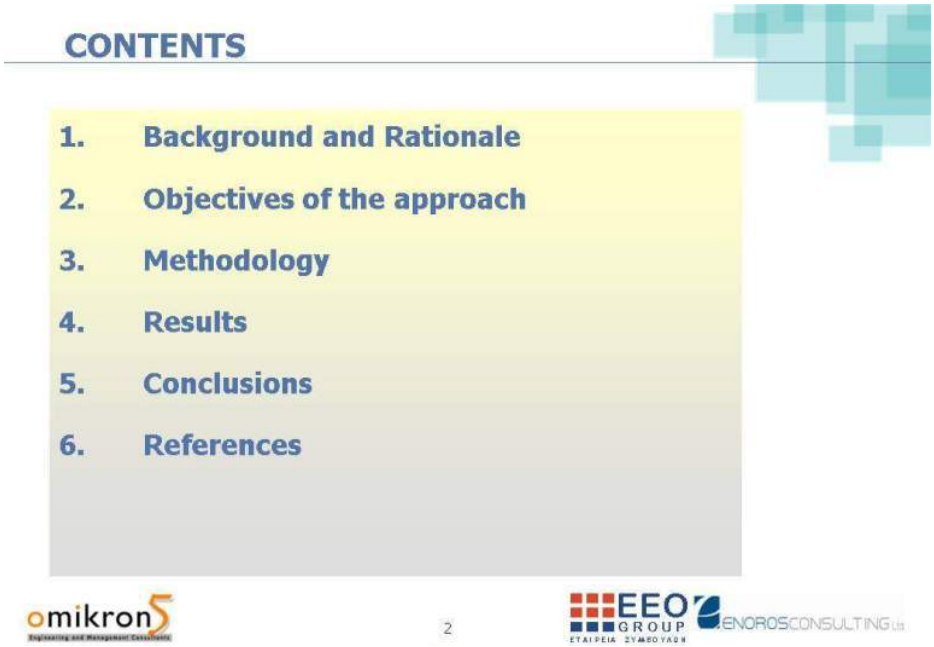

## 1. BACKGROUND AND RATIONALE (1)

**The European Union spends huge amounts of money to support the less developed Member States in order to achieve the key Community objectives, namely:**

- **The Convergence objective, which is aimed at speeding up the convergence of the least-developed Member States and regions by improving conditions for growth and development**
- **The Regional competitiveness and employment objective, which is, outside the least-developed regions, aimed at strengthening regions' competitiveness and attractiveness as well as employment by anticipating economic and social changes**

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## 1. BACKGROUND AND RATIONALE (2)

- **The achievement of the above mentioned Community objectives is assured through the successful development and implementation of Operational Programmes, which include a large number of projects**
- **The Beneficiaries (Implementing Agencies) are responsible for implementation and day by day management of the individual, whether the Managing Authorities are responsible for overall programme management and control**
- **Implementation, monitoring and control of the Operational Programmes has to be compliant with strict European Commission regulations. Thus, effective programme monitoring/ performance assessment is an issue of crucial importance**

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## 2. OBJECTIVES OF THE APPROACH (1)

- **To provide a simple but efficient tool for:**
  - ✓ **Monitoring overall schedule and absorption performance at all levels required (from the individual contract to the whole operational programme)**
  - ✓ **Assessing the capacity of the beneficiaries to implement its projects on time**
  - ✓ **Assessing the fulfillment of the n+3/n+2 funds deployment rule**

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## 2. OBJECTIVES OF THE APPROACH (2)

- **To provide a simple but efficient tool for:**
  - ✓ **Assessing plausibility and credibility of beneficiaries' project planning and implementation**
  - ✓ **Giving early warnings to the beneficiaries to undertake corrective actions**

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## 3. METHODOLOGY (1)

- **The approach presented hereby is based on the "Earned Value Management (EVM)" method, , which is well established and widely used in project management for all kind of projects. In the following, only the EVM principles relevant to this approach will be outlined.**

- **Project work needs to be logically scheduled and resourced in a work plan. The work scope, schedule and cost need to be integrated and recorded in a time-phased budget known as "performance measurement baseline (PMB)"**

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## 3. METHODOLOGY (2)

| Task | Budget | Months | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| | | 6 | 6 | | | | | | | | | | |
| 1 | 12 | | | | | | | | | | | | |
| | | | 8 | 12 | 16 | 12 | | | | | | | |
| 2 | 48 | | | | | | | | | | | | |
| | | | | | | 7 | 21 | | | | | | |
| 3 | 28 | | | | | | | | | | | | |
| | | | | | | | | 18 | | | | | |
| 4 | 18 | | | | | | | | | | | | |
| | | | | | | | | 4 | 8 | 10 | 6 | | |
| 5 | 28 | | | | | | | | | | | | |
| | | | | | | | | | | | | 8 | 8 |
| 6 | 16 | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| SUM | 150 | 6 | 14 | 12 | 16 | 19 | 21 | 22 | 8 | 10 | 6 | 8 | 8 |
| CUM | 0 | 6 | 20 | 32 | 48 | 67 | 88 | 110 | 118 | 128 | 134 | 142 | 150 |

**Table 1: Building the PMB**

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## 3. METHODOLOGY (3)

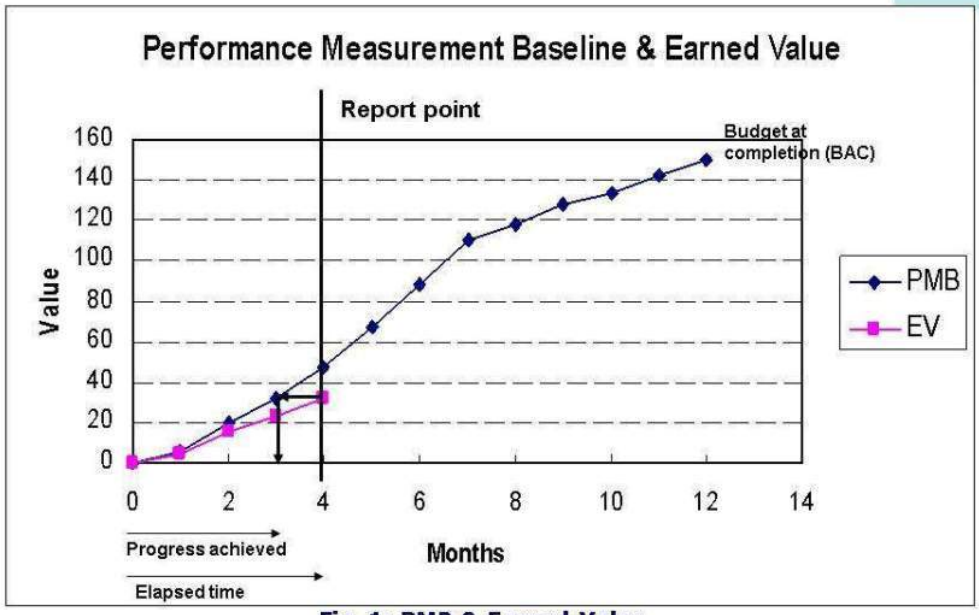


**Fig. 1: PMB & Earned Value**



## 3. METHODOLOGY (4)

- **Performance indicators - Definition**
  - ✓ **Absorption performance (AP): earned absorption (value)/planned absorption (value)**
  - ✓ **Schedule performance (SP): progress achieved/elapsed time**
  - ✓ **To complete performance index for schedule (TCPI), which is calculated according to the formulae (see Fig 1): TCPI = (BAC – EV)/(BAC – PV). This indicator demonstrates the level of absorption capacity required to finish the project on time from the report date**

## 3. METHODOLOGY (5)

- **Performance indicators – Example (see Fig. 1)**
  - ✓ **Absorption performance = 32/48 = 0.67**
  - ✓ **Schedule performance = 3.1/4 = 0.78**
  - ✓ **To complete performance index for schedule = (150 - 32)/(150 - 48) = 1.16**



## 3. METHODOLOGY (6)

- **Performance indicators – Benchmarks**
  - ✓ Excellent performance (very low risk): AP ≥ 0,95
  - ✓ Very good performance (low risk): 0,80 ≤ AP < 0,95
  - ✓ Good performance (moderate risk): 0,70 ≤ AP < 0,80
  - ✓ Fair performance (high risk): 0,50 ≤ AP < 0,70
  - ✓ Insufficient performance (very high risk): AP < 0,50

## 3. METHODOLOGY (7)

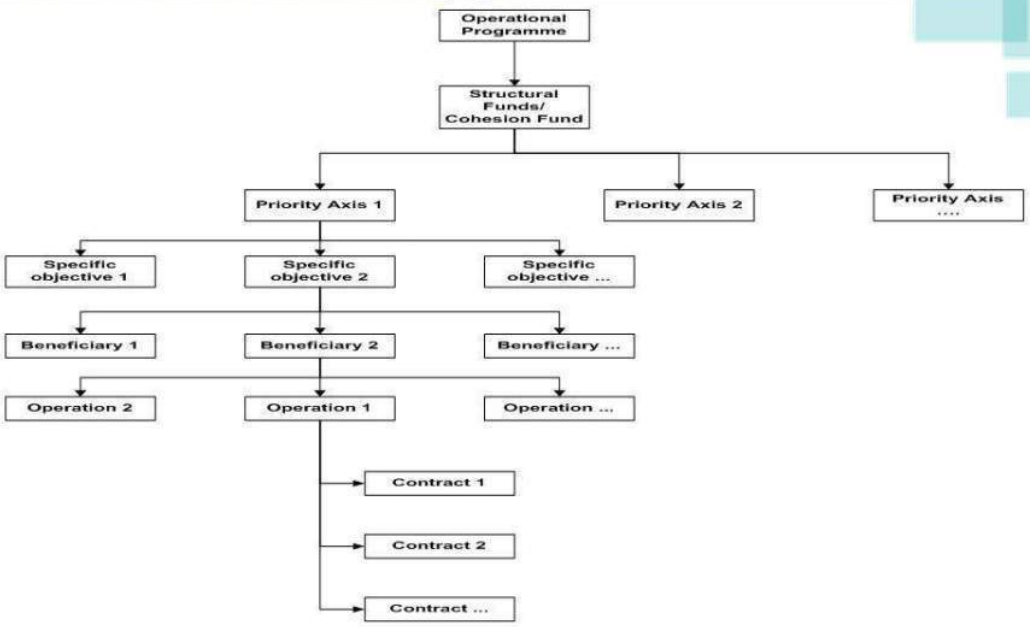


**Fig. 2: Structure of a typical Operational Programme (OP)**



## 3. METHODOLOGY (6)

- **Implementation steps of the approach**

1. Define PMBs at contract level based on the agreed payments
2. Define/aggregate PMBs for the higher levels of the programme
3. Define earned value lines for each level
4. Assess programme performance at the different OP levels regularly (e.g. on quarterly or biannual basis) by using the performance indicators previously mentioned

## 3. METHODOLOGY (6)

- **Implementation steps of the approach**

5. Classify beneficiaries and relevant absorptions into risk groups
6. Check performance against fulfillment of the n+3/n+2 rule at the level of Fund
7. Identify performance trends and elaborate corrective actions and performance recovery scenarios
8. Prepare consolidated progress reports for the awareness of decision makers



## 4. RESULTS – CASE STUDIES (1)

- **Risk evaluation regarding loss of funds of the 25 operational programmes of the 3rd Community Support Framework in Greece (Client: Ministry of Finance, 05/2005 – 02/2006)**

✓ Building of the PMBs for each OP at OP level, according to the absorption commitments

✓ Building of the respective EV curves on the basis of actual absorptions for the years 2000 – 2004. Extrapolation of the EV curves based on three absorption scenarios (business as usual, pessimistic, optimistic) and estimation of the cumulative absorption at the end of the programming period (31/12/2008)

## 4. RESULTS – CASE STUDIES (2)

- ✓ Calculation of loss/overage of funds per OP
- ✓ Assessment of OP performance and classification of OPs into performance/risk classes based on the values of absorption performance indicator for each OP at the end of year 2004
- ✓ Assessment of beneficiaries' performance for each OP



## 4. RESULTS – CASE STUDIES (3)

| Operational Programme | Absorption performance |
|---|---|
| **Sectoral Programmes** | |
| Road axes - Ports - Urban development | 0,60 |
| Employment and vocational training | 0,57 |
| Education and initial vocational training | 0,54 |
| Culture | 0,54 |
| Fisheries sector | 0,49 |
| Railways - Airports - Public transport | 0,43 |
| Agricultural development and Reform of the country side | 0,42 |
| Health | 0,41 |
| Competitiveness | 0,38 |
| Environment | 0,38 |
| Technical assistance | 0,38 |
| Information society | 0,29 |

**Table 1: Performance assessment of the 12 sectoral OPs of 3rd CSF in Greece (2004)**

## 4. RESULTS – CASE STUDIES (4)

| Operational Programme | Absorption performance |
|---|---|
| **Regional Programmes** | |
| Western Greece | 0,56 |
| Attica | 0,52 |
| Crete | 0,52 |
| Western Macedonia | 0,42 |
| Eastern Macedonia and Thrace | 0,39 |
| Central Macedonia | 0,39 |
| Thessaly | 0,38 |
| South Aegean | 0,36 |
| Ionian islands | 0,35 |
| Sterea Ellada | 0,33 |
| Peloponnese | 0,33 |
| North Aegean | 0,30 |
| Epirus | 0,29 |

**Table 2: Performance assessment of the 13 regional OPs of 3rd CSF in Greece (2004)**



## 4. RESULTS – CASE STUDIES (5)

- **Technical assistance to the Managing Authority of the OP Railways - Airports - Public transport for the monitoring of projects and the OP (3/2006 – 2/2008)**
- **Evaluation of the indicators systems of the Operational Programmes "Sustainable development and Competitiveness" and "Employment, Human Capital and Social Cohesion" included in the National Strategic Reference Framework of Cyprus for the period 2007 – 2013 (Client: Planning Bureau, 1/2009 – 12/2009)**

## 5. CONCLUSIONS

**The present paper presents a simple and straightforward approach for monitoring of operational programmes. This approach is easily implemented in existing Management Information Systems or in widely used project management software packages (e.g. MS Project, Oracle Primavera etc.) and does not require extensive knowledge of project management.**



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# A new approach to assessing Malaysian contractor satisfaction levels

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## Abstract
The extent of poor project outcomes is a recurring issue for construction industries worldwide. One of the main causes of these and project failure seems to be the inability of contractors to provide a high level of service quality to the project team. In Malaysia, design failures have also been identified as a further contributory factor.

To overcome this, different types of subjective performance measurement have been progressively developed. These approaches are typically concerned with client satisfaction, customer satisfaction, home buyer satisfaction and occupant satisfaction, but very seldom consider contractor satisfaction.

This paper examines the implications of this, and what is involved in developing satisfaction measures based on contractor perception instead of the typical sole concern with client performance. As a result, other attributes such as participants' performance, business performance, project performance, external factors and contractor characteristics are also examined. Several potential attributes are derived from interviews among Malaysian contractors, namely: performance (direct attributes) and contractor characteristics (indirect attributes) that possibly influence contractor satisfaction levels. These attributes are then developed to improve the existing conceptual framework.

The developed framework is expected to help the project team in performing projects more efficiently, maintaining service quality and improving relationships between participants. In addition, the findings of the paper should assist contractors enhance competitiveness, improve their image and create more job opportunities in the future.

## Keywords
Attributes, contractor satisfaction, framework, measurement, performance, projects.

## 1. Introduction

The performance of the construction industry is of some cause for concern throughout the world. This seems to be mainly due to substandard construction work of contractors and the absence of a high service quality from contractors is widely recognised as an important influential factor. In Malaysia, however, although the issue of contractor service quality is still important, design failures have been

found to be the main cause of problems. In response to this, it is argued, an effective attempt is needed to determine the contributory factors involved and develop diverse types of performance measurement.

There are two basic approaches to measuring the level of performance in the construction industry - objective measurement (time and cost) and subjective measurement (quality and satisfaction). Objective measurement, also known as the *iron triangle* has extensively been used. However, this has some limitations. For example, it is ineffective for large development projects and where there is a diverse group of participants (Toor and Ogunlana, 2009). To alleviate this, subjective indicators such as satisfaction measures have been used to enhance existing objective methods and project outcomes.

Satisfaction measurement and measures (SM) are derived from perceptions, services and values, and have received great attention in performance studies involving several disciplines, such as marketing, business and psychology. SM has also been used in the construction industry to gauge service quality. Although contractor satisfaction (Co-S) is one of the best indicators of construction project performance measurement (Soetanto and Proverbs, 2002), it is seldom used in practice. Additionally, existing studies on the attributes of Co-S are very limited as they are purely concerned with client performance. Accordingly, this study is focused on determining the potential attributes of Co-S and the development of a contractor satisfaction (Co-S) conceptual model or framework appropriate for construction projects.

## 2. Previous studies of SM in construction

In recent years, subjective measurement has been conducted in the construction field to improve construction performance in terms of level of product and service delivery. A number of methods and tools exist to evaluate the satisfaction levels of participants involved in construction projects. Previous work on performance measurement based on SM is dominated by client satisfaction (Cl-S), customer satisfaction (Cu-S), home-buyer satisfaction (Ho-S) and occupant satisfaction (Oc-S). This suggests that SM is an efficient indicator in demonstrating performance levels. To establish performance standards necessitates a paradigmic shift of the construction industry from a product-oriented culture to a service–oriented culture. This is also thought to be important in improving construction project quality. As Soetanto and Proverbs (2004) emphasize, satisfaction and performance are interrelated in determining the level of performance outcomes. The different perspectives of the roles of SM and the attributes involved are explained in the following discussion.

Arditi and Lee (2003) acknowledge that the performance of project outcomes could be measured in terms of client perceptions. Cl-S measurement is important to determine the performance levels of other parties, such as consultants and contractors. However, Cl-S levels can be different from one client to another as each client perceives service quality in his/her own unique way based on the

cumulative memory of many experiences. Cheng et al., (2006) also emphasize that client characteristics, including sector, size or location, may have a significant impact on Cl-S levels.

Studies of SM concerning the client/customer's perspective have been the most popular among researchers from a variety of disciplines. Cu-S, for example, has been developed to investigate customer perceptions of facilities management services (Tucker and Pitt, 2009). This means that satisfaction is not only limited to measure the quality of the end product but it seems also to be an adequate process in identifying service quality levels. In the construction industry, Cu-S is widely used to improve participant relationships, with increased understanding and enhanced cooperation among the participants. However, Cu-S could possibly be influenced by the several expectation factors, including past experience, their own personnel needs, image of the contractor, their own investment and relationships (Karna et.al, 2009).

In a different perspective, several empirical studies emphasize the satisfaction of home buyers and occupants. Ho-S and Oc-S are important in demonstrating the project team's performance level. Torbica and Ricoh (2001) stress that Ho-S is not only influenced by product design or product quality, but other home buyer characteristics such as experience, income, age, knowledge and location. To investigate the level of Ho-S, an instrument called HOMBSAT was developed, comprising the three dimensions of design quality, house quality and service. On the other hand, Oc-S has been introduced to determine the inappropriateness of design and performance of the building. This method can be conducted during the design stage (in the form of value engineering) as well as after completion of the building.

## 3. Study gap

According to the earlier discussion, SM is becoming a prominent approach to improving service and product delivery of construction projects (Chan, 2009). SM can provide several benefits, as it is a comprehensive way to create differentiation among the competitors, increase the level of service, improve the quality of the end product, gauge business performance, sustain business in the market place, increase the opportunities for repeat business with stakeholders, and enhance image and company reputation. Project performance measurement based on satisfaction levels could be made more effective by considering all project participants including the contractor. Soetanto and Proverbs (2002) have suggested that SM from a contractor perspective is an ideal assessment by which to increase the quality of projects. However, the evaluation of Co-S is still not extensively conducted. Therefore, there is a need to improve the existing Co-S model. The following discussion focuses on the development of a Co-S framework by including other significant elements that are not fully explained in previous studies.

## 4. Research methodology

According to the issues highlighted above, this study aims to identify the main attributes of Co-S for incorporation into a preliminary conceptual framework. The main attributes are derived from an extensive review of the literature and preliminary interviews. The framework was developed by combining two elements, i) performance attributes and ii) contractor characteristics. The development of the Co-S framework is important in order to refine the existing model.

Several attributes were obtained by consulting previous studies. As Chen et. al (2009) point out, exploring the literature avoids duplicating work, identifies previous work in the same fields and helps attain some ideas and information that may suitable for the study. To establish a comprehensive Co-S model, face-to-face preliminary interviews were conducted with contractor personnel registered under the Malaysian Construction Industry Development Board (CIDB). The objective of the interviews was to identify additional information and specify problems not identified in previous work. Additionally, the interviews were important to address the participants' understanding of the problems and issues involved in the study (Cheng et.al, 2006). Six different grades of Malaysian contractors were selected at random for participation in the open-ended interviews. The findings were employed in the development of the preliminary conceptual Co-S framework.

## 5. Research findings and discussions

The previous literature on performance measurement indicated that project outcomes, profitability and productivity can be improved by having an effective satisfaction evaluation method. In this regards, the development of a unique Co-S model and identification on interaction between Co-S attributes are discussed in the next section.

### 5.1 Potential attributes pertinent to Malaysian contractor satisfaction levels

This study begins by identifying the attributes for measuring Co-S. To attain a better understanding, this section provides a detailed discussion on the attributes includes performance attributes (direct attributor) and contractor characteristics (indirect attributor) as depicted in Figure 1.

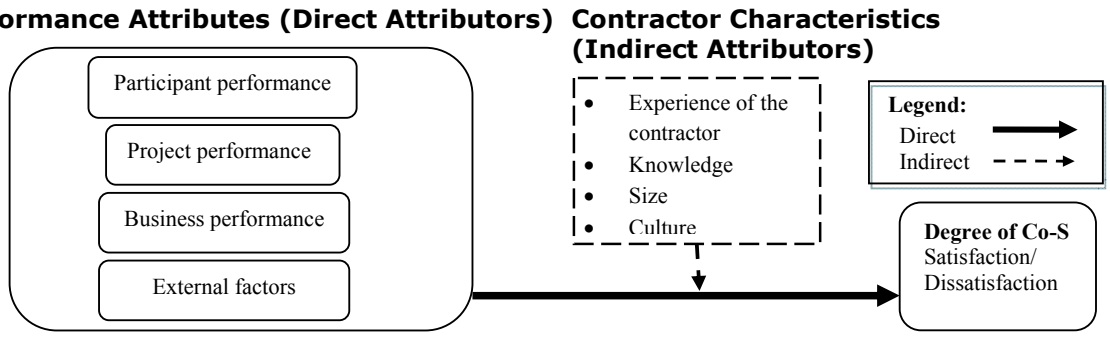


Figure 2**: Proposed conceptual framework of Co-S measurement**

### 5.1.1 Performance attributes

The outcome of the research to date shows that Co-S levels depend on methodologies, and perspectives and attributes have been selected to measure degree of satisfaction. Four indicators of performance attributes were derived namely: i) participants' performance; ii) project performance; iii) business performance; and iv) external factors (comprising project related factors, project procedures and the external environment). The following discussion describes each Co-S attribute in detail.

This paper proposes an enhancement by integrating three elements, namely service delivery, relationships of people/participants and communications. Service delivery consists of items relating to products and/or services performed by the participants (such as clients, consultants, subcontractors and suppliers). Butcher and Sheehan (2010) assert that an excellent performance evaluation of the overall perspectives leads to a longer term improvement of performance levels. Additionally, trust has been identified as one of the important factors to improve relationships among participants (Smyth et. al, 2010). One of the interviewees also emphasized communication as another item for evaluating the service quality of participants. Effective communication is needed to improve project team relationships as it influences participant satisfaction (Leung et al. 2004). This shows that service quality is not only based on service delivery but relationships of participants and communications between project team also need to be taken into account in developing a Co-S framework.

Project performance is often used as a major indicator in performance measurement studies. Construction projects are commonly acknowledged as successful when timely completed, within budget, conform to specification and satisfy stakeholders. To determine the appropriate Co-S attributes, this study proposes other attributes: functionality; profitability; absence of claims and fitness for purpose. However, five additional performance measures have been identified as applicable to contractors: cost performance; time performance; quality performance; owner satisfaction; and profit margin (Ling et al., 2008). As the interviewees emphasized in the interviews, these attributes are important for contractors to maintain their performance.

Business performance is another important element in measuring Co-S levels. Commonly, contractor performance is judged by cost, time and quality alone. However, some previous studies argue that contractor performance should be extended to include the continued activity of contractors, as measured by their profitability, investment in research and development, harmonious working relations throughout projects, environmental protection and safety. Furthermore, business performance also depends on the resources and capabilities of the construction company, its project management competencies, the strengths of its relationships between project team members and the strategies of the company.

Another key attribute that influences Co-S levels is external factors. Project characteristics and the transparency of government procedures on contractor selection are considered to be among the important external factors influencing Co-S. Having good connections (*guanxi*) between the contractor and the client are still essential for the successful procurement of projects in many countries (Ling et al., 2005). In addition, the environmental issues of: economic environment; social environment; political environment; physical environment; industrial relationships environment; technology advance have a potential influence on Co-S levels.

### 5.1.2 Contractor characteristics

The impact of indirect attributes or contractor characteristics are important to examine the degree of Co-S levels. Informed by the literature and the preliminary interviews results, the four indirect attributes of contractor's experience, knowledge, size and culture, were found to be necessary to taken into consideration.

The contractor's experience is an important criterion for evaluating the performance of the contractor which may influence Co-S levels. The contractor's experience is commonly determined by the number of years working in construction. Pemsel et al. (2009) assert that experience from previous projects influence the expectation of the final outcome. However, the contractor's expectations also affect the decision as they are based on perceived service performance. The expectation or standard of experience of a contractor could be determined by the contractor's familiarity with the market, understanding of regulations and technical and management skills. The result indicates that, to evaluate Co-S levels, it is important to consider experience in terms of the total work volume on similar projects, the average work volume on similar projects, experience of contract types and teams, working in similar geographical conditions and working in similar weather conditions on similar projects.

Another characteristic that impacts on Co-S is knowledge. Currently, most projects require a high level of skills in terms of technology, material and safety, thus the contractor's personnel need to have sufficient basic knowledge in these areas. Interviews results indicate that an effective and knowledgeable contractor is necessary to ensure the work is delivered according to the work programme, standards of requirements and specified level of quality. Know-how knowledge is important but hardly to be shared as it acquired through learned behaviour. The relationship between this knowledge and Co-S can be derived as the contractor has different levels of expectation from which judge performance.

In construction, contractors can be distinguished according to several sizes - such as small, medium and large - and based on their capital and financial capabilities. Additionally, this includes organizational structure, current workload, technical personnel and management capability. Larger contractors have different expectations than small or medium size contractors. Although several direct attributors influence performance measurement based on Co-S levels, the literature

and the interviews results show that characteristics such as the contractor size indirectly impact on the degree of Co-S. For example, larger size contractors have different needs, as they are as concerned as much with their reputation as with profit.

In construction, culture is concerned with the impact of a nation's culture on construction management. Additionally, culture in project management also has been investigated by Bredillet et.al (2010). Every organization practices different systems, arrangements and procedures. Co-S levels could be affected by culture as it relates to motivation, efforts to innovate, incentives offered and implementation of new technology. Additionally, the construction industry currently emphasizes environmental issues and innovation as there are several important requirements that need to be fulfilled.

## 6. Conclusions

An integrated framework of Co-S levels is proposed as shown in Figure 1. This integrates the two main attributes (direct attributes and indirect attributes) that have been discussed in the previous section. The paper demonstrates these two highlighted components to measure performance, namely: (1) direct attributes also known as performance attributes that consist of several elements such as participants' performance (service quality), project performance, and business performance and external factors; (2) indirect attributes also known as contractor characteristics that comprises several elements including knowledge, size of the organization, experience and culture. The model established is likely to be beneficial to contractors in enhancing and maintaining their level of business as well as improving project performance. Additionally, the proposed Co-S framework may be able to motivate clients, consultants and other participants to enhance their service and product quality, compete in the market place, eliminate claims and disputes, and increase their trust in the contractor's capability.

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# Low Energy And Passive Housing Standards In Europe

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## Abstract
Implementation of building energy ratio for new buildings resulted with a need to establish standards and certificates suitable for different building codes, geographical locations and building traditions of a specific nation or region. For Europe most highlighted energy rating indexes are "EPBD" ("Energy Performance of Building Directive"), with British version "BER" ("Building Energy Rating"), German "Energie-Pass" and Swiss "Minergie®", as well as for USA "LEED". Also well known are standards for extremely low energy buildings as "PassivHaus", "Minergie®P-Eco", "Zero Energy" and "**klima**:aktiv".
By the directive of the European Union all the buildings on the market that are being built, sold, or rented need to be certified. Gained certificate and annual energy consumption data could be presented to anyone interested, which will intensively affect the market.
This article is presenting different energy rating certificates with specific energy consumption data which enables the energy consumption comparison of different buildings. The article also presents the comparison of low energy building standards as: "PassivHaus", "Minergie®" and "LEED".

## Keywords
low energy housing, passive housing, standards, certificate, certificate comparison

## 1. Introduction

Inducing the obligation of certifying the energy performance of the buildings resulted with establishing different standards and certificates which are customized according to different laws, geographic location, and building tradition of a specific region and a nation. Specially these certificates are worth mentioning: EPBD (Energy Performance of Buildings Directive), with it's versions like British BER (Building Energy Rating) and German Energie-Pass, but also American LEED, Swiss Minergie®, with their well known standards for very low energy buildings like PassivHaus, Minergie®P-Eco, Zero Energy and klima:aktiv.
By the directive from EU all the buildings that are built, sold or rented will be certified, and the data of annual energy consumption for heating will be provided or can be seen by all interested customers, which could have a major impact on the community and the market.

## 2. Comparison of needed conditions for very low energy consumption buildings in different EU countries

The assumptions and basics for energy consumption are different and therefore the comparison of required energy performance is not possible. For instance energy performance can be calculated by the area of heated floor, or by the populated area, or by the big floor area and these can vary 10 to 20%. Furthermore, which energy consumption processes are included in calculations of energy performance also makes a difference. Table 1. shows the limit consumption for several countries which have these regulations.

| *Country* | Very low energy building limitations |
|---|---|
| ***Austria*** | Low energy buildings are usually those buildings with heating energy consumption below 60-40 kWh/m$^2$ of the total area (larger numbers for single family housing). Standard passive houses with 15kWh/m$^2$ are defined by the usable area in Styria and by heated area in Tirol. |
| ***Denmark*** | Temporary building regulative defines two different low energy consumption (LOC) classes. LOC class 1 and LOC class 2 are defined by the energy performance calculations which are 25 or 50% lower than the maximum obligatory for new buildings.<br>Minimum energy consumption that is requested for new residential buildings is 70 + 2200/A kWh/m$^2$ annually (where A defines total heated floor area). For the other the minimum energy consumption request is 95 + 2200/A kWh/m$^2$ annually. Minimum energy consumption for the non residential buildings includes lighting. |
| ***France*** | Since May 8$^{th}$ 2007. "Arraté ministeriel" is defining requests for energy consumption of buildings. These regulations have five building types: HPE, HPE EnR, THPE, THPE EnR, BBC and "Low consumption building".<br>BBC requests:<br>New buildings: annual energy consumption for heating, cooking, airing, warm water and illumination have to be lower than 50 kWh/m$^2$ (40 – 60 kWh/m$^2$ depending on climate and height over the see level). For other new buildings: annual energy consumption for heating, cooking, airing, warm water and illumination need to be at least 50% lower than the temporary building regulation proscribes. |
| ***Germany*** | Minimal energy consumption performance for a new residential building are defined and calculated by:<br>50,94 + 75,29*(A/Ve)+[2600/(100+An)] kWh/m$^2$<br>where A defines the outer area of insulation, Ve is the volume surrounded by the insulation and An defines the usable area.<br>Public definitions which are meant for public support for low energy buildings are in suborder of state (Kreditanstalt für Wiederaufbau, Frankfurt (KfW)). These programs are mostly financed from public monetary funds. Temporary energy limit is 60% (KfW60) (request for primary energy is limited at 40 kWh/(m$^2$a), but the insulation of the buildings are 45% better than EnE level).<br>Besides that there is a financial aid program for "Passiv-Haus" |

| | |
|---|---|
| | buildings, which is defined by the Passiv-Haus-Institut as KfW40 with annual energy consumption lower than 15 kWh/m$^2$. |
| ***Swiss*** | Some cantons include "Minergie®" as their regulations for new buildings: Minerge (38 kWh/m$^2$). Energy consumption includes heating, warm water and ventilation. Additional electricity consumers need to satisfy some criteria. |
| ***United Kingdom*** | Indices show that regulations are going to proscribe next: at 2010 level 3 (25% better than the contemporary regulations); 2013 level 6 (zero carbon for all the consumed energy – including the additional energy consumers) |

**Table 1**: Low energy consumption building definitions

## 3. Comparison of different national standards for low energy buildings

Several countries have developed standards and design processes in order to standardize, control and promote best low energy building practices. These three standards will be analyzed: German PassivHaus, Swiss Minergie® and American LEED.

### 3.1. PassivHaus

Passive house institute (Passiv-Haus-Institut – PHI) in Darmstadt is intensively orientated towards studying energy characteristics of buildings. "PassivHaus" certificate means that the building complies with the requests for low energy building of PHI. Technical definition of that certificate is quite clear when speaking of climate for buildings between 40° and 60° northern geographical longitude. Or more precisely, a house can get a "PassivHaus" certificate if it complies with next criteria:

1. Comfortable inner climate can be preserved without using the central heating or cooling systems. Annual energy consumption for heating needs to be designed in that way that it doesn't rise above 15 kWh/m$^2$.

2. The comfort criteria needs to be preserved in all rooms of the building as during the winter as during the summer. With those aims, certificate requests very precise levels of insulation for every construction element:

    a. Lost heat ratio for all cross sections needs to be lower than 0,15 W/m$^2$K

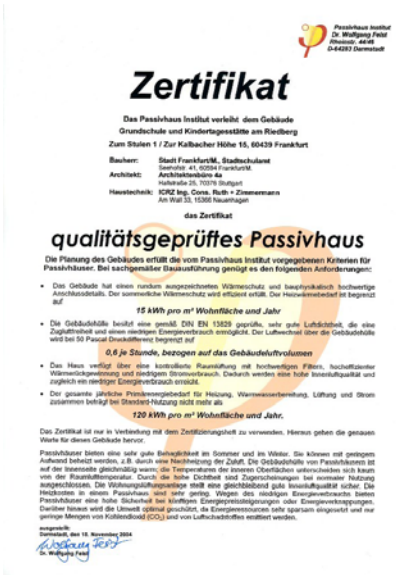
    b. Every window and outer door needs to be with U-value lower than 0,8 W/m$^2$K, as well as precisely defined window areas. The windows need to be at least with double isolation glass (triple isolation glass is recommended) with high thermal quality and good /BRTVLJENJE/

    c. Air exchange per hour needs to be less than 0,6; Depending on the orientation and the building construction strong limitations are prescribed for each transparent element, regarding the orientation and a possibility to open. Ventilation openings are strictly controlled.

    d. Ventilation and recuperator in passive houses are obligatory.

$Q_{sum} = (Q_{trans} + Q_{vent}) - Q_{gain} < 15$ kWh /m$^2$ annually

3. Total primary energy consumption for all home appliances, sanitary water, heating and cooling of the area does not exceed 120 kWh/m$^2$. This design is included in the project planning.



Zertifikat

Das Passivhaus Institut verleiht dem Gebäude
Grundschule und Kindertagesstätte am Riedberg
Zum Stulen 1 / Zur Kalbacher Höhe 15, 60439 Frankfurt

Bauherr: Stadt Frankfurt/M., Stadtschulamt
Seehofstr. 41, 60594 Frankfurt/M.
Architekt: Architektenbüro 4a
Hallenstraße 25, 70376 Stuttgart
Haustechnik: ICRZ Ing. Cons. Ruth + Zimmermann
Am Wall 33, 15366 Hauenhagen

das Zertifikat

qualitätsgeprüftes Passivhaus

Die Planung des Gebäudes erfüllt die vom Passivhaus Institut vorgegebenen Kriterien für Passivhäuser. Bei sachgemäßer Bauausführung genügt es den folgenden Anforderungen:

- Das Gebäude hat einen rundum ausgezeichneten Wärmeschutz und bauphysikalisch hochwertige Anschlussdetails. Der sommerliche Wärmeschutz wird effizient erfüllt. Der Heizwärmebedarf ist begrenzt auf
  **15 kWh pro m² Wohnfläche und Jahr**
- Die Gebäudehülle besitzt eine gemäß DIN EN 13829 geprüfte, sehr gute Luftdichtheit, die eine Zugluftfreiheit und einen niedrigen Energieverbrauch ermöglicht. Der Luftwechsel über die Gebäudehülle wird bei 50 Pascal Druckdifferenz begrenzt auf
  **0,6 je Stunde, bezogen auf das Gebäudeluftvolumen**
- Das Haus verfügt über eine kontrollierte Raumlüftung mit hocheffizienter Wärmerückgewinnung und niedrigem Stromverbrauch. Dadurch werden eine hohe Innenluftqualität und zugleich ein niedriger Energieverbrauch erreicht.
- Der gesamte jährliche Primärenergiebedarf für Heizung, Warmwasserbereitung, Lüftung und Strom zusammen beträgt bei Standard-Nutzung nicht mehr als
  **120 kWh pro m² Wohnfläche und Jahr.**

Das Zertifikat ist nur in Verbindung mit dem Zertifizierungsheft zu verwenden. Hieraus gehen die genauen Werte für dieses Gebäude hervor.

Passivhäuser bieten eine sehr gute Behaglichkeit im Sommer und im Winter. Sie können mit geringem Aufwand beheizt werden, z.B. durch eine Nachheizung der Zuluft. Die Gebäudehülle von Passivhäusern ist auf der Innenseite gleichmäßig warm; die Temperaturen der inneren Oberflächen unterscheiden sich kaum von der Raumlufttemperatur. Durch die hohe Dichtheit sind Zugerscheinungen bei normaler Nutzung ausgeschlossen. Die Wohnungslüftungsanlage stellt eine gleichbleibend gute Innenluftqualität sicher. Die Heizkosten in einem Passivhaus sind sehr gering. Wegen des niedrigen Energieverbrauchs bieten Passivhäuser eine hohe Sicherheit bei künftigen Energiepreissteigerungen oder Energieverknappungen. Darüber hinaus wird die Umwelt optimal geschützt, da Energieressourcen sehr sparsam eingesetzt und nur geringe Mengen von Kohlendioxid ($CO_2$) und von Luftschadstoffen emittiert werden.

ausgestellt:
Darmstadt, den 18. November 2004
Dr. Wolfgang Feist

**Fig. 1:** PassivHaus certificate

After all works have been finalized each building is checked for the achieved properties especially all the seals are being checked. PassivHaus institute also certifies building elements as doors, windows, wall elements, etc. This process guaranties that after a new construction has been finished all the elements really comply with building requirements. Since the 80's, when the concept was founded, up to these days there are over 6000 projects finished in Germany, 1500 in Austria and about 300 in Benelux.

## 3.2. Minergie®

MINERGIE-P

Mehr Lebensqualität, tiefer Energieverbrauch
Meilleure qualité de vie, faible consommation d'énergie

Verein MINERGIE® / Association MINERGIE®

Der Verein MINERGIE® verleiht dem
Gewerbebau WATTWERK in 4416 Bubendorf
das Zertifikat

Zertifikat provisorisch bis zur Abgabe der Baubestätigung

qualitätsgeprüftes MINERGIE®-P-Haus

Nr. BL – 001-P

Die Planung des Gebäudes erfüllt den von Kantonen, Bund und Wirtschaft vorgegebenen Kriterien für MINERGIE®-P-Häuser. Diese entspricht dem MINERGIE®-P-Standard und damit dem neusten Stand der Technik. Bei sachgemässer Bauausführung erfüllt es die folgenden Anforderungen:

- Das Gebäude hat eine hochwärmedämmende Hülle und bauphysikalisch hochwertige Anschlussdetails. Der sommerliche Sonnenschutz wurde bestellt. Der Heizwärmebedarf ist begrenzt auf 20 % des Grenzwertes für den Heizwärmebedarf [$H_L$]. Der spezifische Wärmeleistungsbedarf ist begrenzt auf 10 W pro m² Energiebezugsfläche (EBF) und Jahr.
- Die Gebäudehülle besitzt eine gemäss ISO 9972 geprüfte, sehr gute Luftdichtheit, die eine Zugluftfreiheit und einen niedrigen Energieverbrauch ermöglicht. Der Luftwechsel über die Gebäudehülle wird bei 50 Pascal Druckdifferenz begrenzt auf 0,6 je Stunde, bezogen auf das Gebäudeluftvolumen.
- Das Haus verfügt über eine kontrollierte Wohnungslüftung mit hocheffizienten Filtern, hocheffizienter Wärmerückgewinnung und niedrigem Stromverbrauch. Dadurch werden eine hohe Innenluftqualität und zugleich ein niedriger Energieverbrauch erreicht.
- Das Haus verfügt über einen tiefen Haushaltsstromverbrauch, da ausschliesslich Haushaltgeräte mit der Effizienzklasse A, gemäss E-Deklaration der EU, eingesetzt werden.
- Das Haus verfügt über eine Wärmepumpenheizung mit Erdsonden/-sonde und einer Sonnenkollektoranlage für Heizung und Warmwasseraufbereitung. Eine Photovoltaikanlage deckt den Eigenbedarf an Elektrizität und liefert zusätzlich Strom zur Einspeisung ins Netz.
- Der gesamte jährliche gewichtete Energiebedarf für Heizung, Warmwasser und Lüftung zusammen beträgt bei Standard-Nutzung nicht mehr als 30 kWh pro m² EBF und Jahr.

Das Zertifikat ist nur in Verbindung mit dem Zertifizierungsheft zu verwenden. Hieraus gehen die genauen Werte für dieses Gebäude hervor.

Horw, 11. September 03

Leiter MINERGIE®-P Zertifizierungsstelle
Prof. Gerhard Zweifel

**Fig. 2:** Minergie® certificate

The Minergie certificate is temporarily available only in Swiss and Liechtenstein. Minergie certificate is conceptually very close to the PassivHous. It defines very precise levels of energy consumption, and especially the Minergie-P® version. Minergie is a certificate that is appropriate for every type of buildings (residential buildings, hospitals, industrial buildings, etc.). There are two ways how to get a Minergie certificate. The first one is to use standard solutions that are usable only in single house projects. Those solutions cover three points:

1. Very precise insulation values for each construction element

| Construction element | Values if in contact with outer climate or if berried less than 2m [W/m$^2$K] | Values if in contact with non heated rooms or if berried more than 2m [W/m$^2$K] |
|---|---|---|
| **Roof, sealing** | 0,2 | 0,25 |
| **Wall** | | 0,28 |
| **Floor** | | 0,28 |
| **Heated floor** | | 0,25 |
| **Windows** | 1,3 | 1,6 |
| **Doors** | 1,6 | 2,0 |

**Table 2:** Insulation standards requested for Minergie certificate

2. Choice between 5 technical solutions for heat production and distribution

| Standard solution | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| **System** | Geothermal heat pump | Boiler heated by biomass + solar water heater | Automated heating system using biomass | Heating by waste | Air heat pump |

**Table 3:** Available technical solutions for heating and warm water

Using all of these heating systems require double-flow heat exchanger with minimum 80% energy efficiency.

3. Additional costs for using Minergie standard solutions may not exceed 10% of conventional solution costs (15% by Minergie-P).

Second way of getting the Minergie certificate, which is also the only way for residential buildings, is by examining the buildings performance. Those performance tests are very detailed, and here are some specifications:

- Tests are different for private homes and for residential buildings
- Tests are different for new houses and for retrofitted houses
- Tests are customized to specific climate conditions (mostly height above see level)

| Building type | Residential buildings | Individual housing | Office buildings | Hospitals | Industrial buildings | Sport buildings |
|---|---|---|---|---|---|---|
| **Maximal values [kWh/m²/y]** | 42 | 42 | 40 | 75 | 20 | 25 |

**Table 4:** Some of the requests for Minergie certificate

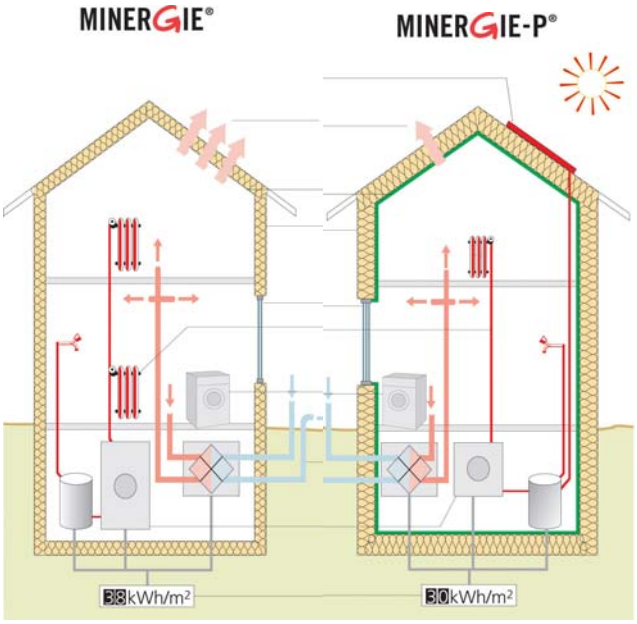



**Fig. 3:** Minergie and Minergie-P standard differences

www.minergie.ch web page ahs announced that by the year 2007. 8200 buildings have received Minergie certificate. Minegie-P certificate, or better known as Minergie-Eco certificate is meant for buildings that use ecological building materials and processes.

## 3.3. LEED

**Fig. 4:** LEED standard certificate

LEED's (Leadership in Energy and Environmental Design) Green Building Rating System® is a voluntary national standard for high efficient building development. The system was developed by American Green Building Council, which has designed 7 different certificates. Certificates relate to the type of the building: LEED-H for houses, LEED-EB for existing buildings, etc. Certifying procedure is founded on a whole list of criteria, which by far exceeds the limits of using the energy. These certificates consider aspects such as energy transmission, visual design, use of local materials, etc. LEED uses Energy Star sign for request of energy consumption in a household. 15% decrease is proscribed in comparison with IECC (International Energy Conservation Code) form 2006. These regulations are delicately coordinated with the local climate and in accordance with that they define constructive elements and techniques.
In order to certify a building some basic rules are a must. A bonus is included for improved performance. Certificate is given in 4 different forms: certified, silver, gold and platinum. Although most of these building types have been constructed in Northern America, there are some in Europe as well.
Since LEED is including not only low energy consumption, but also the whole process of construction, activities, and the expected live cycle of the building LEED is a good example of a wider scope over civil engineering.

## 4. Conclusion

Because the energy consumption limitations differ from place to place according to the climate and specific conditions and parameters, the simplest way to compare various energy icons is to compare the technical requests, and especially the requested insulation values. On the next picture there are several energy consumptions requests compared.

| | Water heating | Other consumptions | Natural and local materials | Transportation | Inner air quality | Water | Education |
|---|---|---|---|---|---|---|---|
| **PassivHaus** | YES | NO | NO | NO | NO | NO | NO |
| **Minergie®** | YES | Minergie-P | Minergie-Eco | NO | NO | NO | NO |
| **LEED** | YES | YES | YES | YES | YES | YES | YES |

**Table 5:** Comparison of observation areas for 3 standards

Most of the aspects in the Table 3 have energy values. Transportation is a good example: building a low energy home is useless if that requires increase in vehicle energy consumption. A certificate is available only by tests performed by the authorized institute, which can, but doesn't need to be, locally active. However, criteria and the evaluation of those low energy consumption buildings can serve as an inspiration and a guideline for every project.

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Standards:

Passive House Standards

ISO 13790:2008 – Energy performance of buildings – calculation of energy use for space heating and cooling

EN 15217:2007 – Energy performance of buildings – Methods for expressing energy performance and for energy certification of buildings

Internet:

CEPHEUS – http://www.cepheus.de

PassivHaus Standard: Passiv-Haus-Institut - http://www.passiv.de

Minergie® - http://www.minergie.ch

LEED standards - http://www.usgbc.org/leed

Klima:aktiv standards - http://www.klima:aktiv.at

*PRC1*

# Modelling with uncertainty for control tasks

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## Abstract
This study presents appropriate methods for control modelling with uncertainty for the analysis of management activities and the certification that they meet the performance standards. Dealing with and understanding the effects of uncertainty are important tasks for the project controlling. Reducing the effects of some forms of uncertainty (initial conditions, low-frequency disturbances) without catastrophically increasing the effects of other dominant forms (sensor noise, model uncertainty) is the primary job of the feedback control system. Closed-loop stability is the way to deal with the (always present) uncertainty in initial conditions or arbitrarily small disturbance. This paper outlines the methods available in the control theory and their applicability on management systems

## Keywords
Project management, uncertainty modeling, optimal control, dynamical systems

## 1. Introduction

Control is the process in management that allows measurement of the realized results and their comparison with the target performance standards in order to validate the attainment of the program goals or to find divergence and initiate cause-based corrective actions. By setting the goals and ensuring the resources to meet them, a successful system of feedback for the desired results is created.

Control in this study is presented as a process that includes four stages 1. Setting the standards and goals. 2. Measuring the realized performance. 3. Comparing the realized results with the standards. 4. Taking corrective actions. The goal is the nominal and robust performance of a system. Specifically for the nominal performance, the performance index stability of the organization and the small size of operational errors are required. For the robust performance, all the criteria of the nominal performance should apply, despite all modelling errors and the uncertainty of conditions. A two port diagram is presented, under conditions of uncertainty, for the control modelling of the organizations.

The use of these models is of significant importance for the operation of an organization, as it facilitates the control of production effectiveness, the control of the organization structure as well as the control and evaluation of the services

provided to the company's customers. This paper demonstrates the applicability of control modelling with uncertainty for the analysis of management activities.

## 2. The control process

The rationale of the "governmental" control system is expressed in control through the following steps:

### 2.1 Definition of goals and standards

The goals and standards are set, normally, during design. They are, by definition, performance criteria. They are selected points in the whole design system, where performance (and not only) measurements are elaborated, so that the managers receive "signals" as to how things proceed and they are not obligated to follow every step of the execution of the designs and programs.

The selected points for control should be critical, in comparison to other factors, whether the designs application is evolving well. The standards are of various types, such as for example:

- Natural: they are non-monetary, usually referring to a productive, functional level, such as man-hours per production unit, production quantity, quantity of consumed fuel per, unit of product, etc.

- Cost: here monetary values of expenses are connected to activities or produced products, such as the expected per unit cost of a meal that is offered in the airplane of a flight company

- Capital: this has to do with the invested capital and in terms of accounting it is related to the balance sheet of a company. An example here is the amount of invested capital per resident of an area from the cleaning service of this area.
- Revenues: they are monetary values referring to the sales, such as the revenues per visitor of an amusement park.

- Intangible standards: such can be the company's profile, the consumers' attitudes, the level of public relations, the employees' morale etc.

Nevertheless, the type and form of these standards depends on the area of control of the company. This topic is further developed below.

### 2.2 Measurement of the true performance

"Feedback" is necessary for the measurement of the performance or other company variable. This is often done through written reports, as we mentioned before. Other ways of information are, as we noted, personal observation and oral reports. In addition, the statistical reports are more and more being adopted lately, which contain, among others, graphs of various types and tables through which the managers evaluate better the performance of the company, of the departments and the people.

## 2.3 Comparison of the true results to the standards

Here is defined the degree of divergence between true performance and standards. Some divergence between reality and standards is usually acceptable. Therefore, the important is to set the accepted range of divergence.

## 2.4 Undertaking a corrective action

Usually at this stage there are three alternative choices. To leave things as they are (do nothing), to correct the true performance or to redefine the standards. At this stage of control and particularly in the two last choices, the exercise of the other functions of management is introduced again and as a result, control takes a dynamic and continuous character.

# 3. Types and areas of control

The administration of the company is likely to exert control before starting some activity, during the activity and when it finishes. The first type of control, the **preliminary or feed forward control**, aims to ensure that the appropriate directions are given and the necessary resources are available for realizing the activities. The preliminary controls are designed so that the company is ready for the case that potential problems appear. So when there are indications that problems appear, the appropriate preventive actions are adopted. Therefore, the company foresees and takes into account the changes in its environment and adjusts accordingly its control systems. An example of such a control type could refer to the preparation of a company producing detergents to convert its products to ecological ones, when it has substantial information that a change in the current relevant legislation is about to happen, which will impose ecological standards to the detergents. This means that in the preliminary design, the company aims to prevent the appearance of problems rather than cure them after they appear. However, this type of control requires early and concise information, which is often very hard to get. In any case, this type of control, if we see it from another perspective, is, we would say, a proper design.

The second type of control, the **concurrent control**, takes place when an activity is in progress. In this case the administration of the company has the opportunity to correct a problem before this becomes too expensive for the company. The direct supervision of the staff is such a type of control.

The third type of control, the **feedback control**, is performed when an activity or a task has finished. It focuses on the final results. It is the most wide-spread and popular type of control. An example of this type is when the customer of a restaurant is asked, after he eats the meal, whether he liked it. The main disadvantage of this type is that the manager receives the information about a problem that possibly occurred, after the damage has taken place. (Miara et all. (2007)).

# 4. The feedback control as a process for the control of smart management systems

A "smart" structure is one that monitors itself and its environment in order to respond to changes in its conditions, (Tamer (2002)). The smart structure is made of four basic physical elements: 1) a host structure, 2) an array of sensors 3) one or more actuators, embedded or attached/installed on it, and 4) controllers. For instance, in civil infrastructure a host structure may be a bridge, a highway, or a dam that has to be monitored and controlled for safe performance of its intended use. The main types of controlling and supervising constructions are the following: the simple surface control, which is similar to the accelerated optical one, the instrument control, and finally the control, which is based on 'smart' systems. The efficient deployment of smart structures requires the employment of equally smart management systems to operate them. Smart infrastructure system refers to the combination of smart structures, (Tamer (2002)).

## 4.1 Smart management system

This criterion could be the most influential as it addresses the needed management support to smart infrastructure system. It includes:

**Product Modelling:** In the case of Smart Systems (SS) a user organization needs to adopt consistent presentation of SS physical components to achieve seamless exchange of product data among manufacturers, suppliers, designers, permitting agencies, owner, contractor, users, and facility managers. Product modelling promises to achieve higher levels of performance in material management (in contrast to outdated techniques being used to control traditional materials), integrating vendor data into the design process, and facilitating design changes. Such approach help realize an adequate level of the potential of SS through integrating SS physical data in the procurement, design and operation processes leading to optimized life cycle costing , (Tamer (2002)).

**Process Modelling:** This includes developing flexible process modules that assures synchronized work flow within different departments and across different organizations. Research is underway in different universities to investigate the development of consistent standards for conducting and describing work process [8]. Moreover, pioneering Virtual Design Team (VDT) analysis software are already under development, (Levvit et all (1993)).

**Organizational Modelling (Reengineering):** This covers issues ranging from structuring decision cycles to address SS needs, fostering cross-organizational data exchange regarding SS, encouraging the deployment of SS, to threading SS benefits and knowledge within an organizational culture. This includes addressing how to design information flows within an organization to support effective SS deployment, defining decision criteria that foster optimized life cycle costing of SS, embracing open information exchange policies, fostering SS knowledge preservation. Personnel quality: evaluates the readiness of company personnel to adapt to the required change. This could include their competence in information technology practice, technical backgrounds, quality of training programs, etc, (Tamer (2002)).

## 4.2 Design objectives and system specifications for smart management systems

Design objectives fall into two categories (Pouliezos (2006)):

Nominal performance
1. Stability of closed loop system (plant+controller).
2. Disturbance attenuation with satisfactory transient characteristics (overshoot, settling time).
3. Small control effort.

Robust performance
4. (1)-(3) above should be satisfied in the face of modelling errors.

**System specifications**

To obtain the required system specifications to meet the above objectives we need to represent our system in the so-called ($N$, $\Delta$) structure. To do this let us start with the simple typical diagram of Fig. 0.1.

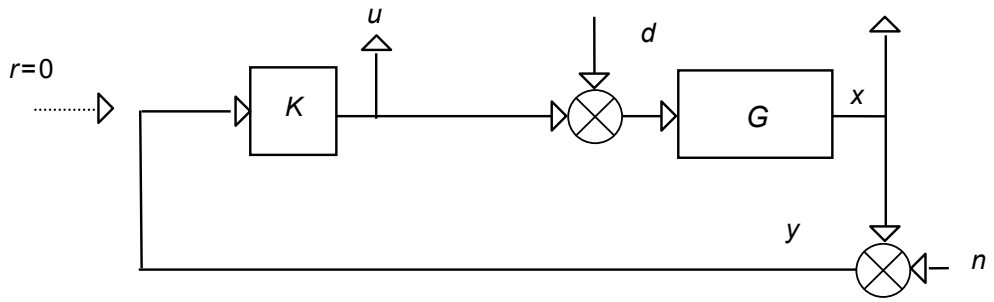


**Figure 0.1:** Classical control block diagram

In this diagram there are two inputs, $d$ and $n$, and two outputs, $u$ and $x$, $G$ is the initial system and $K$ is the controller. In what follows it is assumed that,

$$\left\| \begin{matrix} d \\ n \end{matrix} \right\|_2 \le 1, \quad \left\| \begin{matrix} u \\ x \end{matrix} \right\|_2 \le 1$$

If that is not the case, appropriate frequency-dependent weights can transform original signals so that the transformed signals have this property.

Let us reorganize Fig 0.1 into Fig. 0.2:

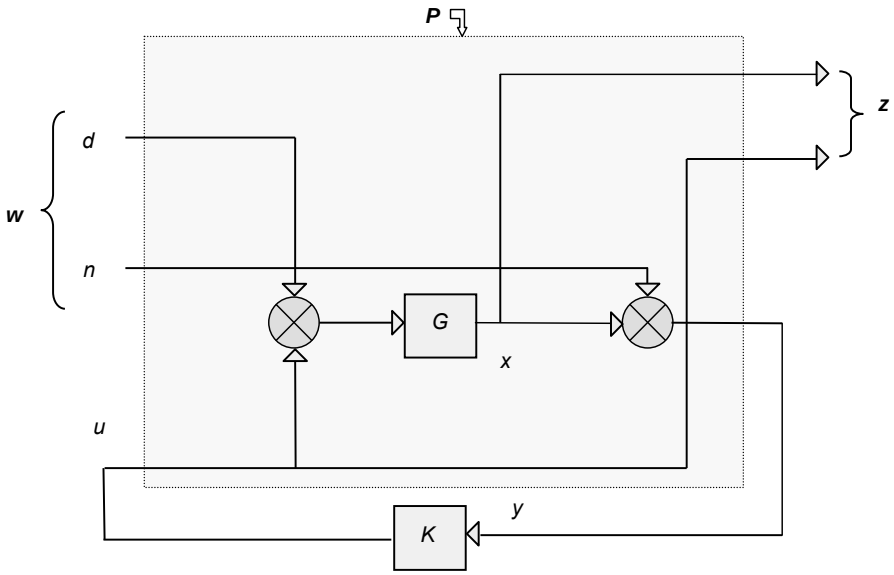


**Figure 0.2:** Detailed two-port diagram

or in the less detailed Fig.0.3,

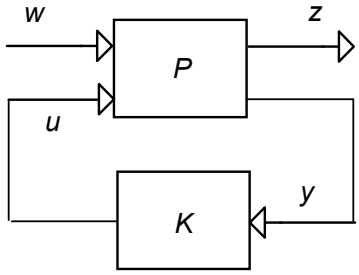


**Figure 0.3:** Two-port diagram

with,

$$z=\begin{bmatrix} u \\ x \end{bmatrix},\quad w=\begin{bmatrix} d \\ n \end{bmatrix}$$

where *z* are the output variables to be controlled, and *w* the exogenous inputs, *K* is the controller and *P* is the controlling system.
Given that *P* has two inputs and two outputs it is, as usual, naturally partitioned as,

$$\begin{bmatrix} z(s) \\ y(s) \end{bmatrix}=\begin{bmatrix} P_{zw}(s) & P_{zu}(s) \\ P_{yw}(s) & P_{yu}(s) \end{bmatrix}\begin{bmatrix} w(s) \\ u(s) \end{bmatrix}\overset{\text{ορ}}{=}P(s)\begin{bmatrix} w(s) \\ u(s) \end{bmatrix} \tag{0.4}$$

With the above equation we combine the inputs with the outputs, and we try to find the transfer function $N_{zw}(s)$.
Also,

$$u(s)=K(s)y(s) \tag{0.5}$$

Substituting (0.5) in (0.4) gives the closed loop transfer function $N_{zw}(s)$,

$$N_{zw}(s)=P_{zw}(s)+P_{zu}(s)K(s)(I-P_{yu}(s)K(s))^{-1}P_{yw}(s) \quad (0.6)$$

To deduce robustness specifications a further diagram is needed, namely that of Fig.0.4:

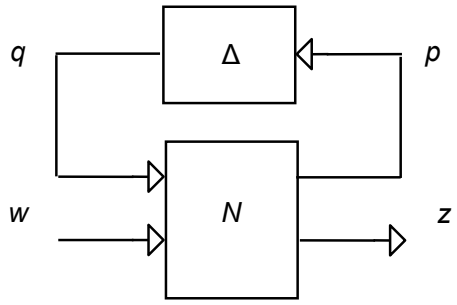


**Figure 0.4:** *N-Δ* structure for uncertainty modelling

where *N* is defined by (0.6) and uncertainty modelled in *Δ* satisfies $\|\Delta\|_\infty \le 1$ (details later). Here,

$$z=\Phi_u(N, \Delta)w=[N_{22}+N_{21}\Delta(I-N_{11}\Delta)^{-1}N_{12}]w=Fw \quad (0.7)$$

Given this structure we can state the following definitions:

| | |
|---|---|
| Nominal stability (NS) ⇔ | *N* internally stable |
| Nominal performance (NP) ⇔ | $\|N_{22}(j\omega)\|_\infty<1$, $\forall\omega$ and NS |
| Robust stability (RS) ⇔ | $F=\Phi_u(N, \Delta)$ stable $\forall\Delta$, $\|\Delta\|_\infty<1$ and NS |
| Robust performance (RP) ⇔ | $\|F\|_\infty<1$, $\forall\Delta$, $\|\Delta\|_\infty<1$ and NS |

It has been proved that the following conditions hold in the case of block-diagonal real or complex perturbations Δ:

I. The system is nominally stable if *N* is internally stable.

II. The system exhibits nominal performance if $\bar{\sigma}\left(N_{22}(j\omega)\right)<1$

III. The system (*N*, Δ) is robustly stable if and only if,

$$\sup_{\omega\in P}\mu_\Delta\left(N_{11}(j\omega)\right)<1 \quad (0.8)$$

where $\mu_\Delta$ is the structured singular value of *N* given the structured uncertainty set Δ. This condition is known as the generalized small gain theorem.

IV. The system *(N, Δ)* exhibits robust performance if and only if,

$$\sup_{\omega\in P}\mu_{\Delta_a}\left(N(j\omega)\right)<1 \quad (0.9)$$

where,

$$\Delta_a = \begin{bmatrix} \Delta_p & 0 \\ 0 & \Delta \end{bmatrix}$$

and $\Delta_p$ is full complex, has the same structure as $\Delta$ and dimensions corresponding to ($w$, $z$).

## 5. Conclusions

In this paper we make an effort of applying control theory with uncertainty, in project management. Robust process control stands at a crossroad its ability to impact the management engineering community imperilled by a number of issues one of which is uncertainty modelling. A direction for robust project control lies in the field of intelligent control which is qualitatively understood as the ability of a control system to learn about its environment and process the information to reduce uncertainty plan and execute control action in a safe and reliable manner. Robust control theory and uncertainty modelling will only find life in the process and management industries if they are successfully integrated into an intelligent control system. This work has a profound effect on the future impact of modern robust control theory on process control practice.

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*AA014*

# The relationship between construction conflicts arising between oil companies and poverty of host-communities in the Niger-delta region of Nigeria

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## Abstract
The purpose of this paper is to examine the nature of project conflict between oil companies and host-communities in which they operate in Nigeria's oil-rich Delta region, with a particular focus on the place of poverty in fuelling the lingering conflict and the difficulty in curbing the conflictual situation. The method is essentially a review of various available relevant literature and deductive arguments that will give insights to whether poverty can be a catalyst to conflicts between oil companies and host communities. The paper concludes that poverty of host-communities to a project is usually at the heart of many project conflicts arising between operating companies and host-communities. The paper usefully points out the pervasive poverty in the Niger-delta region of Nigeria; and how poverty has continued to ignite serious conflict among all stakeholders in the region with grave consequences.

## Keywords
Poverty, Violent conflict, Oil, Niger-delta.

## 1. Introduction

Conflicts, such as the kind that arise between oil host-communities and oil exploration companies, have not traditionally been seen through an economic lens. In the Nigeria's Niger-delta region, such conflicts are violent conflicts characterised by the rise of armed rebel movements and militias. Their activities profoundly disrupt oil production, and consequently, consumption, investment, taxation, and provision of public facilities all suffer. Because manifest reasons for conflicts often seem essentially non-economic (conflicts of values, self-determination, and justice), a usual tendency has been to suspend economic analysis of a place or a process when a conflict erupts, and resume analysis only after it stops. Starr M, (2006).

Yet the surge in violent conflict in the tail-end of the 20th century, poses questions as to the connection between economic factors-poverty and conflict risks, especially because many of the areas in which new conflicts were breaking out were in economic decline, notably in sub-Saharan African states. Strand, H. et al,(2002).

Another problem is volatile oil prices. Revenue volatility hampers planning, boosts deficits (when prices are high, it is easy to raise spending but hard to cut back when prices fall, especially for governments whose legitimacy rests on allocating oil rents) and tends to raise debt (when oil prices are high countries are more creditworthy and tend to borrow more; when prices fall arrears build up on irredeemable debts, increasing debt further). Volatility depresses economic growth by increasing both interest rates (to compensate lenders for risks and costly bankruptcies during crises) and uncertainty. Shaxson, N (2005). Productive

industries are hurt during booms (typically through Dutch Disease effects or increased interference by stronger governments), but not easily rebuilt during busts. Financial crises can cause conflict and give powerful players opportunities at the expense of smaller players. The economic and political conditions people in non-oil sectors have in mind when signing contracts change when oil prices move, creating reasons to renegotiate, so it is harder to follow rules, and this erodes institutions. The list goes on. 'Excess volatility is bad for growth, bad for investment, and bad for the poor. Because the poor are typically less able to cope with high volatility, volatility tends to increase poverty and worsen income distribution,' says Professor Ricardo Hausmann of Harvard University, a former chair of the IMF–World Bank Development Committee. 'There is convincing evidence that excess volatility is bad for all the important dimensions of development that we care about. Hausmann, R (2004).

In his investigation of the relationship between violent conflict and economic decline, Collier ,et al.(2003), describes the central theme of his finding as ''It's the economy stupid''—that is, economic factors are central in all dimensions of violent conflicts: poor economic policies predispose countries to conflict, economic incentives cause armed rebellions to break out, economic factors sustain rebellions and explain their durations, manipulation of economic incentives and resources is essential for bringing conflicts to an end, and installing the right kinds of post-conflict economic policies is vital for keeping the peace.

This paper examines some recent research on the economics of conflict. The literature review shows how conflict is used to reinforce a neo-liberal view of economic growth: war is said to result from poverty, and poverty from poor economic governance, so that avoiding conflict or recovering from it requires redoubled efforts to liberalize markets, attain price stability, establish property rights, uphold rule of law, etc. We then discuss how oil prices volatility have contributed to poverty in the Niger-delta, and its implication for the rise of violent conflict between the host-communities and the government on one hand, and the oil exploration companies on the other. The paper concludes that social economics are valuable for developing an alternative view of conflict that takes seriously its social dimensions, especially ideas of preventing or alleviating poverty in oil producing regions, in order to forestall the incidence of conflict between host-communities and oil exploration companies.

## 2. Literature review

In an attempt to examine violent conflict from a poverty perspective, Collier and co-authors argue that people's behaviour in conflict must be understood as rooted in individual incentives, and conflict itself must be understood as a process that is produced. Thus, likely participants in conflict are viewed as implicitly making a rational choice: they choose whether to get involved in a rebellion or not, based on whether the expected gains from rebelling exceed the other choice-opportunity cost. Gains may also be driven by ''greed—the income that can be achieved either during the rebellion from quasi-criminal looting and the benefits that ensue if the rebellion is victorious from control of the state revenues,'' or they may rest in ''grievance—the opposition to perceived or actual injustice'' Collier and Hoeffler (2002). In this situation, opportunity costs are earnings foregone from alternative economic activities, like farming, fishing and trading. The direct consequence is the launch of conflict against governments or and business concerns that are perceived as the cause of growing poverty.

To assess the validity of these ideas empirically, Collier and Hoeffler (2004) conduct an econometric analysis of outbreaks of conflict in countries in the post-World War II period. The breakdown of the data shows a five-year interval over which the question of what determines whether a country experiences a conflict in a given intervals is measured i; a ''violent conflict'' is defined as an internal conflict in which the government participated and for which there were at least 1,000 battle deaths per year. They find that, ceteris paribus: (a) countries rich in natural resources are more likely to experience violent conflicts, consistent with the ''greed'' idea; (b) various partial quantitative measures matter less, casting doubt on whether ''grievances'' per se are important in explaining conflict; and (c) conflicts are more likely to break out in countries with low per-capita incomes and poor growth records, consistent with the idea of opportunity costs. From this they conclude that ''international policies for conflict reduction should therefore be aimed at increasing the cost of rebellion and at reducing the revenues from it'', especially by cutting off revenues from natural-resource sales e.g. crude oil and inflows of funds from abroad Azam et al. (2001). It is also vital to raise the opportunity costs of conflict by redoubling efforts to promote growth.

According to Starr M. (2006), it is denied that ''objective'' reasons for grievance underlie outbreaks of violent conflict, it is conceded that subjectively felt grievances can be quite important in mobilizing participation in violent conflict. This poses a serious problem for the conclusion that policies must address greed, not grievance, in trying to bring conflicts to an end: If subjectively felt grievances are important in people's understandings of their social, political, and economic lives, and help explain their willingness to take up arms, then we cannot assume that such grievances are devoid of content just because they are hard to trace in a statistical way to ''objective'' circumstances. On the contrary, the existence of subjectively felt grievances powerful enough to lead people to war suggest profound problems in the socio-political and economic mechanisms that ought to enable different peoples to co-exist, produce, and exchange to mutual benefit.

While multiple factors (political, cultural, religious, ethnic, linguistic) are usually at work when differences fracture into divisions Humphreys, M. (2003), grievances often involve economic dimensions—such as unequal access to livelihoods and uneven distribution of public expenditure across regions; differential access to education, jobs, and business opportunities (as in Nigeria).The role of economic dimensions, particularly of grievance in conflicts has not been systematically studied—a gap that was not rectified by the Collier project.

If economic grievances are important in conflicts, then the value of prioritizing market-oriented policy reforms in post-conflict reconstruction needs to be questioned. Starr, M (2006). As in the case of the Niger-delta, such reforms do not directly address the problem of how to re-construct a common social and economic environment in which peaceable coexistence is possible; rather they simply assume that re-creating profitable business opportunities will divert people's thoughts and energies from conflict by raising opportunity costs. Restive oil-producing communities, where problems of division remain are not good investment climates, as there is considerable uncertainty about whether the peace will stick, the financial system is inoperative, and foreign investors view risks of doing business in the country as high; and like many other parts of Nigeria, there remain the underlying problems of very low levels of education, limited health care, poor access to safe water etc. These conditions are strongly unfavourable to productive investments

and circumscribe the power of policy reforms to change the calculus of risk and expected return; instead, in contexts such as the Niger-delta, they encourage pursuit of opportunities for quick profits, such as kidnapping for ransoms; smuggling, and/or arm struggle Shaxon N, (2005). Thus, this leads to what I would call vicious cycle of conflict-when Poverty ignites violent conflict, and violent conflicts bring insecurity and instability that make business investment and governance impossible, which in turn impoverishes more people, who as a consequence become vulnerable to joining militias who instigate yet more violence.

## 3. Conclusions and limitations

The Niger-delta region of Nigeria that produces the oil revenue for Nigeria is home to many people who have become impoverished due to lack of facilities and alternative means of income, having lost lands and seas to the exploration of oil. The restiveness in the region is fundamentally as a result of the poverty of the people and governments and oil companies operating in the area need to address the poverty issue vigorously to forestall further violent conflicts in the region.
A pragmatic and fore-sighted approach to alleviating poverty by government and oil exploration companies appears to be the way forward towards avoiding the trap of vicious cycle of conflict, which as succinctly described above, does no good to any of the stakeholders in the oil-producing region.

This paper does not of course apply a technical research methodology into how poverty erupts into violent conflict-this aspect should be appropriately dealt with another research paper. It does however highlights the dangers of poverty, and how oil price volatility can lead to poverty in oil producing states with grave consequences on peace and stability, especially in fragile environment where valuable natural resource like oil abound.

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# The Sustainability Dimension in IPMA Competence Baseline Contextual Elements at Project and Programme Levels

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## Abstract
The objective of this paper is to open up a discussion regarding (a) the attributes of sustainability affected by the project/programme manager (PM), (b) the PM's potential for enhancing sustainability through the contextual competence elements of ICB and (c) the PM's potential for affecting the natural, social, human, manufactured and financial capitals at the project and programme levels. It is suggested that, in project/programme management, sustainability refers to three dimensions: (1) The *survivability* of the project as an operational and productive structure within a programme; (2) the *survivability* of the programme as sets of related projects; and (3) the *social acceptability* of the impacts (economic, social, cultural, and environmental) from the project's implementation process and products and the programme's evolvement. Two *study tables* are proposed as a basis for further study. T*he PM's* role in enhancing sustainability is often more crucial at the project rather than at the programme and the portfolio levels.

## Keywords
Project management, Project sustainability, Programme sustainability, ICB/IPMA, Contextual elements

## 1. Introduction

According to ICB (IPMA, 2006), a project or a programme of projects is an operation to realize deliverables or business benefits which define the scope of the operation; the *project* may vary from simple projects to complex endeavours. *Project Management Success* is "*the appreciation by the various interested parties of the project outcomes*". This definition is more challenging than "*to produce the project deliverables within time and budget*" and it smoothes the way for introducing sustainability issues since it accepts the notions of (1) multiple viewpoints in assessing outcomes and (2) subjective success-assessment criteria. Still, some questions remain: How are these "interested parties" recognized and by whom? How are future (possibly unexpected) impacts taken into consideration? In other words, where is the "context boundary" drawn?

The performance of the project/programme manager (PM) is assessed on the basis of criteria which are set by (and express the values and priorities of) an Organization (government, corporation, construction company, business firm, NGO, etc.) which is financing the operation and is interested in its outcome. Regardless of *hierarchy* (project, programme, or portfolio) and *scope*, every such operation

1. is affected by the Organization's competence (the "contextual framework", which later on will be characterized as "social capital"),
2. takes place within a specific socio-economic framework,
3. has an impact on the social, cultural and physical environments.

The socio-economic framework sets bounds on the scope of the Organization's projects and imposes limits on their impacts, aiming at a "sustainable" behavior by the Organization. These bounds and limits must be taken into consideration by the PM who is also keen on adhering to the organisation's strategy and enhancing its survivability.

The sustainability of any system is assessed by its contribution to the sustainability of its hierarchically higher system. Thus, the sustainability of a project (and, thus, the performance of its manager) is tied to the behavior of the Organization creating the project (or the programme of which the project is a part). The Organization's portfolio and its relevant programmes of projects are expected to refer to corresponding hierarchies of *scopes, criteria, inputs and results*. These hierarchies, according to IPMA, are indirectly depicted in Table 1.

| | Project | Programme | Portfolio |
|---|---|---|---|
| The goal of a | is to produce deliverables | is to achieve strategic change | is to coordinate, optimise and align with strategy |
| Vision and strategy | are related through the business case of a project | are realised by a programme | are aligned to and monitored in the portfolio |
| Business benefits | are largely excluded from a project | are largely included in a programme | are largely excluded from the portfolio |
| Organisation-al change | is often excluded from a project | is usually included in a programme | is excluded from the portfolio |
| Time, costs | are defined in the business case and are manageable in a project | are roughly defined within the strategy; are broken down to individual projects | are based on priorities and strategic targets in the portfolio |

**Table 1***: Project, Programme and Portfolio-- Main issues and differences (IPMA, 2006)*

> *The goal of a **project** is to produce the deliverables defined in the business case. Strategy itself isn't an issue for the project manager. […..] The project manager is not responsible for achieving the business benefits of the project. [...] The project is often not about changing the organisation; it may however, include educating people to fulfil their roles in a different way. If the project concerns organisational change, then the change to be implemented as an outcome of the project is managed by line management, not by the project team. .. A **programme** consists of a set of related projects and required organisational changes to reach a strategic goal and to achieve the defined business benefits. . . . A **portfolio** is a set of projects and/or programmes, which are not necessarily related (IPMA, 2006).*

It is realized that the role of the PM in enhancing sustainability varies from project level to programme levels. The question is whether this role widens or shrinks as we move from project to portfolio level. Based on the above IPMA definitions, a project can be considered as a subsystem of a programme since (1) the performance of the programme is affected by the performance of the project and (2) the project's success is evaluated by the project's contribution to the programme performance. This coupling does not apply to the pair programme-

portfolio. The portfolio can not be seen as system comprised of programmes. Strategic Environmental Assessment, for example, makes sense for a programme, not for a portfolio.

This is better understood for construction projects and programmes. A dam is a project within a river-relocation programme. A county road is a project within a transportation system. The projects are linked with the programmes in specific ways affecting the performance of both. Contrary to what one might presume, *the PM's role in enhancing sustainability is often –and* especially for construction projects-- *more crucial at the project than at the programme leve*l. This is due to the fact that environmental and social impacts are often directly connected with the project (and incurred at the project level), while the economic impacts relate to the programme (wider scope). Moreover, the natural, the financial, the manufactured and the human capitals are more directly involved and affected at the project level.

In systems terminology, this implies that the hierarchy "*project-programme-portfolio*" is sensible and acceptable *only* from a specific viewpoint: the Owner's. From the point of view of the "interested parties", the hierarchies of objectives, needs and values do not correspond to the "*project-programme-portfolio*" scheme. Matters are even more complicated by the fact that the hierarchy of objectives, even for a specific "interested party", does not necessarily correspond to a specific hierarchy of technical systems.

In view of the above, the objective of this paper is to open up a discussion regarding

1. the attributes of sustainability affected by the project/programme manager,
2. the PM's potential for enhancing sustainability through the contextual competence elements of IPMA competence baseline.
3. the PM's potential for affecting the natural, social, human, manufactured and financial capitals at the project and programme levels.

The first five of the contextual competence elements (see Table 2) "describe the promotion of project and programme management in an organisation". The last six "describe what the different support functions in line organisations need to know about projects, and what project teams need to know about the support functions" (IPMA, 2006). As Gareis (2010) notes, "both permanent and temporary (such as projects and programmes) organizations change, either in a continuous or in a discontinuous manner. From a systemic point of view, reasons for changes can either be interventions from the relevant environments of an organization or its internal dynamics". It has been suggested in the literature (Gareis, 2010) that projects and programmes are a way of organizing changes. In view of the above, the question here is how the pressure for sustainable performance affects a project/programme oriented organization and whether such a change (should it be desirable) can better be effected through a project/ programme.

According to Ashby's law of requisite variety, "only variety can absorb variety", implying that "organizations need to build up complexity in order to cope with complexity in their environment" (Ashby, 1970). The issues raised in this paper may be seen as a contribution to the evolving discussion about the adjustment processes (probably, in extreme cases, the transformation) of organizations that desire to improve their sustainability performance.

## 2. The Sustainability Dimension in Project Management[1]

From a systemic viewpoint, the sustainability of any system is assessed by the system's contribution to the sustainability of its hierarchically higher system. Moreover, the pursuance of an objective is but a step in achieving a higher need. In project management, higher systems and needs point to the *context* of the project, while sustainability refers to three distinct dimensions:

1. The *survivability of the project* itself, over its useful life-cycle, as an operational and productive structure, within a programme
2. The survivability of the programme as a set of related projects and
3. The *acceptability of the overall impacts* (economic, social, and environmental) as they result from (1) the project's implementation process and products and (2) the programme's evolvement and its outcomes.

### 2.1 Complex Adaptive Systems and Sustainability Strategies

In an ecosystem analogy, projects or programs may be studied as *Complex Adaptive Systems* (CAS), characterized by non-linearity and potentially chaotic behaviour; these characteristics imply difficulty in predicting the system's behaviour. Ravetz (2000) identifies four key properties that usually characterize CAS (ecological or industrial; in our case, the project or programme) which are sustainable:

- *Co-existence:* Ability to co-exist with other linked systems, at higher or lower scales; i.e. *to respect* the limiting factors of the environment (natural, social, cultural) in which it is embedded (i.e. the context of the project/programme) and *to contain* its pressure on other linked systems. In project management, co-existence is related –almost by definition—to all contextual elements.
- *Effectiveness:* It refers to the utilization of resources by throughput of energy or other resources.
- *Robustness or Resilience:* As the context (i.e. the organizational or physical environment) in which systems are embedded may be dynamic and in constant change, the system (in our case, the project) should be *resilient*, i.e. able to maintain its structure in a variety of external conditions.
- *Adaptability:* Apart from being resilient, a system needs to evolve and change its structure and functions; to survive changes of its environment as it moves into different attractors. Internal variety and complexity are needed for both robust-ness and adaptability.

### 2.2 The Five Capitals Model

As already presented by Panagiotakopoulos (2008), according to the *Five Capitals Model (FCM)* (The Sigma Project, 2003) of sustainability, every project, programme or company needs five capitals, as inputs or resources, to function properly:

- *Ecological* or *Natural capital (N):* the natural resources (energy and material) and processes needed to produce products and deliver services (mainly of *technical nature*, according to IPMA categorization of competence elements).

[1] The analysis and the formulation of the arguments of Paragraph 2 are based on Panagiotakopoulos (2005). See also Panagiotakopoulos (2008).

- *Manufactured capital (M):* the material goods (tools, machines, buildings, and other infrastructure) which contribute to the production process but do not become embodied in the outcome (also of *technical nature*).
- *Human capital (H):* incorporates the health, skills, intellectual outputs, motivation and capacity for relationships of the individual, which can contribute to the productive work. It is also about dignity, joy, passion, empathy and spirituality. For companies, human capital mainly refers to their staff, business partners and suppliers (mainly of *behavioural and contextual nature*).
- *Social* or *organisational capital (S):* The organizational schemes, such as human relationships, state rules, laws, partnerships and co-operation, through which the transformation of inputs to outputs is realized. It embraces communication channels, communities, businesses, trade unions and voluntary organisations (mainly of *behavioural and contextual nature*).
- *Financial capital (F):* The assets of an organisation that exist in a form of currency that can be owned or traded (of *technical nature*).

One could add a sixth type of capital, the *cultural capital (C),* which refers to cultural social norms, values and trust.

Panagiotakopoulos (2005) extended this notion of the FCM to a project. The completion of a project requires the use of a combination of the above five capitals. At the programme level, the selection of the five-capitals combination concerns mainly the production process; at the portfolio level, it concerns mainly (1) the products and their lasting impacts and (2) the impacts on the employed capitals themselves.

For each of the above capitals we recognize *critical levels or boundaries* which must not be surpassed; for example, we recognize the absorbing capacity of the physical environment, the democratic institutions, the laws, the local customs and the trade unions regulations as boundaries for the social capital, the human dignity as boundaries for the human capital, or the budget limits for the financial capital.

## 3. Sustainability of a Project – The Role of the PM

A widely accepted, and politically convenient definition for a sustainable project is a project whose economic, social, environmental and cultural impacts are socially acceptable. The immediate concerns arising from such a definition are: Acceptable to whom, to society in general or to "the interested parties"? Do these sets differ? What of the economic and environmental externalities? Who speaks for future generations?

Realizing that there can never really be a universally accepted and unquestionable definition of a "sustainable project", the issue is bypassed by introducing the notion of a project's or programme's *contribution to sustainability*. This contribution is *assessed* through reference to

- the employment of the five capitals and the extent of their exploitation and
- the societal acceptance of the resulting environmental, social and economic impacts.

Any action by the PM that enhances the project's contribution to sustainability is desirable. But how is sustainability enhanced? Here are some ground rules:

1. *The broader the scope or the viewpoint of the assessment, the better*. This might initially suggest that one should look at the programme rather than at the project. Yet, more often than not, the impact of the project might be greater. As

already argued, the hierarchy project-programme-portfolio might be sensible only from the Organization's or the Owner's viewpoint. This is especially true in construction: The impact of a dam or a road might be more evident and directly felt by the interested parties than the impact of wider hydro-project or of a transportation system.

2. *The critical level of each and every of the five capitals is respected.* The recognition of these levels is another matter and depends on the societal values and priorities.

3. *The wider the societal acceptance of the economic, social and environmental impacts, the better*. The more the interested parties that consent, the better. Of course, the interested parties at the programme level might be more and more powerful than at the project level, although, not infrequently, the programme' s impact are not evident.

4. *The longer the time horizon over which impacts are assessed, the better*. A life-cycle perspective is desired. Some impacts last for decades, others for centuries or forever. Time horizon refers mainly to projects, even in cases of project synergies within a programme. The natural capital is better managed at the project level, the financial at the programme and the cultural at the portfolio level.

5. If a project is a true subsystem of a program (not from the owner's, but from the interested parties' perspective), *it is the sustainability of the higher system that counts*. There can not be a sustainable project within a socially unacceptable programme. (Compare to the case where the project management is successful but the project a failure). Thus, the hierarchy of needs enters the picture. It is noted, however, that, for a specific point of view, the system hierarchy does not coincide with needs and objectives hierarchy –a fact that further complicates the sustainability analysis.

Table 2 is a proposed *study table* for the potential of the PM to enhance project sustainability. The second column is a list of the IPMA (2006) contextual elements. The third column shows the relevant complexity property for each contextual element. The entries in columns 4 to 6 are supposed to express the PM's position vis a vis each of the 11 contextual competence elements. All entries are challengeable preliminary assessments, by this author, of the PM's authority and his/her impact on the parameters affecting project's sustainability. They are supposed to show, in the opinion of this author and with regard to each element, how the PM appreciates the situation and whether she/he can affect it. Specifically:

*Column 3:* Expresses the author's assessment of the complexity properties that relate to each element:
C: *Co-existence,* E: *Effectiveness,* R: *Robustness or Resilience,* A: *Adaptability*.

*Column 4*: Expresses the PM's role regarding the element. Symbols D and C are employed as follows:
D: *Decisive*. The PM is the main, the decisive decision-maker.
C: *Contributory*. The PM contributes to relevant decisions that are taken at higher levels of management.

*Column 5*: Indicates whether the PM, *by his decisions*, affects mostly the:

Viewpoint (V), i.e. criteria, objectives and scope of the project
Extent (E) of social acceptance
Time horizon (T) of the impacts of decisions taken by the PM
Hierarchically (H) higher system (programme)

*Column 6*: Indicates which of the Five Capitals (N, M, H, S or F) and the cultural (C) are primarily involved in dealing with the corresponding element.

It is again noted that the entries in Table 2 refer only to the PM's potential at the project level.

| ICB Contextual Element | | Complexity Properties | PM's Role:<br><br>D: Decisive<br>C: Contributory | The PM mostly affects:<br><br>V: Viewpoint<br>E: Extent of Acceptance<br>T: Horizon of impacts<br>H: Higher system | Mainly Affected Forms of Capital |
|---|---|---|---|---|---|
| No. | Content | | | | |
| (1) | (2) | (3) | (4) | (5) | (6) |
| 3.01 | Project orientation | ***C, A, R*** | ***D*** | ***V, E, T, H*** | ***ALL*** |
| 3.02 | Programme orientation | ***C, A, R*** | ***C*** | ***E, T, H*** | ***S, H, F*** |
| 3.03 | Portfolio orientation | ***C, R, E, A*** | ***C*** | ***E, T, H*** | ***F, H, M, N*** |
| 3.04 | PPP implementation | ***C, A,*** | ***D*** | ***H, T*** | ***ALL*** |
| 3.05 | Permanent organisation | ***C, E, A,*** | ***C*** | ***H, T*** | ***ALL*** |
| 3.06 | Business | ***A, C,*** | ***C*** | ***E , H, T*** | ***S, H, C, F*** |
| 3.07 | Systems, products & technology | ***C, E,*** | ***D*** | ***V, H, T*** | ***ALL*** |
| 3.08 | Personnel management | ***E, A*** | ***D*** | ***H, E*** | ***H, S*** |
| 3.09 | Health, security, safety & environment | ***E*** | ***D*** | ***E, T, H*** | ***H, S, N*** |
| 3.10 | Finance | ***E , A*** | ***C*** | ***V, E , T, H*** | ***F, M, N , S*** |
| 3.11 | Legal | ***E , A*** | ***C*** | ***V, E , T, H*** | ***F, S, H*** |

**Table 2**: *The PM Potential for Enhancing Sustainability through the Contextual Competence Elements at the project level*

Table 3 shows this author's assessment of the severity of impact upon each of the six capitals at the project and programme levels, with emphasis on the construction sector. Here we consider the impact on each type of capital, looking at it as a productive resource, as an input to the process, not as a recipient of impacts. For example, a construction project affects the natural and the manufactured capitals severely as it uses and transforms them. This does not happen with the social capital, since the rules and the organized social structures are not severely affected. This is not to say that the social impacts are negligible. Social capital (which is an important input to the project, a part of the project's "context") does

not coincide with the social impact (output) of the project. Obviously, the assessment varies on the basis of the type and context of the specific construction project. At programme level, there is potentially bigger impact on rules and organizational schemes, since they can be more easily changed. But, again, this analysis here is an invitation for argument, not a justification for a specific position.

| | Severity of Impact on the Six Capitals | | | | | |
|---|---|---|---|---|---|---|
| | Natural | Social | Human | Manufactured | Financial | Cultural |
| Project | S | L | M | S | M | L |
| Programme | M | M | L | M | S | S |

**Table 3**: *Impact on the Six Capitals at the Project and Programme Levels (S: severe, M: moderate, L: light)*

## 4. Conclusions

The issues raised in this paper may be seen as a contribution to the evolving discussion about the adjustment processes (probably, in some cases, the transformation) of organizations that desire to improve their sustainability performance. The question is how the social pressure for sustainable performance affects a project/programme oriented organization and whether such a change (should it be desirable) can better be effected through a project/ programme. The main conclusion of this paper is the suggestion that Project and Programme Management has a crucial role in enhancing organizational sustainability and Sustainable Development in general. So, an attempt is made to open the discussion on the PM's role and to outline a procedure for assessing its significance.

Essentially, here, an additional criterion, referring to sustainability, is proposed for assessing project management success and an indirect suggestion is made to include these issues in the PM's training and certification.

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# The role of health, safety and green principles in estimating construction productivity: an empirical framework

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## Abstract
The current approach to construction health and safety (H&S) and green building underestimates the role of production practices and focuses mainly to the formulation of general guidelines and best-practice policies. This paper adopts a different approach in that it integrates workers' health as expressed by their thermal comfort and environmental parameters in productivity estimation. An empirical framework is presented to evaluate the relationship of the Predicted Mean Vote index to operational efficiency. Process mapping and simulation-based analysis is used for the creation and comparative analysis of productivity models. An exemplar investigation of formwork operations illustrates the applicability of the proposed approach. The main conclusion from the study is that the implementation of the empirical framework enables the creation of foresight in planning construction operations by analysing productivity variations compared to baseline estimates. It is believed that such an approach provides a more realistic representation of construction operations and improves the accuracy of the estimating process.

## Keywords
Construction, health, process, productivity, thermal comfort

## 1. Introduction

The protection of the workers' well being and the establishment of a safe working environment are key prerequisites for the achievement of sustainability in construction (Rajendran et al. (2009)). However in traditional practice the issues of Health and Safety (H&S) are addressed by the formulation of general guidelines, best-practice policies and operating procedures (Wang et al. (2006)), whereas issues relating to work methods and production practices are often ignored (Mitropolulos et al. (2009)). Therefore this paper adopts a different approach in that it integrates H&S and environmental parameters in productivity estimation. Construction workers' H&S is assessed through the evaluation of the thermal comfort, which is a key environmental parameter for rating green buildings. A non-linear relationship between thermal comfort and productivity is established, as a means for quantifying the effect of the environment on job efficiency. Given that construction productivity is often studied in a fragmented manner, the purpose of

the study is to overcome this deficiency and establish an explicit empirical framework that will (i) enable the creation of productivity forecasting models based on environmental data, (ii) delineate the experimental setting for conducting valid productivity measurements in relation to parameters associated with thermal comfort and (iii) set out the criteria which will allow the comparative analysis of the produced estimates.
In the remainder of this paper a brief review of pertinent research on health, safety and green principles is presented along with a description of the main parameters used for the evaluation of the thermal comfort. Then, the research methodology is explained followed by a discussion on the proposed empirical framework. An exemplar evaluation of the suggested approach is presented for formwork operations. Finally, the main conclusions emerging from the study are elucidated.

## 2. Background

### 2.1 Integrating health, safety and green principles

Sustainability is an overarching concept that affects, and can be affected by, every aspect of infrastructure development (Sev (2009)), including the delivery of sustainable construction projects. A concept closely associated with sustainable construction (SC) is that of "green principles", namely the adopted design and construction practices that are related to the environment (Rajendran et al. (2009)). The measurement of construction projects' adherence to green principles is achieved through the implementation of green rating systems, such as LEED (2009). However it seems that green rating systems address the issues of H&S in an ad-hoc manner, making no linkage to operational or working practices which are a key determinant of the H&S status achieved on site (Pantouvakis and Panas (2010)). As such, this study aims at coupling H&S strategies and productivity considerations for shifting current project management perceptions in the pursue of a more sustainable construction environment.

### 2.1 Thermal comfort as a key productivity parameter

It has been long acknowledged that the thermal environment affects labour efficiency and may reduce their productivity (Thomas and Yakoumis (1987)). The effect of the thermal comfort on construction operations has drawn limited attention, hence leaving construction planners or estimators with insufficient information to deal with especially in the design stage (Srinavin and Mohamed (2003)). The most widely used thermal comfort metric today is the Predicted Mean Vote (PMV) index (ISO 7730 (2005)), which represents the thermal strain based on a steady-state heat transfer between the body and the environment. PMV takes values in the range of ±3 where 0 is the ideal thermal comfort point and +3/-3 denote extreme hot or cold environments respectively. PMV is derived from a steady-state model whose main parameters are summarized in Eq. (1) to (5) (ISO 7730 (2005)).

$$\mathrm{PMV} = \left[0.303 \times e^{-0.036 \times M} + 0.028\right] \times \left\{ \begin{array}{c} (M - W) - 3.05 \times 10^{-3} \times \left[5733 - 9.99 \times (M - W) - p_a\right] - 0.42 \times \left[(M - W) - 58.15\right] \\ - 1.7 \times 10^{-5} \times M \times (5867 - p_a) - 0.0014 \times M \times (34 - t_a) \\ - 3.96 \times 10^{-8} \times f_{cl} \times \left[(t_{cl} + 273)^4 - (t_r + 273)^4\right] - f_{cl} \times h_c \times (t_{cl} - t_a) \end{array} \right\} \quad (1)$$

$$t_{cl} = 35.7 - 0.028 \times (M - W) - I_{cl} \times \left\{3.96 \times 10^{-8} \times f_{cl} \times \left[(t_{cl} + 273)^4 - (t_r + 273)^4\right] + f_{cl} \times h_c \times (t_{cl} - t_a)\right\} \quad (2)$$

$$h_c = \begin{cases} 2.38 \times |t_{cl} - t_a|^{0.25} & \text{for} \Rightarrow 2.38 \times |t_{cl} - t_a|^{0.25} > 12.1\sqrt{v_{ar}} \\ 12.1\sqrt{v_{ar}} & \text{for} \Rightarrow 2.38 \times |t_{cl} - t_a|^{0.25} < 12.1\sqrt{v_{ar}} \end{cases} \quad (3)$$

$$f_{cl} = \begin{cases} 1.00 + 1.290 \times I_{cl} & \text{for} \Rightarrow I_{cl} \le 0.078 m^2 \cdot K / W \\ 1.05 + 0.645 \times I_{cl} & \text{for} \Rightarrow I_{cl} > 0.078 m^2 \cdot K / W \end{cases} \quad (4)$$

$$p_a = R_h \times 10 \times EXP\left[(16.6536 - 4030.183)/(t_a + 235)\right] \quad (5)$$

where $M$=metabolic rate [W/m$^2$]; $W$=effective mechanical power [W/m$^2$]; $I_{cl}$=clothing insulation [m$^2$·K/W]; $f_{cl}$=clothing surface area factor [-]; $t_a$=air temperature [ºC]; $t_r$=mean radiant temperature [ºC]; $v_{ar}$=relative air velocity [m/s]; $p_a$=water vapour partial pressure [Pa]; $h_c$=convective heat transfer coefficient [W/m$^2$]; $t_{cl}$=clothing surface temperature [ºC]; $R_h$=relative humidity [%].

PMV's estimation is possible if six of the above parameters are known (usual values in brackets): metabolic rate (M within 46–232W/m$^2$ or 0.8–4.0met), thermal insulation ($I_{cl}$ within 0–0.310m$^2$·K/W or 0–2clo), air temperature ($t_a$ within 10–30ºC), mean radiant temperature ($t_r$ within 10–40ºC), relative air velocity ($v_{ar}$ within 0–1m/s) and relative humidity ($R_h$ within 30–70%) (ISO 7730, 2005). The most relevant research effort to associate PMV with productivity is the regression model developed by Srinavin and Mohamed (2003) for painting, bricklaying and manual excavation operations. However, this model can be criticised for being strictly deterministic, lacking a clear experimental framework and being limited in scope. As such, this study adopts the PMV index within a consistent empirical framework that allows the creation of parametric deterministic and/or stochastic productivity forecasting models that are adjusted to specifically suit the job in hand.

## 3. Simulation modelling

In this study, construction operation analysis and process mapping is based on the STRBOSCOPE simulation language and simulation models for productivity estimation are created with the EZStrobe simulation package (Martinez (2001)), whose basic modelling elements are depicted in Table 1. The investigation of PMV's role as a health metric in productivity estimation is undertaken for both the deterministic and stochastic analysis approach. Deterministic simulation models utilize published historical productivity data (e.g. RSMeans (2009) price book), so as to determine the cycle time duration for specific construction activities. Given that deterministic analysis assumes 100% work efficiency, the deterministic simulation models use an efficiency factor whose value is specified by the estimator to represent the subjective effect of qualitative variables on productivity (Zayed and Halpin (2004)), such as safety risk. On the other hand, stochastic analysis is based upon probabilistic data sets stemming from on-site measurements by the use of established work study methods (Alfeld (1988)). In order for both the deterministic and the stochastic approaches to be comparable, the same output analysis method is deployed: each simulation run set comprises of 40 replications at a 95% confidence level, resulting in an unbiased point estimator of average productivity. More details on the proposed empirical framework are provided in the next section.

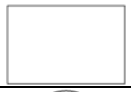
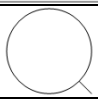
| **EZStrobe simulation platform** | | |
|---|---|---|
| Modelling element | Name | Description |
| | COMBI | Logically constrained in its starting logic, otherwise similar to the NORMAL element. Always preceded by Queue Nodes. |
|  | NORMAL | Logically unconstrained in its starting logic, indicates active processing of (or by) resource entities. |
|  | QUEUE NODE | Precedes all COMBI activities and denotes the idle state of a resource entity symbolically representing a queuing up or waiting for use of passive state resources. |
| | ARROW | Indicates the logical structure of the model and direction of entity flow. |

**Table 1**: EZStrobe modelling elements

## 4. The proposed empirical framework

The proposed methodological framework for the investigation of thermal comfort and productivity is shown on Fig. 1. It is essentially a four-phase process whose steps are explained in the next paragraphs.

### Phase 1 – Preliminary steps

The first phase initiates with the definition of the activity and the respective number of sub-tasks ($n_s$) required for completing it. In addition, the analyst identifies the risk associated with the activity along with a classification of possible accidents. Using risk taxonomies included in industrial classification codes the estimator evaluates the safety demand imposed on the respective labour crew for a given operation. In other words, the safety demand reflects the added difficulty imposed on a crew when executing a work task, due to deviations from the normative activity description in comparison to the job in hand.

### Phase 2 – Forecasting productivity model

The definition of the operational setting enables the creation of a forecasting model based on historical data. These data serve as a basis for the definition of the Baseline Reference Productivity (BRP), namely each activity's cycle time per unit of measurement (e.g. $h/m^2$). However, for every standard BRP estimate allowances have to be added to reflect possible losses in productivity due to the peculiarities of the current construction operation, since past construction operations can never be replicated in the exact same way in future projects. For the current study the induced productivity losses are represented by an empirical efficiency factor (E), which can be either a constant value or a distribution taking values in the range of [0,1]. The expected productivity (EP) of each activity is established as a sum of the respective EP of all its sub-tasks. In case only a cumulative productivity estimate for the entire activity is available, sub-tasks productivity is specified according to empirical rules. Finally, the expected environmental conditions are defined based on previous experience or historical meteorological data.

## Phase 3 – Empirical productivity model

This is a parallel phase to the one before, aimed at delineating the experimental framework for the evaluation of the relationship between the PMV index and productivity. First, the operational reference conditions are defined (e.g. building element, crew characteristics, shift), followed by a specification of the PMV parameters that are going to be measured. Then, work studies are undertaken to elicit productivity data and measure the PMV parameters by the use of appropriate instrumentation (direct observation for the former and thermal camera combined with probe sensors for the latter). The collected data is categorised in clusters based on the six main PMV parameters specified in section 2.2. In case a statistically sufficient amount of data is contained in each cluster, then probabilistic analysis determines the distribution of the activities' duration. On any other case, supplementary data has to be provided otherwise the operational setting represented by the specific data cluster cannot be qualified for modelling and analysis.

## Phase 4 – Modelling process

The modelling phase commences with the mapping of the construction processes. Simulation models are created for every cluster's dataset and intra-cluster analysis is undertaken to compare the results. In the case of the forecasting productivity models, simulation is used to generate productivity outputs based on BRP inputs, whereas for empirical models activities' durations are assumed to be probabilistic. Simulation output is validated and a regression analysis between PMV and productivity is undertaken. Key parameters are varied to evaluate the system's sensitivity and the comparative analysis of the results finalises the investigation.

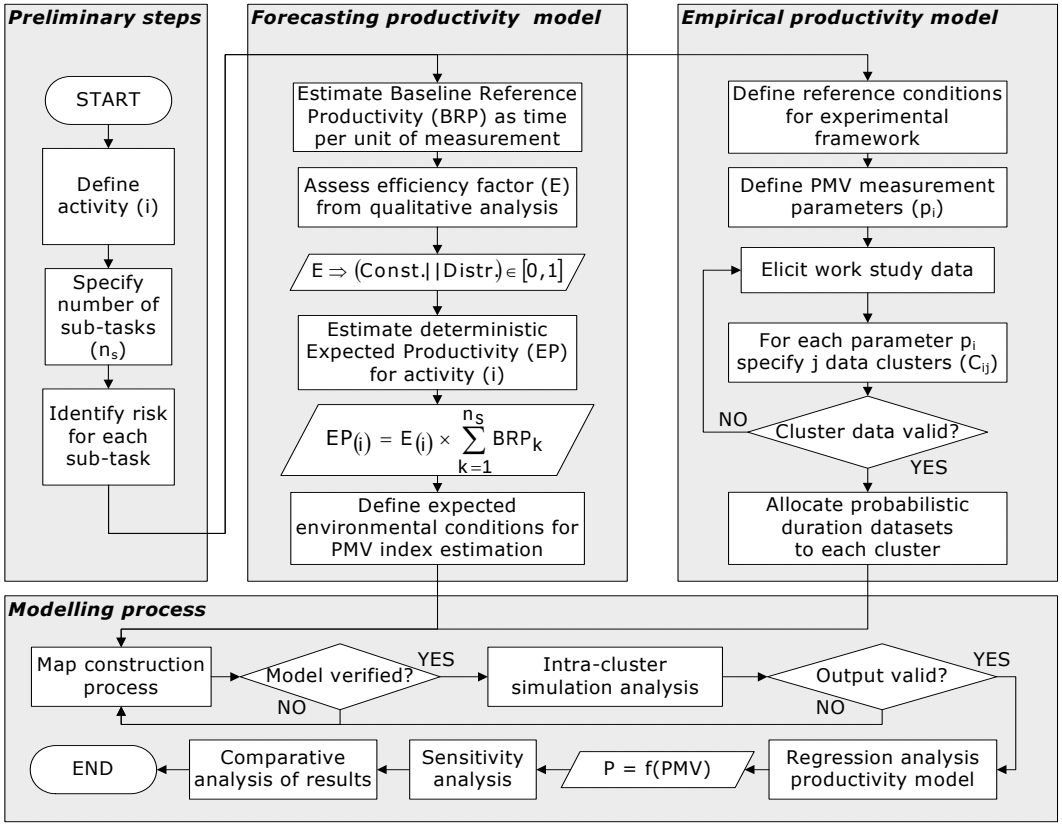



**Fig 1**: Proposed empirical framework

## 5. Exemplar implementation for formwork operations

The proposed methodology is implemented for a hypothetical analysis of foundation walls formwork operations taking place in Athens, Greece. Historical productivity data published by RSMeans (2009) and meteorological data provided by the Hellenic National Meteorological Service (HNMS (2010)) are used for the forecasting models. The development of the empirical models is based on field data provided by Thomas and Yakoumis (1987) with respective rationalization adjustments where appropriate. The application of the steps described in section 4 yields the following results.

*Phase 1 – Preliminary steps*
The investigation regards formwork operations for basement walls which comprise five ($n_s$=5) sub-tasks as follows: Fabrication, erection, plumbing, stripping and cleaning. The main risks associated with fabrication are cutting and lifting/lowering of materials, whereas attention should be given to nailing/screwing/drilling operations when erecting the form panels to avoid transportation accidents or overexertion. Plumbing involves using bodyweight, pry bars or other equipment to shift and adjust the formwork which increases the risk of getting caught within the structure. Stripping operations that occur above or below grade typically require workers to ascend or descend ladders to manually transport equipment and materials and relates to the risk of falling on lower or the same level. Form lubrication and preparation involves spraying form oil and/or curing compound, thus exposing labour crews to harmful substances.

*Phase 2 – Forecasting productivity model*
Each sub-task's BRP is estimated according to formwork operations cumulative productivity data averaged at 1,292h/$m^2$ (RSMeans (2009)). The efficiency factor (E) is assumed to take values in the range of 0.75–1.00 following a uniform distribution. Historical meteorological data show that the minimum, average and maximum expected air temperature in March would be 8.4ºC, 12.3ºC and 15.7ºC respectively, with an average humidity of 65,9%. Finally, 35 data points for the PMV index were calculated for gradual variations of $t_a$.

*Phase 3 – Empirical productivity model*
Foundation wall formwork executed by an experienced crew in an 8-hour shift is the focus of operations. Eq. (1) to (5) were computed in a spreadsheet program and the PMV index was estimated for the six main parameters (M, $I_{cl}$, $t_a$, $t_r$, $v_{ar}$, $R_h$) under the following assumptions: The metabolic rate for formwork operations was taken equal to 180W/$m^2$ or ~3.1met. Work clothing comprising of "underwear with short sleeves and legs, shirt, trousers, jacket, socks and shoes" (ISO 7730 (2005)) was assumed for the whole crew ($I_{cl}$=1.00clo). Wind velocity was set at 0.25m/s as a representative value of outdoor construction tasks. The rest of the parameters are input variables in the model. One data cluster has been defined for M, $I_{cl}$, $t_a$, $t_r$, $v_{ar}$, $R_h$ with the respective cluster range being [2.75-3.44met], [0,9-1,2clo], [8.4-15.7]ºC, [11.4-18.7ºC], [0.22-0.27m/s] and [65-67%] respectively. This means that valid comparisons should be undertaken for models comprising data that fit to all of the aforementioned clusters. In any other case the comparison would be statistically invalid since it would represent a different empirical paradigm. The latter is going to be highlighted in the next paragraph. Lastly, field data from Thomas and Yakoumis (1987) representing 35 productivity measurements for formwork operations were processed and the respective PMV values were estimated.

*Phase 4 – Modelling process*

A generic simulation model was created to represent the construction process, as shown in Fig. 2. 35 independent simulation runs were undertaken for the forecasting model and the results are illustrated on Fig. 3. The forecasting model is consistent with the established notion that the more comfortable the thermal environment (i.e. PMV closer to 0), the more productive a crew can be. Moreover, under the effect of the efficiency factor, simulation-based analysis indicates a drop in optimum productivity of about 10% compared to a 25% decrease in case of a deterministic value. An interesting point of the analysis emerged when an attempt was made to categorize the empirical data into the pre-specified clusters, so as to compare forecasting and empirical models. It was noted that not a single data point from the empirical data set suited the cluster structure of the forecasting one (four data points fitted the $t_a$ cluster but none the $R_h$ cluster). This exemplifies the importance of an explicit determination of the experimental framework, otherwise productivity models of a notably low coefficient of determination ($R^2$) will be created which, although providing an indication of the productivity threshold, have a limited practical utility (Fig. 4). Finally, a sensitivity analysis revealed that the PMV model is particularly sensitive to the metabolic rate which represents the difficulty of the task being performed.

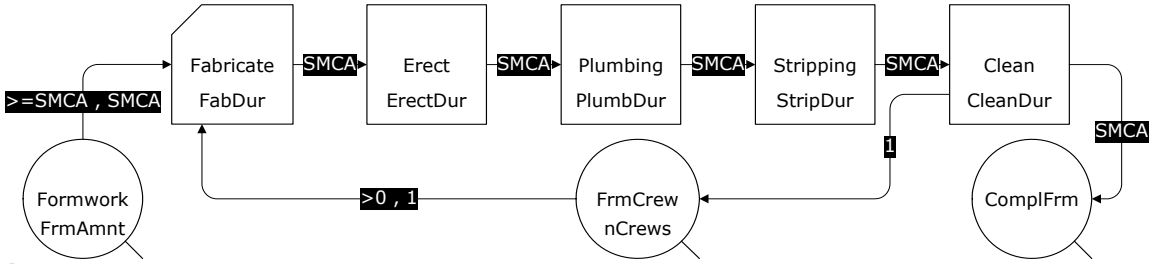



**Fig 2**: Generic simulation model for formwork operations

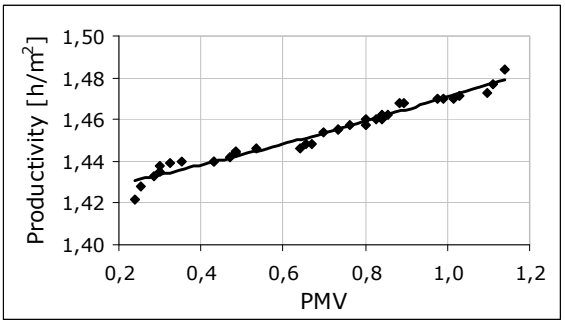



**Fig 3**: PMV forecasting model

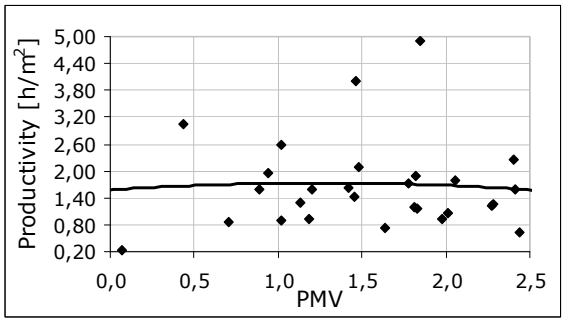



**Fig 4**: PMV empirical model

## 6. Conclusions

This presented work demonstrates that construction labour's productivity variation can be interpreted by sustainable concepts pertaining to occupational health and well being, as expressed by the thermal environment. Simulation-based analysis of the impact of thermal comfort on labour productivity creates insight regarding the work practices of construction labour crews, whose behavioural attitude is rarely included in quantitative productivity analyses. The use of the PMV index helps in relating key environmental variables to productivity. The current approach emphasizes on the creation of a robust empirical framework that enables the

realisation of valid productivity measurements and the subsequent development of comparable productivity models. In addition, the explicit definition of the experimental framework allows the characterisation of each study's applicability and respective scope limitations. The latter contributes to overcoming the methodological inconsistency inherent in many productivity studies, which leads to the creation of fragmented models to the detriment of comparative validity. As such, a more realistic representation of construction operations is achieved which improves the accuracy of the estimating process.

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*W12*

# A Critical Review of Published Research on Construction Productivity

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## Abstract
Despite the large number of published papers in the area of construction productivity, a critical review of contemporary thinking with a discussion of the implications to current researchers is rarely attempted. As such, this paper investigates the subject based upon published papers in major peer-reviewed journals during the last decade. Eighty-nine papers published in both construction journals and broader management science journals have been analysed. The research taxonomy identified three major fields: Archival studies, empirical research and simulation proposals. In terms of the methodological structure followed, three major categories have been recognized: Experimental frameworks, data collection techniques and modeling proposals. The main conclusion is that the selection of the research methodology in published journal papers has been an intuitive decision, grossly relating upon the researcher's ontological and epistemological stance. However, general guidelines on the selection of the most appropriate methodology in relation to the research objectives are also discussed herein.

## Keywords
Construction, Methodology, Productivity, Research

## 1. Introduction

The establishment of the most appropriate methodology for construction research is a current subject of concern. This is corroborated by the special issue of the *Journal of Construction Engineering and Management* (Volume 1, Issue 1) on research methodologies for Construction which only appeared at the beginning of 2010. A previous somewhat organized approach to the subject can be traced back in the mid to late 1990's with a series of papers appearing in *Construction Management and Economics* (Volumes 13-16). The review of those and some other supplementary sources (from relevant papers which did not appear in the above mentioned journals and periods) has led to a number of questions relating to construction management research methodological issues; What are the most suitable criteria for selecting the research methodology? How can the rigour and robustness of a research effort be evaluated? What are the current trends?
The above and similar questions have formed the motivation for the research described in this paper. More specifically, in this paper we aim to provide answers to the above questions, with a particular focus on research related to construction productivity (CP). The field of CP is an expedient research area since the complex and versatile nature of the subject has led to the implementation of multiple

methodological approaches. As such, this study explores the different perspectives for measuring or estimating construction productivity. The main purpose is to capitalise on the trend towards methodological rigour and comprehensiveness by soliciting papers on methodologies that are identified as being typically employed in construction productivity research.

## 2. Theoretical background

The debate on construction research as expressed in Seymour et al. (1997) resulted in a controversy between academics favouring the positivist perspective, which is closely related to rationalism, empiricism and objectivity (Hariss, 1998) and the ones in favour of the interpretivistic approach, which highlights the subjectivity of truth and reality since it depends on the persons investigated (Rook et al., 1997). Traditionally, the former is associated with quantitative research, whereas the latter is related to the qualitative research approach (Fellows and Liu, 2003). However, the current research trend seems to extend beyond the sterile debate limited by the dichotomies of the past and supports a shift towards encouraging more or different research techniques and paradigms to be employed in construction management research, often termed as "multimethodology" (Dainty, 2008). The latter is particularly relevant for CP research, where social and natural science methods are frequently intertwined (Abowitz and Toole, 2010).
As this study's objective is to critically review published research on construction productivity irrespective of the adopted approach, a challenge for the authors was the formulation of a concise and generic set of criteria for the evaluation of all types of research efforts included in the analysis. It has been decided to use two metrics:

- The researcher's *ontological and epistemological stance* (Dainty, 2008); and
- The satisfaction of the *unique adequacy (UA) requirement* of methods, as proposed by Rooke and Kagioglou (2007).

Ontology refers to the conceptions of reality and is divided in "objectivist ontology" which evaluates social phenomena independent of the social actions (quantitative approach) and "constructivist ontology" which recognises that social phenomena are dynamic and produced through social interaction (qualitative approach) (Dainty, 2008). Epistemology refers to what should be regarded as acceptable knowledge in a discipline and is characterised either by a positivist (quantitative) or interpretivistic (qualitative) perspective as mentioned in the first paragraph of this section (ibid.). Whereas the first metric evaluates the researcher, the UA requirement addresses both the researcher and the research itself, through the definition of two satisfaction criteria: the weak and strong forms (Rooke and Kagioglou, 2007). For the UA requirement to be satisfied in its weak form, the researcher must be familiar with the setting under study. For example, a questionnaire should be designed by someone who has direct knowledge of the activity under study. On the other hand, Rooke and Kagioglou (2007) state that the strong requirement concerns the reporting of the research and is based upon the premise that the methods of analysis used to report on a setting should be derived from that setting. In other words, the method of analysis should not necessarily be determined *a priori*, but emerge from the particular setting that is investigated. The UA adequacy is primarily used for evaluating qualitative research without however excluding its application for quantitative approaches. In addition, satisfaction of the weak requirement is a prerequisite for the achievement of the strong requirement (Rooke and Kagioglou, 2007).

# 3. Research methodology

The research strategy used for this paper was to launch a comprehensive review of the CP literature from 1999 to 2009. Eighty-nine (89) papers were selected from top quality journals. 72 papers (81% of the sample) stem from five top quality construction management journals (number of articles in brackets): *Automation in Construction (AutoCon)* (11), *Construction Management and Economics (CME)* (10), *Engineering, Construction and Architectural Management (ECAM)* (5), *Journal of Computing in Civil Engineering (JComCE)* (5), and *Journal of Construction Engineering and Management (JCEM)* (41). The rest can be found in journals that cover a broader spectrum of management science regarding productivity (e.g. International Journal of Project Management; International Journal of Productivity and Performance Management; Personnel Review). The qualitative content analysis technique was implemented, so as to introduce some form of taxonomy in the data (Fellows and Liu, 2003). A three-level hierarchical classification system has been developed for the analysis (Fig. 1). First, three broad classifications have been used for evaluating the researchers' stance: (1) *Qualitative*, (2) *Quantitative*, and (3) *Mixed-method* approach (combination of the first two). A further sub-classification step identified three major categories: (1) *Archival study*, (2) *Empirical research* and (3) *Simulation proposals*. It should be noted that although simulation can be regarded as part of empirical research (Flood and Issa, 2010), it has been decided to be represented by an autonomous category due to its methodological peculiarities (Martinez, 2010). Further analysis showed that the utilized methods and tools focus mainly on: (1) the development of *experimental frameworks*, (2) the description of *data collection techniques* and (3) the suggestion of *modelling methodologies*. Where the research methodology, strategy or design was not clearly defined within the paper, the adopted methodology was identified from the narrative description of the research (Dainty, 2008). In the next paragraphs, the research taxonomy is elaborated in detail, based on specific data from the sample analysis.

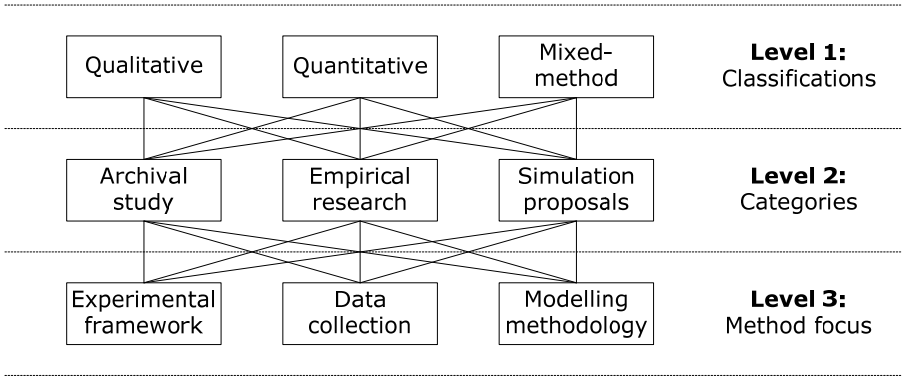


**Fig. 1**: Construction productivity research taxonomy

# 4. Analysis of the results

## 4.1. Descriptive statistics

The total number of papers published in the selected journals in comparison to the CP related papers is shown on Fig. 2a below. A more detailed analysis within the selected journals shows that JCEM has the highest publication rate of 3.24% followed by AutoCon by 1.32% (Fig. 2b). Papers come from 14 countries, where

USA takes the lead with 44 papers, followed by China (incl. Taiwan and Hong Kong) with 18, as shown in Table 1 illustrating the top-5 countries. Canada, the United Kingdom, Australia and South Korea also seem to be major contributors. Out of 149 researchers, the top-10 most cited authors are shown in Table 2, along with the respective number of publications. In parenthesis is shown the current research institution and published work, in case the author has changed in the last decade. Finally, Table 3 summarizes the most frequently cited papers, according to the Institute for Scientific Information's (ISI) index.

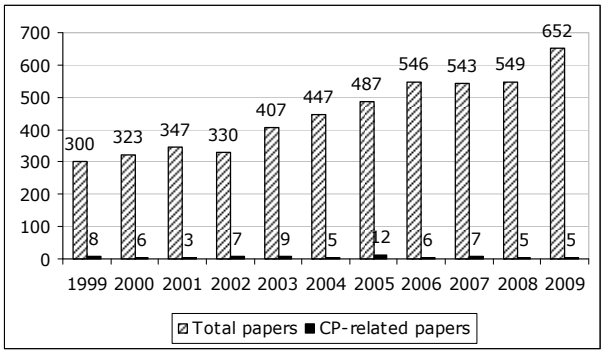


**Fig. 2a**: CP-related papers in selected journals for the period 1999-2009

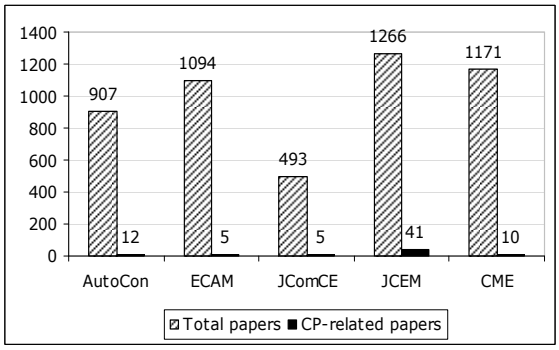


**Fig. 2b**: Published CP-related papers in selected journals

| No. | Country | Research centres | Researchers | Papers published |
|---|---|---|---|---|
| 1 | USA | 20 | 60 | 44 |
| 2 | China | 8 | 24 | 18 |
| 3 | Canada | 2 | 16 | 16 |
| 4 | United Kingdom | 5 | 13 | 9 |
| 5 | Australia | 5 | 6 | 6 |

**Table 1**: Top 5 countries with most published papers

| Researcher | Institution | Country | Papers published | Times cited in sample |
|---|---|---|---|---|
| Halpin, D.W. | Purdue Univ. | USA | 5 | 109 |
| AbouRizk | Univ. of Alberta | Canada | 4 | 94 |
| Thomas, H.R. | Pennsylvania State Univ. | USA | 5 | 90 |
| Martinez, J.C. | Virginia Polytechnic Inst. & State Univ. | USA | 1 | 44 |
| Shi, J.J. | City Univ. of Hong Kong | China | 5 | 38 |
| Moselhi, O. | Concordia Univ. | Canada | 3 | 23 |
| Hanna, A.S. | Univ. of Wisconsin-Madison | USA | 6 | 22 |
| Zayed, T.M. | Purdue Univ. | USA | 5 | 15 |
| Marzouk, M. | Concordia Univ. (Cairo Univ.) | Canada (Cairo) | 2 (1) | 13 |
| Tam, C., M. | City Univ. of Hong Kong | China | 4 | 9 |

**Table 2**: Top 10 researchers with most published papers

## 4.2. Exploration of researchers' stance

In the field of CP, the application of quantitative research dominates (60.7%), followed by the mixed-method (29.2%) and the qualitative approaches (10.1%) (Table 4). The quantitative approach is primarily associated with empirical research, such as statistical analysis (Zayed and Halpin, 2005), artificial neural networks (ANN) development (Tam et al., 2002) and fuzzy set analysis (Yang et al., 2003), as well as simulation studies (Huang et al., 2004). Qualitative research is implemented for archival analysis or empirical work within the framework of questionnaire surveys (Rojas and Aramvreekul, 2003). Mixed-method research stems from papers that combine empirical work (e.g. questionnaire surveys) or archival study (e.g. document analysis) with quantitative modeling of productivity data for the development of statistical models (Hanna et al., 2008) or the training of ANN (Song and AbouRizk, 2008). Taking a more detailed view, Table 5 shows that archival and empirical CP research is essentially equally focused on developing experimental frameworks, improving data collection techniques and delineating modelling methodologies, whereas the latter is almost the exclusive objective of simulation studies (in 19 out of 25 cases).

| No | Author/year | Title | Publi-cation | Sample index | ISI index |
|---|---|---|---|---|---|
| 1 | Martinez, J.C. & Ioannou, P.G. (1999) | General-purpose systems for effective construction simulation | JCEM[1], 125(4) | 9 | 48 |
| 2 | Hajjar, D. & AbouRizk, S.M. (2002) | Unified modeling methodology for construction simulation | JCEM, 128(2) | 6 | 33 |
| 3 | Shi, J.J. (1999) | Activity-based construction (ABC) modeling and simulation method | JCEM, 125(5) | 7 | 28 |
| 4 | Hanna, A.S. et al. (1999) | Impact of change orders on labour efficiency for electrical construction | JCEM, 125(4) | 4 | 26 |
| 5 | Hanna, A.S. et al. (1999) | Impact of change orders on labour efficiency for mechanical construction | JCEM, 125(3) | 5 | 23 |
| 6 | Thomas, H.R. et al. (1999) | Loss of labour productivity due to delivery methods and weather | JCEM, 125(1) | 6 | 20 |
| 7 | Cheng, T.M. & Feng, C.W. (2003) | An effective simulation mechanism for construction operations | AutCn[2], 12 | 1 | 19 |
| 8 | Thomas, H.R. & Zavrski, I. (1999) | Construction baseline productivity: theory and practice | JCEM, 125(5) | 3 | 17 |
| 9 | Zayed, T.M. & Halpin, D.W. (2001) | Simulation of concrete batch plant production | JCEM, 127(2) | 4 | 17 |
| 10 | Thomas, H.R. (2000) | Schedule acceleration, workflow and labour productivity | JCEM, 126(4) | 2 | 17 |

[1]Journal of Construction Engineering and Management (ISI Impact Factor 0.564)
[2]Automation in Construction (ISI Impact Factor 1.664)

**Table 3**: Most frequently cited papers

| | Archival study | Empirical research | Simulation proposals | Total |
|---|---|---|---|---|
| **Quantitative** | 5 (5.6%) | 26 (29.2%) | 23 (25.9%) | 54 (60.7%) |
| **Qualitative** | 5 (5.6%) | 4 (4.5%) | 0 (0.0%) | 9 (10.1%) |
| **Mixed** | 8 (9.0%) | 16 (18.0%) | 2 (2.2%) | 26 (29.2%) |
| **Total** | 18 (20.2%) | 46 (51.7%) | 25 (28.1%) | 89 (100%) |

**Table 4**: Research classifications and categories

| | Experimental framework | Data collection technique | Modelling methodology | Total |
|---|---|---|---|---|
| **Archival** | 7 (7.9%) | 5 (5.6%) | 6 (6.7%) | 18 (20.2%) |
| **Empirical** | 16 (18.0%) | 14 (15.7%) | 16 (18.0%) | 46 (51.7%) |
| **Simulation** | 4 (4.5%) | 2 (2.2%) | 19 (21.3%) | 25 (28.1%) |
| **Total** | 27 (30.3%) | 21 (23.6%) | 41 (46.1%) | 89 (100%) |

**Table 5**: Research categories and method focus

The results of the analysis for every research category and the respective method's focus are as follows:

- **Archival studies:** The development of experimental frameworks is mainly targeted at testing new models, validating existing ones and conducting comparative analyses. Data collection techniques are implemented either in the form of questionnaire surveys or standardized productivity registration forms. Preferred modelling methodologies are the development of linear models, the training of neural networks and the creation of historical databases.
- **Empirical research**: The experimental framework comprises laboratory tests, passive observation, controlled experiments or multi-factor comparative evaluations. Time studies, work sampling, time-lapse photography, image analysis and specialized data elicitation instruments are the most commonly used data collection techniques. Statistical or probabilistic modelling is primarily deployed for processing the collected data.
- **Simulation proposals**: The experimental framework is almost exclusively associated with discrete-event simulation. The data collection techniques are similar to the previous categories (e.g. time-studies or questionnaires). The modelling methodology is divided in the implementation of General Purpose Simulation (GPS) platforms, such as STROBOSCOPE or EZStrobe (Marzouk and Mosehli, 2003), and the utilization of Special Purpose Simulation (SPS) tools, such as SIMPHONY (Mohamed and AbouRizk, 2005).

In terms of the researched productivity factors, the majority of the papers investigated the effect of change orders, construction methods, personnel management and weather on productivity (4 cases for each factor). The excavator is the most frequently studied piece of equipment (4 cases) and excavation works is the most common field of investigation (13 cases). Concrete operations and steel fabrication works follow with 8 and 7 cases respectively. 19 building projects and

17 earthmoving projects have been investigated, followed by industrial (9), roadworks (5), bridge (1), tunneling (1) and reclamation projects (1).

## 4.3. Assessment of the UA requirement

Regarding the satisfaction of the UA requirement's weak form, it should be noted that all papers have been compiled by authors that are experienced and possess the required "know how" to conduct CP research. As such, a useful indication would be whether the findings have been used amongst construction practitioners. Looking back at Table 3, it is fair to suggest that the papers with the most citations amongst their colleagues are obviously deemed more useful. On the other hand, the evaluation of the strong criterion satisfaction is difficult to be definitive especially when only 35% of the papers have included a separate research methodology section in the manuscript. For those papers, the danger of failing the strong criterion seems to be two-fold: firstly, in qualitative surveys some authors tend to generalize on the effect of specific factors on productivity by fitting the practitioners' responses to their own perceptions or those of previous research. Secondly, in quantitative research some authors do not provide sufficient data about the limitations in the productivity prediction capabilities of the developed models, which can be particularly detrimental to the research validity especially in the case of statistical regression models.

# 5. Discussion

This research had to overcome a number of limitations regarding the sample (e.g. it may not be conclusively representative of the CP related research), the documentation of the research methodologies within the papers (e.g. lack of information, provision of superficial data) and the validity of drawing conclusions based on a given number of sources (e.g. conference proceedings or any type of reports were excluded from the analysis). However, several issues have emerged from the analysis. Firstly, from an ontological and epistemological standpoint, CP research is dominated by the objectivist and positivist stance. That is to be attributed to the strong relation of productivity research to the natural science and the traditional interest in investigating purely technical issues, such as project time and cost. However, the multi-paradigm approach seems to be gaining ground, especially given the industry's shift towards intensifying the exploration of productivity's soft aspects as well, such as behavioural and managerial factors and cultural diversions of the project actors. Secondly, the implementation of methodological pluralism, as found in both empirical and simulation-based productivity research, enhances the chance for minimizing the gap between the "decided" methodology on behalf of the researcher and the "accepted" methodology by the research community. That is to be achieved by following some basic guidelines, such as (i) explicitly explaining the research methodology to be followed, (ii) objectively reporting the research results, (iii) unambiguously indicating the research's adequacy and (iv) by practically demonstrating how the selected methodology will serve the objectives in order for the research to provide a clear contribution to the existing body of knowledge. Specifically, in qualitative approaches it is critical to establish the theoretical framework prior to presenting the research results, as productivity factors are multidimensional and can have a different impact or meaning depending on the subjects being investigated. In theoretically driven quantitative empirical work, the clarification of the experimental framework (e.g. type of project and collected data, choice of modelling technique) is vital to understanding the research limitations and thus protecting practitioners

from implementing productivity estimation models that do not suit the project's situation. Finally, in mixed-method research paradigms, the forms or questionnaires used for the collection of productivity data should be fully explained and excerpts should be provided. In addition, data modeling should be clear on whether it is related to daily or hourly productivity data or even cumulative productivity metrics.

The findings of the review can be utilized for the development of a methodological framework that enables the empirical evaluation of the effect of selected factors on productivity while facilitating the comparative analysis of the results. The aforementioned guidelines combined with the review's inferences indicate that such a methodological approach should emphasize primarily on the description of the activity under study, the level of abstraction, the construction technique and both internal (e.g. managerial capability) and external influences (e.g. weather). The ultimate objective should be the preservation of the research validity and the establishment of a seamless methodology that could be repeatedly applied for the exploration of differing productivity factors.

## 6. Conclusions

This paper has explored the role of research methodologies on construction productivity studies. The main conclusion is that linking different methodological aspects within an integrated research design will contribute towards overcoming both the expected and subtle difficulties of conducting valid research. The adherence to the formulated guidelines is expected to assist current and future researchers in the area of construction productivity to generate research results of grater acceptance by both Academics and Industrialists.

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# Factors influencing Project Risk Management Decision Making

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## Abstract
Most investment decisions are characterized by irreversibility and uncertainty about their future rewards. Understanding the nature and magnitude of cost overruns in projects is often considered to be one of the most important challenges facing project managers. The application, therefore, of Project Risk Management (PRM) is widely regarded as in important skill-set in a PM's portfolio. Today's highly volatile economic environment presents new challenges for those seeking to develop robust strategies to respond to events that are likely to impact project budgets. This paper reports on an ongoing doctoral research project in collaboration with Rolls-Royce PLC. The project aims to explore opportunities for improving the management of budget contingency in relation to effective corporate risk management strategy. Initial findings suggest that senior managers recognise the importance of an effective risk management process. However, there is a great opportunity of improving the process of how risk management data can and should be used. Two projects were studied with respect to major difference in the use of risk data. Findings indicate the importance of a top-down risk management approach. The awareness of senior managers needs to be increased. To do this, risk has to be translated into profit through budget contingency.

## Keywords
Risk Management, Budget Contingency, Decision Making

## 1. Introduction

The recent global economic crisis is one of the main factors contributing to the increased focus on risk management by the organisations. It is important to note that practitioners realise that an effective risk management process increases the chance of an organisation successfully achieving its objectives. Risk management is a process that can make a significant contribution to the implementation of better strategic decisions through the appropriate use of risk management data. It was encouraging to find that many organisations change their attitude to risk management. A good example came from Australia where "… *the Corporate*

*Governance Council of the Australian Stock Exchange (ASX) has set guidelines for Risk Management within public listed organisations and the board of directors is seen to hold the primary responsibility over the establishment and the implementation of a proper risk management system"* (Subramanian et all., 2009). The research reported in this paper investigates possible improvements to the effectiveness of the treatment of risk. It is believed that with better use of the risk management data practitioners will explore the opportunity for more effective decision-making process. The investigation of the area of budget contingency management plays a central role in the translation of risk into profit.

## 2. Literature Review

### 2.1 Risk and Risk Management Process

Risk is a threat or an opportunity that could affect positively or negatively the project success. The Project Management Institute (PMI) and Association for Project Management (APM) define risk in terms of threats and opportunities faced by a project.

"An uncertain event or condition that, if it occurs, has a positive or negative effect on a project objective" (PMBOK, 2000, p. 127).

"An uncertain event or set of circumstances that, should it occur, will have an effect on achievement of one or more project's objectives, with the clear understanding that risk can affect achievement of project objectives either positively or negatively" (APM, 2006, p. 26).

In general, unexpected events occur at any point in time during the life cycle of a project, having either positive or negative impacts on project objectives. According to Williams (1995) cited in Ahmed et al., (2007, p.23) "Positive outcomes are opportunities while negative outcomes generate loss. Risk focuses on the avoidance of loss from unexpected events". The authors decided to adopt a wider definition of risk, which is described as project uncertainty management. *"Uncertainty management is not just about managing perceived threats, opportunities and their implications. It is about identifying and managing all the many sources of uncertainty, which give, rise to and shape our perceptions of threats and opportunities. It implies exploring and understanding the origins of project uncertainty before seeking to manage it, with no preconceptions about what is desirable or undesirable" (Ward & Chapman, 2003, p.98).* There are many different views on how a risk management process needs to be implemented within an organisation. A general definition of risk management as a process is given by Thevendram and Mawdesley (2003, p.131):

- Risk identification
- Risk analysis
- Risk Response
- Risk Monitor (Feedback)

Based on the environment within which organisations operate the authors developed the following model for the risk management process. The model comprises five core steps.

- **Step 1** Risk Identification: Risks are identified through various tools and techniques

- **Step 2** Risk Analyses: Risks are analysed through various tools and techniques
- **Step 3** Risk Response/Treatment: risks are mitigated, transferred, accepted or rejected. Following this response to risks, planned treatment activities need to be included in the budget and contingencies set to address any residual risk.
- **Step 4** Allocation of Budget Contingencies and Management: Risk response and treatment must be cost effective, meaning that the overall cost of a project must be reduced when considering the additional cost of the treatment and the reduced contingency requirements. The contingency assigned to risks that do not occur could be released to profit. In this way senior managers understand risk management in terms of profitability. "The holding of budget contingency at the project level to be released to address specific risks if they occur is more likely to result in project success" (Papadaki et. al., 2008).
- **Step 5** Risk Monitor and Controlled: risk mitigation strategies and plans are continuously monitored, updated and controlled. It is important to note that the risk management process is a continuous loop throughout the project lifecycle. The lessons learned database gathers historical data from each of the cycle loops. It is also a database for communication those responsible for risk. The lessons learned database could be a tool for using risk management data from the treatment stage and for the decision making process.

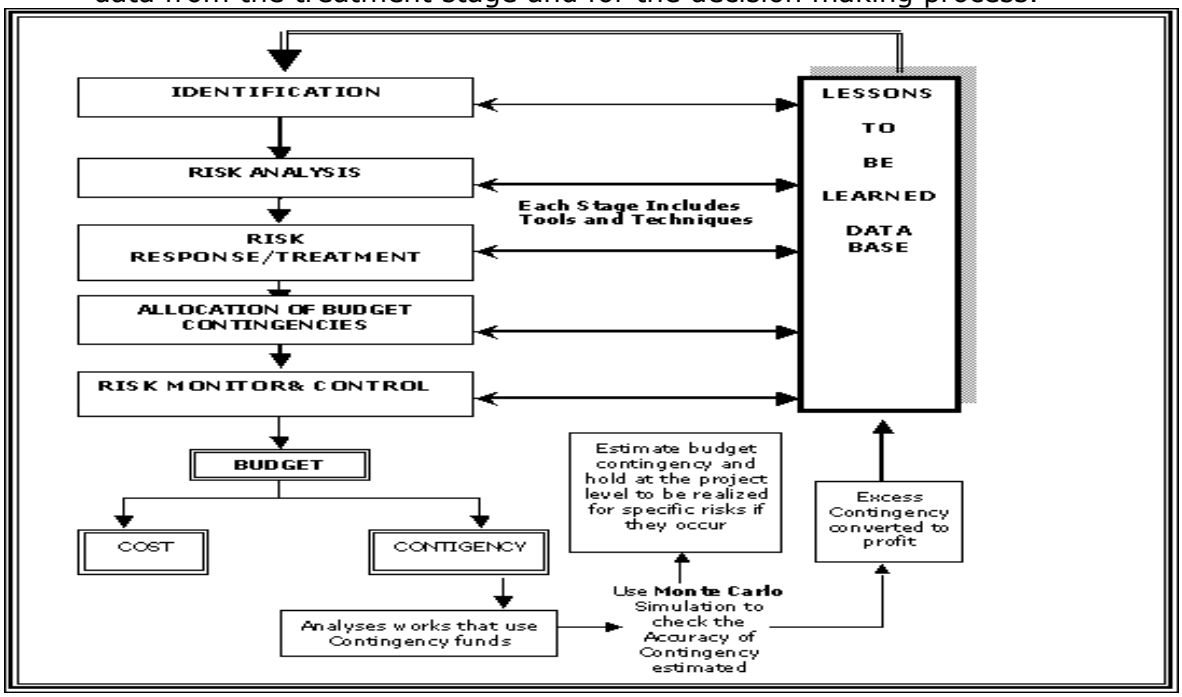


**Fig 1:** Risk Management Process

## 2.2 Risk Governance

According to Merna and Al-Thani (2005) an organisation is divided into three levels: corporate, strategic business and project levels. Corporate level refers to the corporate management of the organisation where strategic decisions are made to meet goals and objectives of the organisation. Corporate level is concerned with risks that are associated with the overall position of the organisation in the market segment. These risks are political, financial, legal, environmental and global.

Strategic business level is concerned with risks such as economic and market risks. However, project risks are specific to the achievement of project objectives. Figure 2 illustrates how the organisation is compose of three levels and can be used as the basis for the risk management process.
Risk management can be undertaken using an upward (bottom-up) or downward (top-down) approach at each level of the organisation. In the upward (bottom-up) approach risk management starts from project level and flows upward to corporate level. The downward (top-down) approach starts at the corporate level and promulgates downwards towards project level. It is believed that the first approach is more detailed. However, in terms of effectiveness the downward approach gives a more positive impetus to the organisation. This is because risk management as a process needs strong leadership, usually found in the upper levels of an organisation. It is also inevitable that the upper levels have the ability to influence more people to use risks management and use it as a tool for decision-making and not an as administrative tool, considered as extra work by employees. The process explained previously (Figure1) could be used at each level of the organisation, whereas in the corporate level risk management is focused on strategic risks. Strategic business is focused on cost effectiveness and on potential projects. The project level considers risks associated with achieving project objectives.

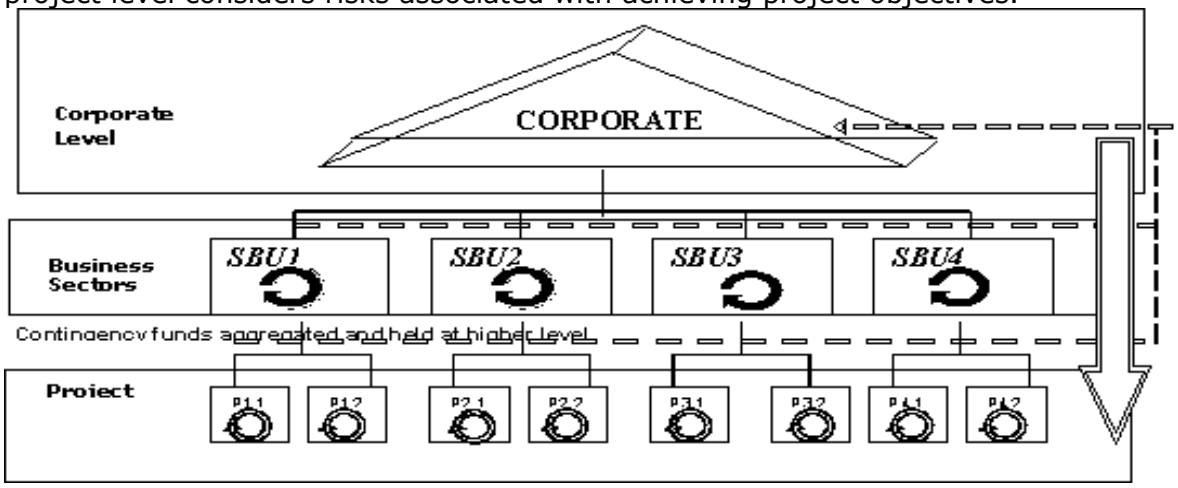


**Fig 2:**Risk Management and organisational structure

## Budget Contingencies and Culture

Improving contingency management requires an understanding of how managers use budget contingency and how they make decisions in relation to budget contingency. When a project starts and the initial plan is created, if it is undertaken prior to any risk management, it will carry a significant amount of risk for which contingency funds should be identified and held. As risk management is undertaken the committed cost of the project will increase and the risk, hence contingency, will reduce. If risk management is carried out effectively then the cost of undertaking mitigation actions will be significantly less than the reduction in contingency requirements and the overall cost of the project (budget plus contingency) will fall. As risk mitigation progresses mitigation actions demonstrate diminishing returns. The art of good risk management is to ensure that the decisions taken in the treatment stage minimise the total project cost.

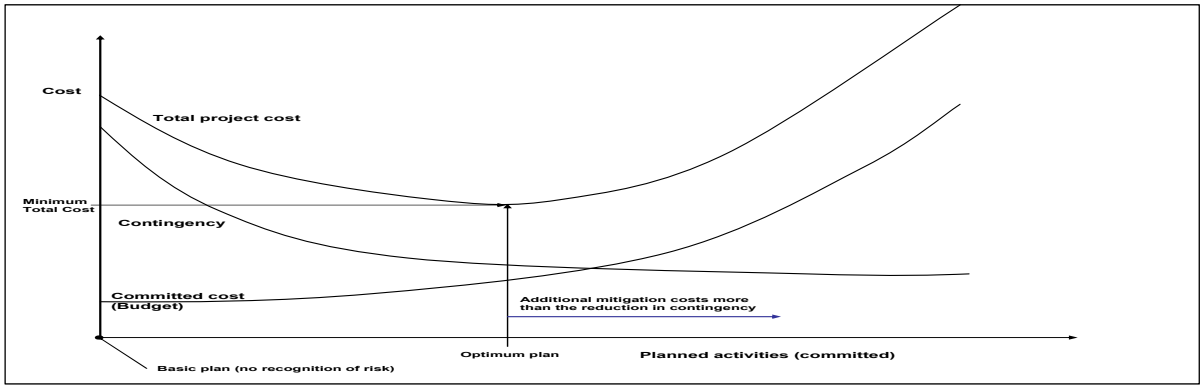


**Fig 3:** Budget Contingencies

## 3. Research Project

Recent studies indicate that there is room for improvement in the effectiveness of the treatment of risk. Many practitioners experience difficulties in the use of the risk management data. The research project reported in this paper investigates possible improvements in the effectiveness of the treatment of risks. The main objectives are as follows:

- Identify the current practice in relation to the development of contingency budgets;
- Identify current practice in the treatment of risk;
- Suggesting possible ways of improving the effectiveness of treating risks.

### 3.1 Research methodology

The research reported in this paper forms only one part of a larger research project. The project tries to identify room for improvement in the treatment of risk. It focuses on four basic areas:

- Risk management and organisational culture
- Risk assessment and treatment
- Contingency management
- Risk management effectiveness

The first stage of this research was a semi-structured interview survey (n=17) administered to key programme/project executives on two programmes. The semi-structured interview survey led to the development of a questionnaire survey administered to a broader population (n=74). Questionnaires were distributed to all of the management levels from project executives to Integrated Project Team leaders. Respondents were asked to answer four types of question. The first one used a five point Likert type scale. Likert-scale questions can be used to measure the level of agreement to a statement, starting from "strongly disagree" to "strongly agree". There were also closed questions, which required respondents to answer "Yes", "No" or "Don't Know". It is important to note that both of the above question types require only one answer. In contrast, the third question type (multiple response) invited respondents to check as many answers as they wanted. Finally, open questions were used. This type of question does not provide a set of

answers; rather it gives the opportunity for the respondents to simply describe a problem in their own words.

The questionnaire instrument contained five parts. The first part gathered information about respondent's general background such as, project name and location, project role. The second part investigated the risk management organisational culture. It was divided into 13 mixed questions. The third part concentrated on risk assessment and treatment and contained 18 mixed questions. The next part explored the area of contingency budget and management within projects/programmes and employed 11 mixed questions. Finally, 12 mixed questions assessed the overall risk management effectiveness. All questions presented in this paper correspond to the second part of the questionnaire, which concerns with the risk management and organisation culture.
Data gathered were non-parametric. This is due to many factors such as: Likert-scale questions referred as ordinal data. Ordinal Data are qualitative data, which are more than two categories in a logical order (12345 Likert-scale) and is often considered as non-parametric.
Possibly, skewness and kurtosis give a reasonable indication of the style of sample distribution (Kerr et al., 2002) The combinations of the one-tail or two-tail Z2 and Z3 tests can be useful in testing normality against the constrained skewness and kurtosis (Mudholkar et al., 2002). Normality of data was tested using various statistical and visual methods and the results unanimously revealed the data to be non-normal. The implication of these results is that a non-parametric approach to data analysis is adopted in this work. The statistical tests were used: descriptive analysis (mean and standard deviation) Mann-Whitney test and Kruskal Wallis-test (for detecting statistical significance between groups).

## 4. Results

The first question asks the respondents to identify the level of importance that risk management has to their organisation. Respondents had to choose between the following statements: not important, somewhat and very important. Initial data indicate that the respondents believe it is important for practitioners to be engaged in an effective risk management process, whereas 83% of respondents believed that for an organisation it is very important to adopt an effective risks management process. In terms of educational background, 100% of practitioners with both an engineering and business background believe that effective risk management is very important for an organisation (Figure 4). However, this was also tested by Krustal-Wallis and the difference between all the groups is not statistically significant.

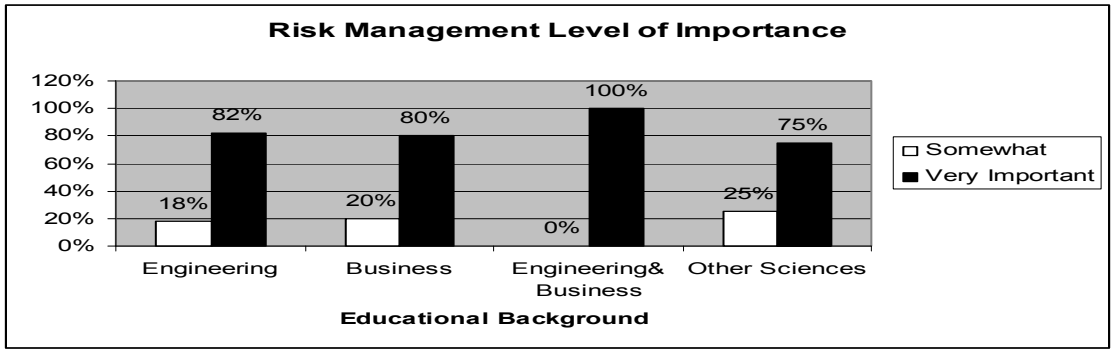


**Fig 4:** Risk Management Level of Importance
(Based on Educational Background)

The following question asked the respondents to express their approval or disapproval relating to the following statement "effective risk management can improve business performance at your organisation". Most of the respondents (approximately 73%) strongly agreed that effective Risk Management can improve business performance of the organisation. Both results show perceptions about risk management shifting in a very positive manner. This helps organisations to use and explore more the risk management process.

The authors attempted to identify any significant difference in the risk management process between the projects studied. Therefore, a question was developed which asked for respondents' perceptions on whether there were any tangible benefits from risk management on their project. Further, analysis of responses indicates that there is a possibility that in projects where risk management is undertaken more rigorously respondents have identified more tangible benefits. Comparisons between the responses given by practitioners from the two projects studied (A and B) showed that there is a major difference in practitioner perceptions towards tangible benefits between the projects studied.

Results show that project B has seen more tangible benefits from the application of the risk management process in their project/programme (>85%), whereas in project A the majority only agree or are neutral ($p<0.05$). This difference between the projects could be due to many factors. It is important to note that in project B there is a dedicated risk manager responsible for ensuring the process in applied effectively, in contrast to project A that followed a more traditional risk management process. Furthermore, risk management seems to have more positive results when it is led from a top-down approach. From the interview survey it was identified that the senior management team in project B had explicitly supported a more rigorous application of the risk management process, and the senior management required the lower levels in the organisation to explicitly demonstrate compliance with the process. Governance plays a vital role. It could be said that a positive domino effect could result when the seniors are more dedicated to and support the idea of an effective risk management process. It is important to note that risk management requires practitioners to undertake extra work and most of them do not see the benefits directly. Therefore, seniors in the early phases of a project must drive the implementation of an effective risk management process through all levels of the project.

Project A shows an opportunity of developing a more effective use of risk management data process. Project B had introduced well defined methods for using the risk data to inform decisions regarding the assignment of contingency funds. The fact that risk could be attached to budget contingency (Project B) made the practitioners recognise the relationship between risk and project costs (in monetary terms). For this matter, in the fourth part of the questionnaire a question was developed in order to see if contingency budget is directly related to some big risks in projects.

## 5. Conclusions

In cases where a top-down approach to risk management is used the results appear more positive. Risk management must not only be seen to be considered important by senior management but they should also understand how to make best use of the information generated by the risk management process. In order to increase the awareness of the benefits of risk management among top executives it is good practice to promote education and training for senior managers. This has been shown to increase their ability to use risk management effectively. Generally, the importance of risk management appears to be recognised across the organisation. This is encouraging and indicates that the organisation is working towards continuous improvement compatible with the current economic environment. It is believed that seniors recognise the need for a structured risk management process. However, there is an opportunity of improving the process of how to use risk management data more effectively. Most of the times lower levels of an organisation see the risk management process as something that they must follow, but from which they get little benefit. The following conclusions are important for a more effective risk management approach.

- Senior managers need to recognise the importance of an effective risk management process. The results show that irrespective of education background, over 75% agree that it is important.
- It is necessary to introduce new ways of using risk management Data. For example, linking risk management to budget contingency management: a way of converting risk to profit. New, non-traditional, approaches to risk management by one project showed that risk data can be translated into monetary terms and can help practitioners deliver a more effective decision making process.
- Risk management needs to be lead by senior managers through a top-down approach, requiring an effective risk management process lower down the organisation. One project explicitly supported a more rigorous application of the risk management process and senior management required demonstrable compliance.
- A dedicated risk manager providing focus and drive adds to project success. Practitioners found more tangible benefits (over 85%) in projects where a risk manager was identified.

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# Collaboration Procurement Methods in Construction Projects-Greek Construction Industry Clients' Perspective

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## Abstract
Traditionally the construction industry characterized by adversarial relationships, the lack of cooperation among project participants and the fact that construction companies and clients focus mainly on the reduction of project cost and neglect the value, are some reasons for the poor performance of construction projects. This research aims to investigate the Greek construction industry, from clients' perspective, in order to present the most common project delivery methods used, the problems faced, the usage of collaborative tools and the motivation factors that could lead clients to establish collaborative relationships. The empirical data were collected through a questionnaire to a population of 19 Greek Construction clients'. Findings confirm the traditional method's extensive usage in Greek construction industry both from public and private firms/organizations. As a result the problems that are reported are similar with the common problems that characterized traditional procurement method. This paper suggests that although Greek construction clients are familiar to some extend with collaboration tools and have some knowledge of the benefits of collaboration in project performance, they need strong incentives, such as cost reduction, to establish collaboration relationships.

## Keywords
Construction, Procurement, Project delivery, Collaboration, Greece

## 1. Introduction

The relationships between contractors and clients are mainly dominated by poor collaboration, limited trust, contract unbalanced risk allocation, and limited customer focus as a result of competitive procurement procedures (Saad et al (2002)), (Eriksson and Westerberg (2010)). Traditional construction procurement methods have often been criticized for being incapable of delivering projects according to cost and time requirements and at their maximum value (Eriksson and Laan (2007)), (Latham (1994)). Collaborative procurement introduces a different working culture that is based on the restructuring of the relationships between project participants and especially between construction firms and clients. Such relationships improve coordination and flexibility, which is often beneficial in construction projects (Pesamaa (2009)), (Egan (1998)), (Bresnen and Marshal (2000)). However there is a lack of empirical research in Greek construction industry concerning collaborative relationships in project delivery.
The aims of this paper are to:

- Identify the most common project delivery method and tendering procedure in Greek construction industry.
- Recognize the main problems concerning project delivery.

- Present the level of usage of collaborative tools.
- Determine the recognition of benefits in project performance.
- Recognize the incentives that could motivate owners to establish collaboration relationships.

The present research is conducted as part of dissertation for the MSc Construction Project Management course of Hellenic Open University.

## 2. Research Methodology

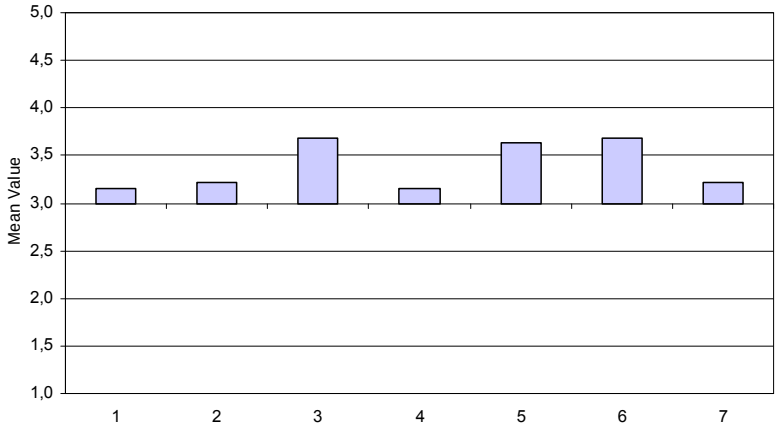
The choice of the methodology was determined by the need to capture the views of managers or directors, who work for construction client's firms/organizations, on the adoption of collaborative relationships during project delivery. The empirical data were collected through a questionnaire to a population of 19 Greek Construction clients'. The population consists of regional (11%), national (42%) and international (16%) companies, municipalities (16%) and also government services and agencies (16%), which procure construction work. Hence, this population provides a suitable representation of Greek construction clients sector. Respondents were mostly procurement managers, project managers or directors of the construction and facilities department in their organizations.

The questionnaire contained two types of closed questions, rating scales and "forced choices" allowing for a variety of individual responses. There were two sections. In the first section there were four "forced choices" closed questions where the targeted respondents were asked to give data about their own experience, the profile of their own firm/organization in terms of size and type of projects undertaken and the type of delivery methods and tendering procedures they use most frequently on the majority of their projects. The second section contained four (4) composite questions requiring between 6 and 8 responses. The respondents were asked to score the responses using 5-point Likert-style rating scale with a score of 5 indicating very important/very often and a score of 1 indicating unimportant/not at all. They were asked about the problems they usually face during construction projects delivery and to what extent do they use different tools/methods for increasing cooperation among the different participants in the construction process. Also they were asked about the influence of collaborative tools in project performance and the reasons that make them establish collaborative relationship with one or more project participants, in a win-win attitude.

## 3. Results and Analysis

The most commonly used project delivery method, according to respondents, is the traditional method at 79% of all responses. Construction management (11%) and Design-Build (5%) were rated far lower. Traditional method is almost the exclusive delivery method for the public sector (100%). For private sector firms, traditional method is still very popular (69%) but the other two methods are used as well. As far as the tendering procedures concerns, when traditional method is used, limited bid invitation and open bid rated 47% and 42% respectively, much higher than negotiation (12%). Consequently, based on the above findings, the predominant project delivery method in Greece is the traditional for both public and private sectors. The usage of this method is almost exclusive in public sector due to law and policy restrictions. In private sector it is used mainly because companies and managers are more familiar with this method.

As demonstrated in Fig. 1 the most commonly faced problems are design changes (3.7) during construction and time (3.6)/cost (3.7) overruns. Quality and post construction problems along with problems based on relationship (lack of trust and conflicts/disputes) are on the same level (3.2) of frequency. The main characteristic of design-bid-build (DBB) procurement method is that design stage is separated from construction stage. The client is responsible for the specification of the product then performs detailed design work before contractors are procured, in order to develop a solid base for competitive bidding. The separation of design and construction, the lack of coordination and integration, are the important impact factors causing performance-related problems, such as low productivity, cost and time overruns, conflicts, and disputes (Allensworth, (2009)). The divorce between design and construction leads to problems such as design changes during construction, as contractor doesn't participate in design stage. This separation also results in long project durations. Consequently, it can be easily seen that problems that clients' faced are closed related with project procurement method. Early collaboration between the design team, owner, and the construction community has many benefits in the later performance of the project (Latham (1994)), (Xue et al (2005)). The participation of contractor or even suppliers and subcontractors as integrated project team will enhance collaboration and transfer of experience at the design stage. Cost and time overruns are affected not only from the design construction separation but also from the nature of sequential and linear process of traditional method, preventing overlapping of tasks which could lead to time and money savings.



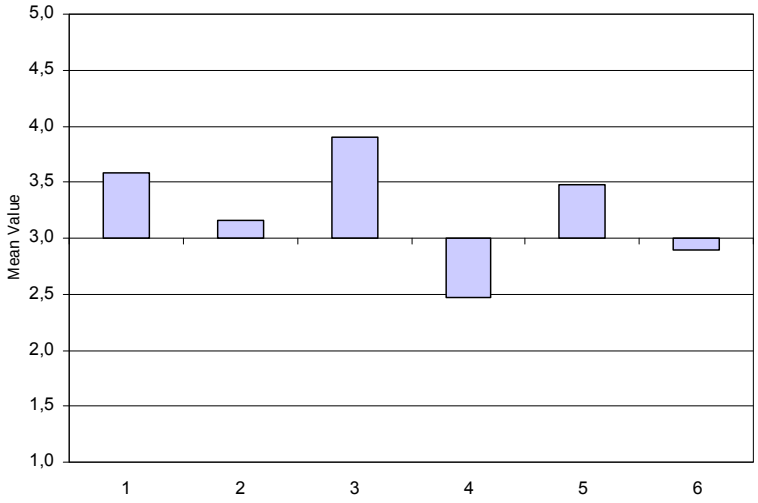

***Question1: During construction project delivery how often do you face:***
***(1: Very seldom….5: Very often)***

1 Lack of trust with contractor
2 Conflicts and disputes with contractor
3 Design changes during construction
4 Poor quality in construction output
5 Cost overruns
6 Time overruns
7 Post-construction operational problems

**Fig 1:** Mean Value of 5-point Likert scale answers (Question 1)

In the questionnaire the respondents were asked about the usage of collaborative tools in construction projects. From the results the most commonly used collaborative tools are follow up meetings (3.9) and integration team creation (3.6). On the other hand early involvement of contractor (2.5) is the least used practice. Shared risks among client (2.9) and project participants are not popular. This could

be easily predicted if you took into account the protection that contract agreement provides to owner during traditional method. Also in Fig 2 can be seen that conflict resolution process is the third most common collaboration tool (3.5) probably as part of contractual agreement of traditional method. To sum up, clients are familiar with some collaboration tools. Shared project risks and mutual goals and objectives are practices of high importance which have low usage. On the other hand integrated team creation and follow up meeting's popularity reveal the potential for collaboration establishment.

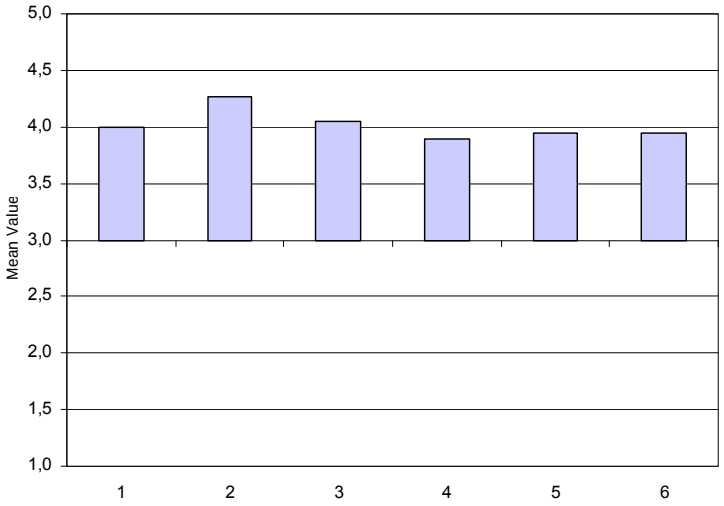



**Question 2: How often do you use the following collaborative tools?**
**(*1: Very seldom….5: Very often*)**

1 Integrated team creation
2 Mutual goals and objectives
3 Follow up meetings
4 Early involvement of contractor
5 Conflict resolution process
6 Shared project risks

**Fig. 2:** Mean Value of 5-point Likert scale answers (Question 2)

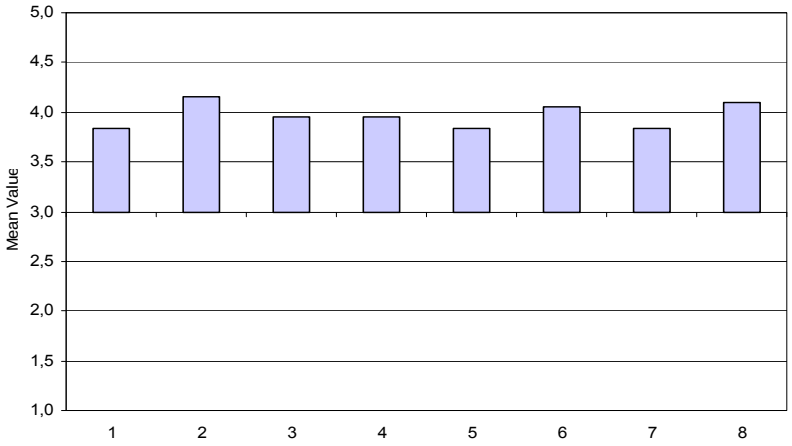
Fig. 3 depicts the respondents view about collaborative tools effect on project performance. It can be seen that respondents view is positive and in accordance with the literature review that mentioned the positive influence on project performance that cooperative procurement procedures have (Pesamaa (2009)). According to answers, long term relationships (4.3) and shared project risks (4.1) are the most common factors that affect mainly project performance. In general respondents recognise the importance of collaborative tools.




**Question 3: How much do you believe the followings can affect project performance? (*1: Not at all….5: Very much*)**

1 Early involvement of contractor
2 Long-term relationship with contractor
3 Shared project risks
4 Conflict resolution process
5 Collaborative relationship with contractor
6 Use of incentives/bonus in order to achieve specific objectives

**Fig. 3:** Mean Value of 5-point Likert scale answers (Question 3)




**Question 4: How easily would you establish collaborative relationship with one or more project participants (in a win-win attitude) in order to: (*1: Not at all….5: Very much*)**

1 Deliver reliably project with budget and timetable maintained
2 Reduce project life cycle cost
3 Reduce conflicts and disputes
4 Share project risks
5 Increase opportunity for innovation
6 Achieve higher quality of construction
7 Establish mutual trust between project participants
8 Achieve cost savings

**Fig. 4:** Mean Value of 5-point Likert scale answers (Question 4)

Finally, according to Fig. 4, the basic motivation factor for clients in order to drive this change is the cost reduction. Both project life cycle cost reduction (4.2) and

project cost savings (4.1) are factors that respondents believe could drive them. This means two things: a) firstly in order to introduce more collaborative project procurement methods, such as construction management or integrated project delivery, the owner should be convinced that this change would lead to cost reduction, b) secondly this shows that owners are not convinced that collaboration leads to cost reduction, as literature review and plenty of case studies reveal. Other major incentives for the owner are quality (4.1), conflict and dispute reduction (3.9) and goal sharing (3.9).

## 4. Conclusions

The research revealed the extensive usage of the traditional procurement method in Greek construction industry. The common use of limited bid tendering procedure shows the recognition of benefits that offers the establishment of long term relationships between client-contractor. The problems mentioned above are basically problems that characterized the traditional method. Time and cost overruns along with design changes come from design and construction stage separation. As far as collaborative tools usage is concerned, the respondents are familiar with tools which are used during project delivery process like follow up meetings, project team formation and conflict resolution process. Collaborative practices such as shared project risks and mutual goals and objectives are tools of high importance with low usage. Finally the research reveals the respondents positive view about the benefits of collaboration in project performance and the incentives that motivate clients to establish collaboration relationships which is nothing more than cost reduction. If construction industry's clients convinced that collaboration procurement methods and relationships results in cost reduction, that would motivate them in order to adopt concepts like partnership and supply chain management in project delivery process.

## 5. Acknowledgements

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# A framework for the implementation of a knowledge management platform in the Greek construction industry

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## Abstract
Contemporary construction organisations realise that managing the acquired knowledge in a more structured manner results in considerable improvements in their working practices and business performance. This paper describes a framework for establishing a knowledge management strategy for construction projects adapted to the Greek construction paradigm. A brief comparative analysis of recent knowledge management models is presented followed by a discussion of the research methodology. The study identified the informational requirements of current knowledge capture mechanisms and developed a knowledge management tool for construction projects. The tool's structure and data requirements are explained. A case study in a Greek design company helped to establish the applicability of the approach. A preliminary evaluation of the knowledge management tool by the end-users suggests that it is a useful template for the systematic capturing and storing of useful knowledge. The main inference emerging from the study is its contribution to the creation of a company-specific knowledge base for future reference, so as to solve recurring problems pertaining to the construction process.

## Keywords
Construction, Database, Framework, Knowledge management, Platform

## 1. Introduction

In the project-oriented construction industry knowledge is generated at every phase of the project development process (El-Gohary and El-Diraby (2010)). Therefore, capturing and reusing the knowledge that is created during and after the project implementation is a key challenge posed to contemporary construction organisations (Udeaja et al. (2008)). This necessity has lead to the development of Knowledge Management (KM) as an emerging topic in construction, especially within the last two decades. However, an important prerequisite for the formulation and implementation of an effective KM strategy is its alignment with the company's strategy and objectives (Kivrak et al. (2008)). The realization of a KM strategy within a construction organisation is supported by the application of specific tools, such as computer-based systems or web-based platforms (Zhang et al. (2009)). In

that view, this paper aims at developing a knowledge management tool adapted to the Greek construction paradigm. A database management system is developed that aids construction operatives to store and reuse project knowledge. Entries include, inter alia, details of project actors, concise project descriptions as well as specific registration of events relating to the project's "lessons learned". The tool differentiates from similar efforts in that it enables knowledge capture regarding the legal framework of the project in hand, which is of particular importance to the Greek construction paradigm.
The paper begins with a brief review of research pertinent to knowledge management followed by a brief review of four recently presented KM models. Subsequently, a description of the adopted methodological approach is provided. The paper then goes on to analyze the development of the knowledge management platform followed by a discussion of its main characteristics. The results of the platform's applicability evaluation are presented and the paper concludes by scrutinizing the emerging implications of the study.

## 2. Theoretical background

### 2.1 Defining knowledge

Knowledge can be considered as the product of learning and can be seen under different perspectives or contexts personal to an individual or organisation (Liyanage et al. (2009)). The foundation of current knowledge management is traced back to the work of Michael Polanyi in the late 1960's (Grant (2007)), who categorized knowledge in two basic categories: tacit and explicit. Tacit knowledge is highly personal and context-specific. It resides in human brain and cannot be easily captured or codified (Liyanage et al. (2009)). On the other hand, explicit knowledge can be codified in words and numbers, easily shared in manuals and distributed amongst individuals (Payne and Sheehan (2004)). Based on this categorization, Nonaka and Takeuchi (1995) defined four ways for capturing and transferring knowledge (Fig. 1). Socialisation denotes the conversion of tacit knowledge to new tacit knowledge through shared experience, such as face-to-face meetings. Externalisation results in tacit knowledge transforming into explicit by formal or informal modes (e.g. project management team meeting minutes). In the case of combination, explicit knowledge is combined and implemented in a more complex form as a result of team work amongst the project's participants (e.g. schematics are combined to produce detailed drawings). Finally, the internalisation approach happens when explicit knowledge is captured and shared within the organisation and then converted into tacit knowledge (e.g. utilizing the results of a simulation study to redesign a building's structural elements).

| ***Tacit Tacit*** | ***Tacit Explicit*** |
|---|---|
| **Socialisation**<br>*Sharing tacit knowledge through direct contact* | **Externalisation**<br>*Articulating tacit knowledge through social interaction* |
| **Internalisation**<br>*Embodying and acquiring new tacit knowledge* | **Combination**<br>*Connecting and applying explicit knowledge* |
| ***Explicit Tacit*** | ***Explicit Explicit*** |

**Fig 1**: Modes of knowledge transfer (adapted from Nonaka and Takeuchi (1995))

The model of Nonaka and Takeuchi (1995) has been criticized as to whether it contradicts with Polanyi's perception that tacit knowledge cannot be formalized and transformed since it is strictly subjective (Grant (2007)). However, it has been widely utilized within the KM community and formed the basis for the development of KM models in construction, as will be described in the next section.

## 2.2 Knowledge management in construction

Knowledge management in construction is essential for improving the business performance and creating a competitive advantage for organisations (Kivrak et al. (2008)). Key benefits of KM in construction are the integration of the project development process (El-Gohary and El-Diraby (2010)) and the establishment of a knowledge base of historical data that can be used in future projects (Kiziltas and Akinci (2009)). Different models and tools have been developed so as to enable the implementation of a KM strategy for construction projects. The following paragraph reviews four recently presented KM models, which have been developed according to the conceptual model presented in Fig. 1, discusses its main features and compares their characteristics.

The first KM model is based on a conceptual framework (ProFIK) that defines a process map for transferring knowledge within and across construction projects (Liyanage et al. (2009)). It focuses on the source (e.g. construction organisations) and the receiver (e.g. team of engineers) of knowledge and covers all organizational levels, from the individual to the team. The second model integrates knowledge management and value engineering within a single system (Value Engineering Knowledge Management System – VE-KMS) for improving the problem-solving approach implemented by the project management team (Zhang et al. (2009)). In VE-KMS knowledge stems from the existing or new projects as well as the project management team and is analyzed so as to (i) identify patterns, (ii) develop new methods for solving problems and (iii) structure all types of knowledge, both explicit (e.g. documents, project records) and tacit (e.g. domain specific problems and proposed solutions). The third model is a web-based prototype (CAPRI.NET) for live capture and reuse of project knowledge (Udeaja et al (2008)). It captures knowledge from groups, individuals or project documents and stores only the parts that have been validated by a designated person, called the Knowledge Manager. CAPRI.NET codifies knowledge (e.g. through keywords) to enable traceability of information and defines a set of standard processes for knowledge sharing and diffusion (e.g. update e-mails automatically sent to users). The last model is a web-based system (Knowledge Platform for Contractors – KPfC) which formalizes the knowledge-capturing process within construction companies (Kivrak et al (2008)). The model differentiates external and internal knowledge and creates a knowledge bank of valuable and reusable information. Both tacit and explicit knowledge is stored after being evaluated by an authorized person (i.e. knowledge manager).

A qualitative comparative evaluation of the aforementioned models on the grounds of what research questions are addressed by each one of them is presented on Table 1, so as to determine their respective divergences and/or convergences in relation to KM concepts. The analysis results have been utilised to specify the main characteristics of the proposed system, which are summarised below:

- Identification of knowledge source, type and traceability (e.g. validation).
- Capture of valuable knowledge to address information gaps (e.g. legislation).

| KM models | Research questions addressed |
|---|---|
| **ProFIK** (Liyanage et al. (2009)) | - Who needs knowledge?<br>- How is it transferred? |
| **VE-KMS** (Zhang et al. (2009)) | - Where does knowledge stem from?<br>- Is it valid?<br>- How can knowledge be re-used? |
| **CAPRI.NET** (Udeaja et al. (2008)) | - What type of knowledge is created?<br>- How is it captured?<br>- Is it external and/or internal? |
| **KPfC** (Kivrak et al. (2009)) | - What are the knowledge gaps?<br>- What type/king of knowledge is needed? |

**Table 1**: Research questions addressed by KM models

## 3. Methodological approach

A structured approach has been followed for the development of the KM platform, as shown on Fig. 2.

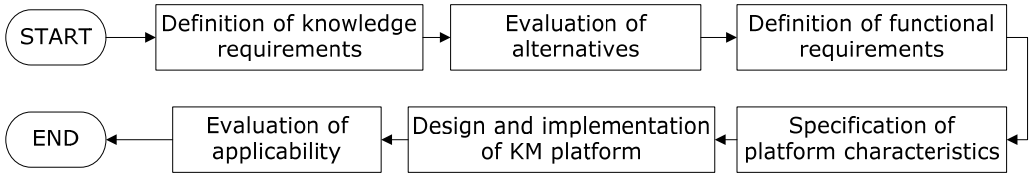


**Fig 2**: Methodological approach flowchart

It is essentially a six-step process, which started with the definition of the knowledge requirements, which for this study would be knowledge created on the project level, stemming from both external (e.g. public authorities) and internal (e.g. construction crews) sources. Having defined the type of knowledge that is required, different alternatives were examined for the realization of the KM platform. On the basis of the analysis presented in the previous section, it was decided to develop a Database Management System (DMS). The functional requirements were summarized in data entry, editing and update for KM (e.g. prompt retrieval). The main characteristics of the proposed KM tool comprised a user-friendly environment as well as dedicated templates for registering project information relating to the main project stakeholders (e.g. owner, project manager, designer, consultant), project knowledge (e.g. type, category) and legal framework (e.g. documents, policies, procedures). The design of the proposed tool was finalized after informal consultation with construction operatives, such as project managers, senior engineers and designers. MS Access 2003 software was used for the realization of the KM platform and the final version was evaluated though a case study in a Greek construction company. More details for the development process of the proposed KM platform will be provided in the next section.

# 4. Development of the KM platform

## 4.1. System design

The design specifications suggested the creation of a database management system that would focus on the construction project in three basic forms: design, construction and consulting or project management. For every design project one or more designers are assigned to it. In a similar manner, one supervising engineer is responsible for a construction project and a project manager runs a project management or consultancy project. In addition, irrespective of the project type, a project owner and one or more project management team members are specified. The system includes both private and public projects. Fig. 3 illustrates the main menu of the developed platform. The technical staff of the company can access the system by having a password authorized by the company. The user is given four main options: (i) register a new project and entry new knowledge, (ii) search for projects through a specially designed index, (iii) make an enquiry by specifying search criteria or parameters and (iv) create reports for projects/knowledge, employees etc.

**Fig 3**: Main menu

A new project entry requires a project title and asks for its type to be determined (e.g. Design, Construction, Project Management). Moreover, an exact address is provided for both new construction and renovation projects. Additional data include commencement and completion dates, total budget and costs as well as a hyperlink to the project's electronic file, containing information such as project mail correspondence, "as-built" drawings, project progress reports etc. All project employees' are registered based on their personal details (e.g. name / surname), profession and contact details (e.g. residence address, mobile / landline, e-mail). It should be noted that all personnel is registered in a central data storage and can be assigned different roles depending on the project. In other words, someone that has served as project manager in one project can be registered as team member in another etc. Thus, the system preserves the integrity of the stored information and improves the efficiency of enquiries on behalf of the users.

## 4.2 Knowledge capture

The captured knowledge is associated with a specific project as shown in Fig. 4. The user enters a topic that best represents the problem in hand. The knowledge category is selected from a predetermined list where three options are available: observations, problems and delays. In a similar manner, the knowledge type relates

to administrative, legal, technical or other registrations. The knowledge origin is specified as external or internal to the project. A keyword is given so as to group knowledge entries that share common characteristics. Then, the knowledge manager enters a short description of the knowledge entry, describes the actions that have been taken to address the emerged situation and the results of the proposed measures. Entries regard tacit knowledge such as know how, innovations, problems/solutions and explicit knowledge such as specifications, drawings and reports. Moreover, the registration date is provided along with the personal details of the user so as to enhance knowledge traceability. Finally, a hyperlink to related files that aid in comprehending the registered knowledge is provided. Once the entry has been completed the user can add new knowledge, view added knowledge by other team members or update the existing knowledge. Updating is important since knowledge can become obsolete and new techniques or solutions to past problems may be found.

**Fig 4**: Template for knowledge capture

## 4.3. Legislative framework

It has been stressed that the Greek legislative framework is a key determinant of the project development process for the Greek construction industry. In that view, the platform enables the capture of legal knowledge pertinent to the realisation of public and private projects. In the case of public projects, the contract type and number is registered along with the respective penalty clauses. Additional explicit knowledge is provided such as applications for appeal, letters of insurance and confirmations of completion. For private projects, contract type and number as well as penalty clauses are registered in the same way as before. Since, though, private projects need to have a building permit, the permit's number and category are also inserted accompanied by a series of necessary approvals from public authorities (e.g. Forest Protection Agency, Archaeological Heritage Agency).

# 5. Evaluation

A case study in a Greek construction company has been undertaken so as to evaluate the developed platform and ensure its conformity to the outlined functional requirements. The company is an ISO 9001 certified organisation, with extensive experience in the design and construction of building and civil engineering projects. The system was first demonstrated by the developer to ten engineers, senior managers and technical staff, who subsequently operated it

themselves. In addition, five completed projects were entered in the system, so as to practically demonstrate its main features and characteristics. After the completion of the demonstration, a semi-structured questionnaire was disseminated and completed by the participants. The questionnaire comprised twelve evaluation questions structured in a Likert-scale format, where the respondents expressed their approval or disapproval of the system on a four-degree scale (Fully agree, Agree, Disagree, Fully disagree). The questions related to issues such as the knowledge types covered by the system, its efficiency, whether it is user-friendly, its structural clarity and overall impression etc. A qualitative analysis of the responses verified the applicability of the proposed platform. The respondents identified some important benefits of successfully implementing the system which could be summarized as follows:

- Systematic capture and reuse of knowledge
- Reduction in costs and time for data management
- Reduction in the needed space for archival storage
- Prompt and efficient problem solving

The last point was highlighted by the participants, since they believed that the capturing of tacit and explicit knowledge preserves experts' know how within the company irrespective of their movement to other projects or companies. Moreover, the systematic capture of knowledge is particularly important for design studies, where recurring problems arise. However, there can be barriers to the adoption of such a system for a Greek construction company, as follows:

- High costs for the development of a fully functional system
- Time needed to familiarise the company's staff with the new system
- Compatibility problems with other existing systems (e.g. ISO 9001:2008)
- Integration of fragmented knowledge (e.g. legislation)

An additional barrier is the lack of expert know-how in the development of construction-oriented knowledge management systems in Greece, since it is still an emerging sector which has been growing rapidly in the last decade, especially in the IT and e-business sectors.

## 6. Conclusions

This paper has demonstrated that knowledge management can be a significant strategic advantage for contemporary construction companies. The implementation of a KM strategy through the development and application of a respective tool reduces the amount of knowledge wasted during the design and construction phases and enables the reuse of accumulated experience, so as to improve business performance and increase productivity. The developed KM tool incorporates key characteristics of similar valid models, whereas at the same time aims at reflecting the peculiarities of the Greek construction paradigm. Both tacit and explicit knowledge is captured and shared amongst the project participants. The evaluation of the proposed platform in a Greek construction company determined the main success factors being the meticulous system's design to reflect the users' needs and the explicit commitment of the organisation adopting the system for its further development and improvement. The perceived benefits of such an effort relate to the creation of a knowledge culture within the organisation, which can lead to the continuous improvement of the provided services and the enhancement of the vocational skills of the company's staff. However, the implementation of a KM strategy should take into account the existing status of the

organisation both from a technical (e.g. costs, compatibility with existing management systems) as well as cultural perspective (e.g. inertia to change). On any case, developing a coordinated KM strategy that fits the overall objectives and strategies of the organisation is believed to be an effective way to manage knowledge assets and remain competitive in the business world.

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*AA033*

# Correlating multiple 2D vision trackers for 3D object tracking on construction sites

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## Abstract
Tracking methods have the potential to retrieve the spatial location of project related entities such as personnel and equipment at construction sites, which can facilitate several construction management tasks. Existing tracking methods are mainly based on Radio Frequency (RF) technologies and thus require manual deployment of tags. On construction sites with numerous entities, tags installation, maintenance and decommissioning become an issue since it increases the cost and time needed to implement these tracking methods. To address these limitations, this paper proposes an alternate 3D tracking method based on vision. It operates by tracking the designated object in 2D video frames and correlating the tracking results from multiple pre-calibrated views using epipolar geometry. The methodology presented in this paper has been implemented and tested on videos taken in controlled experimental conditions. Results are compared with the actual 3D positions to validate its performance.

## Keywords
Vision tracking, epipolar geometry, 3D positioning

## 1. Introduction

3D object tracking on construction sites has a wide variety of applications. Being able to effectively identify and track personnel, equipment and materials can effectively support progress monitoring, activity sequence analysis, productivity measurements, asset management as well as enhancing site safety. In addition, real time tracking instantly enables the identification of critical activities and problems, which allows for in-situ project control and decision making capabilities. Available tracking solutions are mainly based on Radio Frequency technologies including Global Positioning System (GPS), Radio Frequency Identification (RFID), Wireless Networks (Wi-Fi) and Ultra Wideband (UWB) technologies. They all work under the same principle of having a sensor attached on each entity to be tracked. In outdoor and congested construction sites (e.g. highway construction), due to the large amount of items involved, tracking technologies that require attaching

sensors to each single item have additional time and cost burdens associated with performing sensor installations.
The research, part of which is presented in this paper, proposes an alternate tracking methodology based on vision. Under this method, video-streams are collected from constructions sites and then used to determine the spatial location of project related entities across time. In order to achieve this, the first step is to compare the performance of existing 2D tracking methods. It has turned out that kernel-based methods are most suitable for construction related applications (Makhmalbaf et al., 2010). Using a selected kernel-based 2D tracking algorithm (Ross et al., 2008), the 2D locations of an entity are determined and recorded for corresponding video frames. Since 2D locations are not sufficient to be used for construction management tasks, the next step is to correlate corresponding views in order to calculate depth values. For this purpose, epipolar geometry is used to provide the 3D aspect, which allows the user to retrieve 3D location information in real time. Preliminary results were obtained by testing this method on a scaled model of a highway construction site at the Construction Information Technology Laboratory. The results are compared with the actual 3D position in order to validate that the method proposed can effectively provide accurate localization of construction site entities.

## 2. Object Tracking

### 2.1 Current Practice in 3D Tracking

Common tracking methods are based on Radio Frequency and include several types of technologies like Global Positioning Systems (GPS), Radio Frequency Identification (RFID), Bluetooth and Wireless Fidelity (Wi-Fi, Ultra-Wideband, etc). They have been successfully used when tracking prefabricated materials (Song et al. 2006), equipment, inventory (Caldas et al. 2004) and personnel (Teizer 2007). RFID technology does not require line-of-sight (as opposed to vision-based methods), and also it is durable to harsh environments and can be embedded in concrete. Reading range depends on the frequency at which the tag operates, and it varies from several inches up to about 10 feet. Unlike barcodes, reading range is not a fixed distance, allowing tags to be read at any distance within the range. In addition, RFID enables efficient automatic data collection since readers can be mounted to any structure to detect and each reader can scan multiple tags at a given time.

However, all RFID technologies face several limitations, which restrict their applicability in outdoor and congested construction sites. The main disadvantage of frequency based systems is the need for installing a sensor in each entity before any type of tracking information can be acquired. Due to the large number of entities that need to be tracked in congested construction sites, in most cases it is infeasible to attach a sensor on each entity since the cost associated with this work and equipment becomes considerable. Moreover, RFID technology, unless combined with other tools (Ergen et al, 2007), can only report the radius inside which the tracked entity exists, and the near-sighted effect (the location is not reported until the reader reaches the radius of the reading range) prohibits its use in real-time tracking applications. Another important aspect is privacy. Since RFID tags have to be attached to persons, who are to be tracked, this method is not favored by Construction Unions due to the lack of privacy they provide workers on the site (Juels 2006).

## 2.2 Vision based 2D Tracking

Vision based 2D tracking can be a proper alternative to RFID methods because it removes the need for installing sensors and ID tags of any kind on the tracked entity. For this reason, this technology is (a) highly applicable in dynamic, busy construction sites, where large numbers of equipment, personnel and materials are involved, and (b) more desirable from personnel who wish to avoid being "tagged" with sensors. In Gruen (1997) it is highly regarded for its capability to measure a large number of particles with a high level of accuracy. Generally, vision tracking fuses video cameras and computer vision algorithms to perform several measurement tasks and has been considered as an inference problem (Forsyth and Ponce, 2002). The moving entity has a certain internal state which is calculated in each frame. The tracking algorithms then need to combine these calculations to estimate the state of the entity. Information such as the speed, acceleration, flow and periodic motion of the entity can then be inferred.
Vision tracking methods can be categorized in kernel-based, contour-based, and point-based methods, depending on the way of representing objects. In kernel-based methods, an object is represented by the color or texture in the region of interest, and its position in next frame is estimated based on the region's color or texture information. In contour-based methods, an object is represented by silhouettes or contours that determine the boundary of the object. In point-based methods, an object is represented by a set of feature points extracted from the region that contains the object. Out of the three categories, kernel-based methods are most suitable for construction related applications regarding the construction sites' characteristics such as illumination condition and object types on construction sites (Makhmalbaf et al., 2010). Compared to the kernel-based methods, point-based methods (Mathes et al., 2006) are prone to lose the object whenever it gets difficult to extract sufficient feature points (e.g. when it is very dark or bright). Also, contour-based methods (Vaswani et al., 2010) do not provide a consistent centroid of the object.

# 3. Vision based 3D Tracking

2D vision tracking results, which just present 2D object positions in an image, are not sufficient to be used for construction management tasks due to the complexity and large scale of the construction sites. To obtain meaningful 3D location information, an additional process of integrating 2D vision tracking results from multiple camera perspectives is required. The objective of this work is to accurately determine the 3D location of distinct construction related objects, such as equipment, personnel and materials of standard shape and size across time.

## 3.1 Methodology

The tracking methodology proposed in this paper consists of a computer receiving video feeds collected from on site video cameras. The method can be used with several cameras connected simultaneously. These cameras must have at least partially overlapping views of the site object that is to be tracked in order to calculate the 3D location of the entity. After receiving the video feed, the cameras' views are projected in the user's window simultaneously. The user can select an entity of interest in both of the views. Selecting an area corresponding to the object (e.g. safety vest or hardhat) is enough to initialize tracking.

The method then calculates the selected area's centroid, as a representation of the object's 2D location on the image frame. Subsequently, a kernel-based tracking algorithm (Ross et al., 2008) is used to track the areas identified in each of the views. The object tracking is performed simultaneously and independently in each camera. This feature allows the user to locate and track the object in real time across the entire site simultaneously. The result of the 2D tracking algorithm is the 2D position of the object's centroid in each window. Subsequently, epipolar geometry is used to calculate the depth of the centroid that determines the 3D location of the object in each frame. The system records the tracking information and displays the 3D coordinates of the entity in the user's window. The methodology for this algorithm is illustrated in Figure 1.

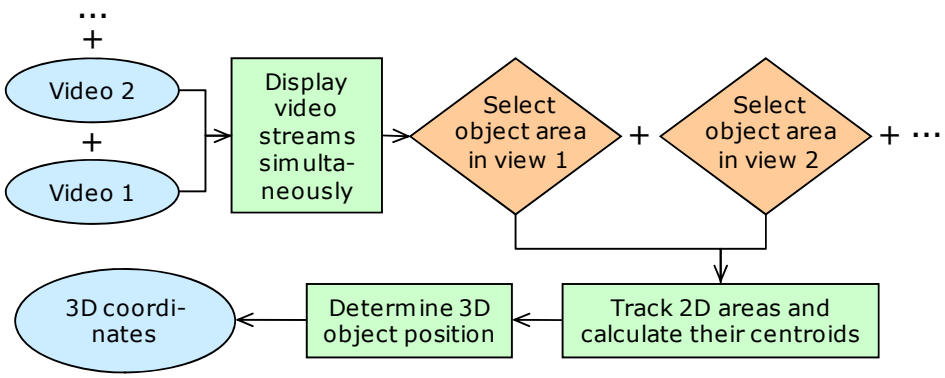


**Fig 1**: Methodology overview

## 3.2 Object Selection and 2D Tracking

The identification of the object area of interest is performed interactively by the user. The user selects the same object area in both of the views presented to him by marking it on the screen. The created rectangular areas are used to determine the object location in the image planes by simply calculating the centroids (centers of gravity) of the marked regions. Using the 2D tracking algorithm described above, the object location is recalculated in each subsequent frame and updated as the marked object moves. The result of the 2D object tracking is the real-time object location in each camera's view.

## 3.3 3D Location Calculation

The 2D tracking results are used to determine the real-time 3D object location based on epipolar geometry. In order to perform epipolar geometry calculations, at least two cameras must be present and their views must overlap in the region that contains the object of interest. Based on the overlapping regions, the 8-point-algorithm is used to determine the fundamental matrix, which geometrically relates corresponding points ($P_L$, $P_R$) in stereo images (Fig. 2). The fundamental matrix enables full reconstruction of the epipolar geometry, since it encodes information about both intrinsic and extrinsic parameters of the cameras views. The centroid's coordinates of the object are used to calculate the epipolar lines in each of the camera's views. These epipolar lines are necessary to find the 3D location of the object. Since the centroid of the object is known on both camera views, the projection of that point across the epipolar plane in both of the views leads to an intersecting point P in 3D space (Fig. 2). This intersection point contains the depth

coordinate of the object's centroid. This procedure provides 3D perspective reconstruction and allows for the calculation of the 3D object location (P) in every frame. For a more detailed description of epipolar geometry, the 8-point-algorithm, and the fundamental matrix, the interested reader is referred to Hartley and Zisserman (2003).

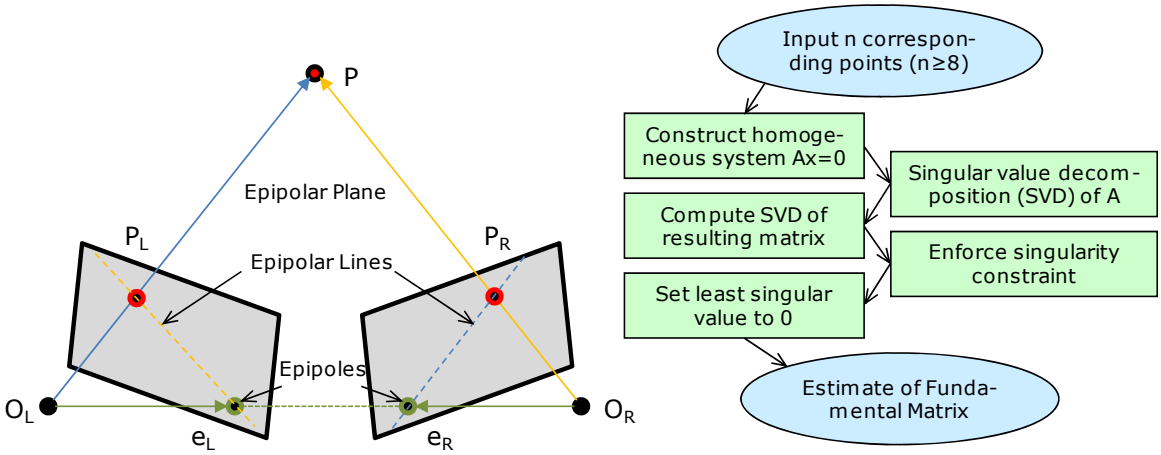


**Fig 2**: Epipolar Geometry for two cameras $O_L$ and $O_R$ (left) and 8-point-algorithm for Fundamental Matrix calculation (right)

## 4. Results

The method presented in this paper has been implemented and tested on videos taken in controlled experimental conditions. Results are compared with the actual 3D positions to validate its performance.

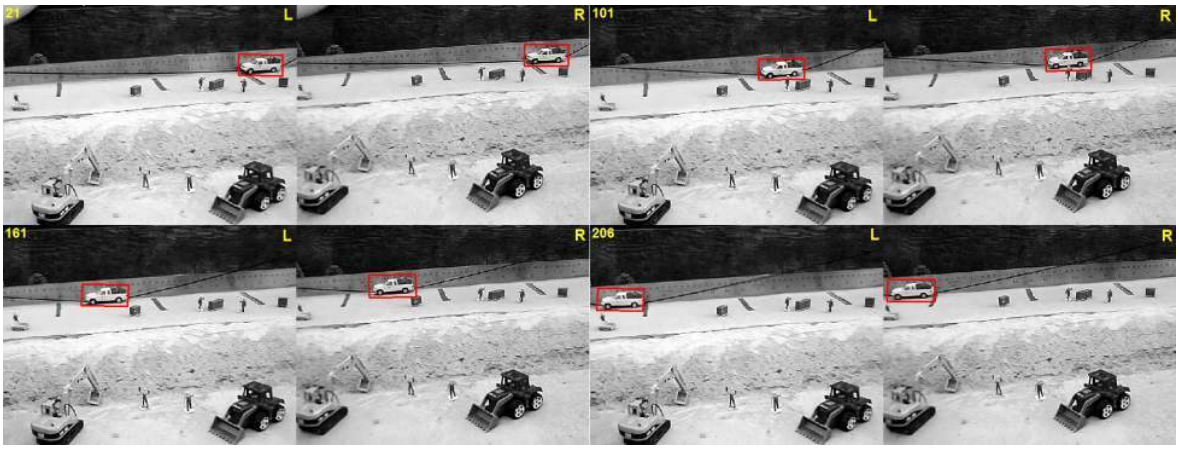


**Fig 3**: 2D tracking sequence for left (L) and right (R) camera view (frame no. 21, 101, 161 and 206)

Although the method can be implemented with several cameras simultaneously, the basic example (2 cameras) was used for experimental purposes and to reduce the computational load of the system. In order to minimize the error of manually synchronizing a pair of frames according to time, it was decided to use a stereo USB webcam. This webcam by default records synchronized frame sequences. The stereo videos taken contain 191 frames (~ 13 sec) each at a resolution of 640x480

pixels and a frame rate of 15 fps. The highway construction site model used for testing is of scale 1:87. The moving object to be tracked was a small truck at a size of 6.5 mm length, 2.2 mm width and 2.2 mm height (Fig. 3).
The actual positions of the truck were determined by a start point $Q_1$ and an end point $Q_2$ that were measured manually. For simplicity reasons it was intended and assumed that the truck moved straight along the line $L$ defined by $Q_1$ and $Q_2$. Figure 3 presents example video frames showing the model environment and the tracked truck object.
Based on the corresponding 2D centroid positions $P_L$ and $P_R$, the 3D location $P$ of the truck was determined for every video frame. The performance results are quantified by an absolute error $E_{ABS}$ that is defined as the distance between the determined 3D position $P$ and the line $L = Q_1 + t\,(Q_2 - Q_1)$.

$$E_{ABS} := |(Q_2 - Q_1) \times (P - Q_1)| \,/\, |(Q_2 - Q_1)| \qquad (1)$$

Figure 4 presents the overall performance results by plotting the absolute errors $E_{ABS}(i)$ against the frame numbers $i$ = 21..211. The graph shows the maximum error $E_{MAX}$= 105.4 mm at frame #127 and the average error $E_{AVG}$ = 47.8 mm.

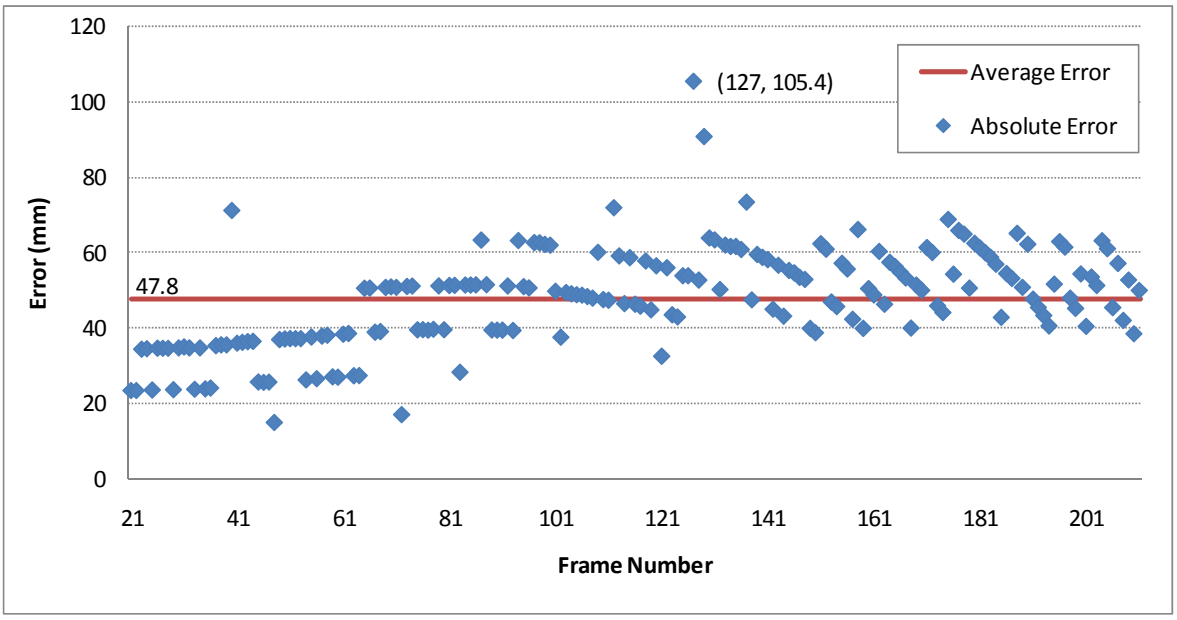


**Fig 4**: 2D tracking sequence for left (L) and right (R) camera view (frame no. 21, 101, 161 and 206)

Due to the model scale of the test environment the determined errors have to be scaled by factor 87. This yields a maximum error $\bar{E}_{MAX}$ = 9.17 m that obviously can compete stand-alone GPS with an accuracy of around 10 m (Caldas et al. 2004). Moreover, scaling the average error yields $\bar{E}_{AVG}$ = 4.16 m, which is less than the actual length of the tracked object. Based on these error magnitudes it can be stated that the vision based 3D tracking approach presented was successfully tested and verified.
However, it is believed that the first results presented can be improved. Considering frame #127, which is related to the maximum error $E_{MAX}$, it was recognized that the determined centroid positions $P_L$ and $P_R$ differ to a significant extent. Figure 5 presents the left and right view of frame #127 highlighting the rectangular areas used for 2D tracking and their centroids. The noticed difference is about 3 to 4 pixels according to a fixed position (e.g. bottom right corner of the side window). Misarranged coordinates determined in the triangulation process

result in an incorrect depth value for the 3D location of P. It is concluded, that the position of the selected rectangular area has a significant impact on 3D tracking results. Based on this finding, it is proposed to specify the area by selecting its centroid, rather than by selecting the area's exterior shape and determining the centroid afterwards. Furthermore, the 2D tracking results can be enhanced by utilizing high resolution cameras, which directly affects the accuracy of the 3D tracking result.

**Fig 5**: Differing centroid position $P_L$ and $P_R$ after 2D tracking in video frame #127

## 5. Conclusions

3D object tracking on construction sites has a wide variety of applications. Being able to effectively identify and track personnel, equipment and materials can support progress monitoring, activity sequence analysis, productivity measurements, asset management as well as enhancing site safety. Available tracking solutions based on Radio Frequency technologies have been successfully used when tracking prefabricated materials, equipment, inventory and personnel. However, in open construction sites (e.g. highway construction), due to the large amount of items involved, tracking technologies that require attaching sensors to each single item have additional the time and cost burdens associated with performing sensor installations.

This paper presented an alternate tracking methodology based on vision tracking, which removes the need for object tagging. Under this method, video-streams are collected from constructions sites and then used to determine the spatial location of project related entities across time. Using a selected kernel-based 2D tracking algorithm, the 2D locations of an entity are determined and recorded for corresponding video frames. Epipolar geometry is then used to correlate multiple views and to calculate the depth value, providing the 3D aspect and allowing the user to retrieve 3D location information in real time. Preliminary results were obtained by testing the method on a scaled model of a highway construction site at the Construction Information Technology Laboratory. The maximum error determined is comparable with the standard accuracy of stand-alone GPS, and the average error is even less than the maximum dimension of the tracked object. It was found that the errors are reasonably attributed to incorrect 2D tracking in terms of an inaccurate determination of object centroids. However, the results presented validate that the vision based 3D tracking approach proposed can effectively provide accurate localization of construction site entities. The next step is to investigate how visual pattern recognition methods can be used to automatically recognize and match entities removing the need for manual entity selection.

## 6. Acknowledgements

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*AA083*

# Working Cultures and Human Resources in the Construction Industry of the Balkan Peninsula

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## Abstract
Factors such as characteristics of the human resources, labour conditions, labour relations and others are referred to as "working cultures". The basic goal of the current paper is to identify and discuss main existing characteristics of the "working cultures" that appear in the Balkan. Moreover to consider how attractive such characteristics are for the development of construction projects in the area.
Based on the analysis, the research concluded that Balkan countries include a variety of labour "fields" under continuous evolution. A S.W.O.T. analysis (from the point of view of a foreign employer and employee) led to the conclusion that these countries appear to have interest both for the potential employer and employee.

## Keywords
Working cultures, human resources, Balkans, construction industry.

## 1. Introduction

The term "working cultures" refers to the employees and includes the following main characteristics: labour force, labour organization, labour environment, labour conditions and labour relations. The study of the "working cultures" in various levels is essential for a formed and successful business action. [Naniopoulos A. (1998), Rahtz N. (1998), Naniopoulos A.-Christidis P. (2000)]
Labour force concerns social characteristics (age, sex, nationality etc) as well as the work contract (full time, part time, regular), the source of employment and the number of employees proportional to the field of the market and the category of the profession. Labour organization consists of the work systems, the operational flexibility and the organizational structure. The basic characteristics of the labour environment are health and safety, the human factor in the work field and the natural conditions. Labour conditions include hours (basic working hours, shifts system, overtime) and pay-systems (basic salary, economical motivation, supplementary fees, privileges), process of employment and welfare status (pension, sickness allowance etc). In labour relations the existence of unions, consultation, conflicts and strikes are examined.

## 1.1 Industrial relations (associations) in the Balkan countries.

The construction sector has always been featured by strong union consciousness and action. The hard working environment in the construction industry resulted to

the formation of a coalition of workers to fight for better working conditions. But this has changed, as the employees nowadays show little interest for participation in trade unions because they believe that the associations and unions in the construction sector are often under the control of employers.

One of the most striking examples (among those countries that collecting data was feasible) is **Bulgaria**, where the percentage of workers who are members of trade unions is only 16% which is even lower to the respective 20% that was recorded a few years ago.

In **Serbia**, unions are weak, mainly due to the mistrust to union trade leaders who are perceived as seekers of their own –instead of common- interests.

The country where the situation differs from the above is **Bosnia and Herzegovina**. Both state entities, the Federation of Bosnia and Herzegovina and the Republika Srpska, demonstrate a high rate of union participation. Since 2005 in Bosnia and Herzegovina trade unions from the two state entities have formed a new –yet still not recognized at the state level- association that is expected to represent the great majority of workers in the country.

**Slovenia** is also one of the exceptions among the Balkan countries on the issue of trade union density with a large number of employees being organized in associations and trade unions.

**1.2 Hours, fees**

The basic salary for workers amongst the Balkan counties shows a wide range. Aggregated data on working hours and minimum wage for an unskilled worker drawing by ILO (2009) and FedEE (2009) are presented in Table1. All Balkan states have institutionalized the 5 days and 40 hours work week.

| COUNTRY | MANDATORY WORKING HOURS | OVERTIME (HOURS PER WEEK) | BASIC SALARY (local currency) | BASIC SALARY (€) | REFERENCE YEAR |
|---|---|---|---|---|---|
| **Bulgaria** | 40 | 6 | 240 Lev | 122,83€ | 2009 |
| **F.Y.R.O.M.** | 40 | 10 | 20116 denars | 327,64€ | 2009 |
| **Albania** | NOT FOUND | NOT FOUND | 18000 lek | 130,14€ | 2009 |
| **Serbia** | 40 | 8 | 12133,33 dinars | 125,06€ | 2009 |
| **Montenegro** | 40 | 8 | NOT FOUND | 55,00€ | 2007 |
| **Bosnia & Herzegovina** | 40 | 10 | NOT FOUND | 127,00€ | 2010 |
| **Croatia** | 40 | 10 | 2814 HRK | 386,11€ | 2009 |
| **Slovenia** | 40 | COLLECTIVE CONTRACTS | NOT FOUND | 566,53€ | 2008 |
| **Romania** | 40 | 48 TOTAL | 600 RON | 146,20€ | 2009 |

**Table 1:** Data on working hours and minimum wages (*source:* authors' processing)

## 1.3 Legislation

The growth of the construction industry is strongly affected by the respective legislation in each country.

A clear and streamlined labour law can be a powerful tool both for workers and employers who are allowed to perform in a steady environment that facilitates planning, organizing and implementing with a long term perspective.

On the other hand, laws in a specific country can be a powerful tool for any trader who operates in the country. An institutional and legal framework that simplifies approval procedures for investments in a country, that demonstrates clear rules about reinvestment and export earnings, and that even helps contributing the increase of information on opportunities, obviously supports the investors as a key concern.

The tax system and potential tax exemptions provided to investors are very important factors that influence entrepreneurship. Agreements signed for the protection of investments are a great tool for entrepreneurs, and agreements on avoidance of double taxation can be a key incentive for the establishment of a company in a specific region.

## 1.4 Occupational Health and Safety

The number of occupational accidents and diseases that lead to injuries and deaths is very high. The Balkan countries, mostly developing ones, need to achieve significant improvement in order to reduce fatalities in the working environment and keep up with the high health and safety standards in the EU.

Aggregated data drawn by Hämäläinen et al (2009) on occupational accidents and fatal work-related diseases are presented in Table2.

| COUNTRY | FATAL OCCUPATIONAL ACCIDENTS | FATALITY RATE | OCCUPATIONAL ACCIDENT RATE |
|---|---|---|---|
| **Bulgaria** | 288 | 10,2 | 9,551 |
| **F.Y.R.O.M.** | 60 | 10,9 | 10,264 |
| **Albania** | 91 | 9,8 | 9,220 |
| **Serbia** | NOT FOUND | NOT FOUND | NOT FOUND |
| **Montenegro** | NOT FOUND | NOT FOUND | NOT FOUND |
| **Bosnia and Herzegovina** | 128 | 12,4 | 11,698 |
| **Croatia** | 58 | 38,0 | 3,538 |
| **Slovenia** | 49 | 5,5 | 5,163 |
| **Romania** | 1016 | 11,0 | 10,360 |

**Table 2:** Data on occupational accidents (*source:* authors' processing)

## 1.5 Workforce

The workforce of the Balkan countries consists of workers who have reading and writing skills at an average of 98% while a 30% has received primary education. [Agency for statistics of Bosnia and Herzegovina (2010), Institute of Statistics (2010), Croatian Bureau of Statistics (2010), Croatian Bureau of Statistics (2010), Republic of F.Y.R.O.M. – State statistical office (2010), Statistical Yearbook of Serbia 2009, CIA World Factbook].

Typically in the Balkan countries the tendency is for employees rather than self-employed workforce. On average, 77.3% of workers are employees of whom 33% are employed in the public sector and 44.3% are private employees. The proportion of self-employed workers is quite low, averaging between the Balkans estimated at a 14,6% of all workers. [ILO(2009), fedEE (2009) , P3C – Republic of Serbia (01-2010, National Institute of Statistics (2010)].

Another conclusion drawn from the study about the labour force in the Balkan Countries is that the largest proportion of the population is in the age group between 15-64 years. A main feature of the working environment in the Balkan countries is the high unemployment rate, which is increasing in the recent years. The above figures appear in detail in Table 3.

| COUNTRY | WORK FORCE (millions) | PORTION OF EMPLOEES (Total population) | WORK FORCE Composition by sector | | | Unemployment | Population below poverty |
|---|---|---|---|---|---|---|---|
| | | | Agriculture | Industry | Services | | |
| Bulgaria | 2,670 | 37,06 % | 7,5% | 35,5% | 57,0% | 6,3% (79) | 14,1% (2003) |
| F.Y.R.O.M. | 0,925 | 44,76 % | 19,6% | 30,4% | 50,0% | 33,8% (182) | 29,8% (2006) |
| Albania | 1,103 | 30,31 % | 58,0% | 15,0% | 27,0% | 12,5% (138) | 25,0% (2004) |
| Serbia | 2,961 | 40,13 % | 30,0% | 46,0% | 24,0% | 18,8% (163) | 6,5% (2007) |
| Montenegro | 0,259 | 38,53 % | 2,0% | 30,0% | 68,0% | 14,7% (152) | 7,0% (2007) |
| Bosnia & Herzegovina | 1,863 | 40,38 % | 19,8% | 32,6% | 47,6% | 29,0% (174) | 25,0% |
| Kosovo | 0,550 | 30,47 % | 16,5% | - | - | 40,0% (187) | 37,0% (2007) |
| Croatia | 1,731 | 38,56 % | 5,0% | 31,3% | 63,6% | 13,7% (147) | 11,0% (2003) |
| Slovenia | 0,940 | 46,87 % | 2,5% | 36,0% | 61,5% | 6,7% (84) | 12,9% (2004) |
| Romania | 9,320 | 41,95 % | 29,7% | 23,2% | 47,1% | 4,4% (56) | 25,0% (2005) |

**Table 3:** Establishment of labour and rising unemployment rate (*source:* various sources and authors' processing)

| | Basic education (or less) | Secondary education | Man | Woman | University degree | Man | Woman |
|---|---|---|---|---|---|---|---|
| **Bulgaria** | NOT FOUND | NOT FOUND | NOT FOUND | NOT FOUND | NOT FOUND | NOT FOUND | NOT FOUND |
| **F.Y.R.O.M.** | 32,7 | 55,5 | 36,2 | 4,2 | 9,9 | 20,9 | 5,8 |
| **Albania** | 37,1 | 23,6 | 22,2 | 12,9 | 6,2 | 4,9 | 4,2 |
| **Serbia** | 45,3 | 47,6 | 57,5 | 38,3 | 7,1 | 8,3 | 5,9 |
| **Montenegro** | 26,1 | 67,9 | 43,1 | 14,4 | 6,0 | 35,5 | 6,9 |
| **Bosnia & Herzegovina** | 17,0 | 62,3 | NOT FOUND | NOT FOUND | 20,7 | NOT FOUND | NOT FOUND |
| **Kosovo** | NOT FOUND | 36,0 | 17,2 | 18,8 | 18,9 | 8,0 | 10,9 |
| **Croatia** | 24,9 | 61,7 | 35,2 | 26,4 | 13,5 | 7,2 | 6,5 |

**Table 4:** Education of population (*source:* various sources and authors' processing)

## 2. SWOT Analysis

A SWOT analysis was conducted both from the Greek point of view of the employer and the employee aiming basically at the categorization of data -that were collected and concern the "working cultures"- in advantages and disadvantages that influence decision making of the foreign employer and employee. The latter refers to the possibility of taking action in the Balkan "work arena": developing construction enterprises for the employer and finding an occupation for the employee.

### 2.1 SWOT analysis - employer

Strengths

- ✓ Labour hours
- ✓ International conditions included in labour legislations (Serbia, Slovenia)
- ✓ Labour code, annual collective labour bargaining, social security (Romania)
- ✓ Common culture with that of Greece as far as labour is concerned
- ✓ Well organized trade unions (Bulgaria, Romania, Slovenia, Bosnia & Herzegovina) – labour stability
- ✓ Low density of unionists (the rest countries)

Weaknesses

- ✓ Insufficient terms of law
- ✓ Sectors of labour health and safety are under development
- ✓ Excess of different nationalities (F.Y.R.O.M., Serbia, Romania)
- ✓ Low organization in trade unions
- ✓ Low educational level

Opportunities

- ✓ Low basic payment
- ✓ High unemployment (Kosovo 40%, F.Y.R.O.M. 33,8%, Bosnia 29%, Serbia 18,8%)

- ✓ High percentage of the population belongs to the ages of 15-64 (67-70%, on average)
- ✓ High percentage of the population are employees-clerks
- ✓ Know-how by the occupation in heavy forms of industry

Threats
- ✓ High percentage of the population is under the limits of poverty (Kosovo 37%, F.Y.R.O.M. 29,8%, Albania 25%, Bosnia 25%, Romania 25%)
- ✓ Variety of religious beliefs (Slovenia, Croatia, Serbia)

## 2.2 SWOT analysis - employee

Strengths
- ✓ Organized unions (Bulgaria, Romania, Slovenia, Bosnia)
- ✓ International conditions included in labour legislations (Serbia, Slovenia)
- ✓ Labour code, annual collective labour bargaining, social security (Romania)
- ✓ Common culture with that of Greece as far as labour is concerned

Weaknesses
- ✓ Insufficient terms of law
- ✓ Sectors of labour health and safety are under development
- ✓ Low basic payment
- ✓ Low educational level
- ✓ Low level of services referring to the quality of the habitants' life

Opportunities
- ✓ Know-how by the occupation in heavy forms of industry
- ✓ Need of E.U. membership
- ✓ Research Institutes and Universities
- ✓ Cooperation for the proper human resource management aiming at the development of employment
- ✓ High percentage of the population belongs to the ages of 15-64 (67-70%, on average)

Threats
- ✓ High unemployment (Kosovo 40%, F.Y.R.O.M. 33,8%, Bosnia 29%, Serbia 18,8%)
- ✓ High percentage of the population is under the limits of poverty (Kosovo 37%, F.Y.R.O.M. 29,8%, Albania 25%, Bosnia 25%, Romania 25%)
- ✓ Variety of religious beliefs (Slovenia, Croatia, Serbia)
- ✓ Excess of different nationalities

## 3. Conclusions – Suggestions

Based on the previous analysis, it is concluded that Balkan countries are an interesting research field. These are developing countries with uncertain political status, whose future is directly dependent on the decisions of external organizations such as NATO and the E.U. (Bulgaria, Romania, Slovenia are members of the European Union and NATO). Some countries have recently obtained their independency, while others have history but with a recent Republic status. The most stable countries are Bulgaria, Romania, Albania and Slovenia, though they are not relieved from political turbulences. Croatia reserves low profile with the pending issue of its borders. In Bosnia is observed general political

division, whereas in Albania crisis is being revitalized. F.Y.R.O.M. has not yet solved the issue of its name and there are internal conflicts between the ethnic Albanians and the ethnic Sebs. Bulgaria implements energy-politics.
The countries of the Balkan Peninsula are not characterized as having high-dense population. There is a slow rate of population augmentation. The positive fact is that in most countries the highest percentage of population is in the constructive ages.

S.W.O.T. analysis led to the conclusion that these countries appear to have interest for foreign investors – maybe low because of the global economic crisis but still present. Specifically, strengths and opportunities appear to be more significant for employers than employees. On the other hand, as far as the human resources are concerned threats and weaknesses tend to tilt the balance against their interests. Countries that facilitate foreign investment activities (according to the legal status) are those of the Western Balkan area, providing motivations such as low taxes and opportunities of contracts avoiding double taxation. In the countries that are already members of the E.U., a working culture similar to that of Greece is gradually developing. Hence, the businessman who is about to take action in these countries, has a high knowledge of the problems as well as the requirements and obligations that is going to face.

Large and "mature" companies tend to prefer countries of the Eastern Balkans and in particular countries – members of the E.U. because of the stability and the favorable fiscal conditions. There is also cheap labour force and low cost of living. In Romania, there is land offer. Land purchase in combination with the development of power plants seems to be a good perceptive in these countries.

In a sense, countries that are not E.U. members, despite the unstable political climate, would seek to attract foreign investors by offering privileges to create the conditions that will improve their image in the European environment. On this basis, and given the fact that large companies are already operating in other Balkan countries (Bulgaria, Romania, F.Y.R.O.M.), the other could be a destination for smaller companies (with a relative risk).

Choosing the Balkan area as a labour destination, a key element is the unemployment rate. The lowest unemployment rates among the Balkan countries are Bulgaria, Slovenia and Romania.

The worker, who comes from Greece and works in a Greek company abroad, will have the advantage of high purchasing power because the salary will be Greek but the cost of living will be low. On the other hand, a worker from the Balkans that will work there in a Greek company enjoys the benefits of good working conditions and the fact that he/she will have the opportunity to work.

This paper was based on contemporary data that were gathered together mainly by official sites in the internet and also by some interviews. The study led to first conclusions that, besides others, show that the process of analyzing the factors concerning labour and that influence the construction industry is dynamic. Further surveys, besides the theoretical research and analysis in each case (employer and employee), must be carried out, as well as on site investigation of circumstances and opportunities that may arise (ad hoc).

The working cultures, and especially the state of labour conditions and labour force, have a great impact at the activation of construction enterprises. The human resources are considered as the most important asset in the possession of an organization, an important factor that can lead in the creation of the desired competitive advantage. The Construction sector needs high skilled employees that can perform comfortably under ideal circumstances and conditions and within the ideal cost limit; demands not only new techniques, due to the high evolvement of construction complexity, but also better management of all the operations and tasks of the organization in general and of a project in particular.

The Balkan area provides opportunities in this field because these countries are developing and require approaches that can upgrade them. They also desire to attract foreign investors and construction projects to diminish their unemployment rate. Working cultures need to be monitored in all circumstances, in order to aid their improvement. Gathering statistical data for all the factors taken into account and developing the proper model for the continuous update and development of the above information is essential not only in terms of providing the guarantees for the enhancement of the construction sector's activities but also in terms of improving working cultures in the region.

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*INV-4*

## PMForum – The Untold Story!

Pells David L.
*(President, Managing Editor PMForum, Inc, USA)*

**PMForum .....**
*The Untold Story!*

**David L. Pells**
President, Managing Editor
PMForum, Inc.

**PM-05 Project Management Conference**
**Advancing Project Management For the 21st Century**
*Heraklion, Crete, Greece – 31 May 2010*

**The PMForum Story**
**is the**
**Story of Project Management**
**over the last**
**15 years**

**PMForum** ... *The Untold Story*

# PMForum is...

- A reflection (of the PM profession)
- A conduit for PM ideas
- An opportunity to influence
- A source of knowledge & inspiration
- A living and growing family (of stories)
- A showcase for people & organizations



**PMForum** ... *The Untold Story*

# PMForum was created circa 1994 based on 3 main Ideas

- Worldwide Web as an Information Resource
- Globalization of the PM Profession
- Value of Diversity – people, organizations, experiences – and cooperation

*David Curling*
*Founder of PMForum*

***PMForum was the world's 1st Project Management Website***

**PMForum** ... *The Untold Story*

# PMForum was also based on

- The Global PM Forums (1995-2005)
  - Annual Meetings of Leaders from PM associations around the world
  - To promote cooperation on PM education, standards, certifications & outreach
- Co-sponsored by PMI & IPMA

*GPMF 7 - 1998*

*GPMF Steering Committee - 1998*



**PMForum** ... *The Untold Story*

# PMForum Mission:

"Connecting the World of Project Management"

But what is "project management" today?

and

What is the "world of project management"?

**PMForum** ... *The Untold Story*

# What is Project Management?

Captain Bob Tarrant, *HMS Endurance*

- Most people assume a common definition

But ...

- Definitions may depend on your business, industry or role

Are you captain?

or Crew?



**PMForum** ... *The Untold Story*

# Definitions of Project Management

- IPMA's ICB
- PMI's PMBOK Guide ®
  - Extensions to PMBOK Guide
- ISO Definition
- Wikipedia Definition?
- Other?

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## So is Project Management a (an)

- Approach? Methodology?
- Practice? Process?
- Application? Model?
- Body of Knowledge?
- Management Philosophy
- Career? Profession?
- Business? Industry?

**PMForum** ... *The Untold Story*

## Is Project Management Art or Science?

Knowledge based

People oriented

Experience & Competency based

PMForum ... The Untold Story

## Does one's Definition Depend on Role or Relationship to a Project or Program?

- Project management **practitioner** or team member
- Program or **project manager**
- Corporate **executive** – project sponsor
- **Customer** or owner
- PM **consultant** or service provider
- PM technology or tools **supplier**
- PM academic **researcher** or **teacher**



PMForum ... The Untold Story

## Do Definitions or Perspective depend on Industry or Type of Project?

- Archibald suggests Categorization*
  - Industries: aerospace, construction, environmental, government, etc.
  - Types: facilities, IT, product dev, etc.
  - International development
  - Categories & subcategories exist

**Archibald, Russell; A Global System for Categorizing Projects, 2006*

PMForum ... The Untold Story

## What is the World of Project Management?

### Doesn't it now include...

- PM Research (pure & applied – academic & industrial)
- PM Bodies of Knowledge (definitions, concepts, models)
- PM Education (courses, curricula, degree programs)
- PM Application & Experience (real projects, best practices?)
- PM Supplier Marketplace (tools, technologies, services)
- PM Profession (standards, qualifications, ethics, orgs)
- PM Communities (geographic, virtual, industries, internal)

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## Some additional discussion of PM Application & Experience

- Projects, Programs & Project Portfolios (various types, sizes & characteristics)
- People in PM (Project & Program Managers, Team Members, Stakeholders, Mentors, Leaders)
- PM in Organizations (Best Practices, Organizational Maturity, issues, politics, etc.)
- Project – oriented Industries
- PM in Fields of Science, Technology, General Fields of Practice
- Projects & PM in government & society

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# The World of PM Experience

- People
- Projects
- Programs
- Organizations
- Industries
- Government
- Society

represent

1. Users of PM
2. Market for PM products and services
3. Real world PM experience & practice

PMForum ... The Untold Story

# Modern PM Supplier Marketplace

1. Turnkey project delivery
2. Contract PM
3. PM Staffing Services
4. PM Consulting Services
5. PM Education & Training Providers
6. PM Software, Tools & Technology
7. PM Books & Magazines (Publishing)
8. PM Knowledge Vendors, Portals, On-Line Resources
9. PM News & Information Vendors (media)
10. Other PM Products & Services

***2010 Estimate: US$10 Billion***

***PMForum*** *... The Untold Story*

# Projects & Project Management Now a Global Phenomena

- Every industry and type of business
- Every country and geographic region
- Every government and NGO

500,000 professionals (memberships) worldwide – hundreds of branches & chapters of professional organizations

PMI estimates 25% of global economic output by projects!

**There are now MILLIONS of projects & project managers.**

***PMForum*** *... The Untold Story*

# The New Challenge...

- Rapidly expanding sets of project management applications, definitions, issues & TOPICS
- Rapidly expanding sets of STAKEHOLDERS

A Rapidly Growing

**WORLDS OF PROJECT MANAGEMENT**

PMForum ... The Untold Story

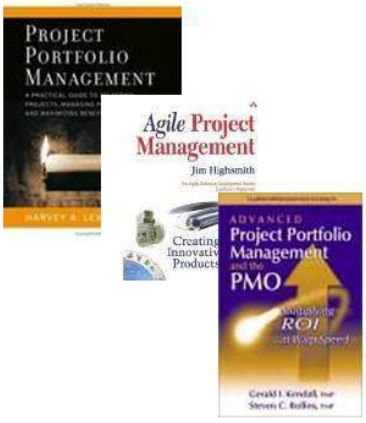
# Add in - Recent Trends in PM

- Evolving PM Concepts & Methods
- Trends in PM Tools & Technologies
- PM as Industry
- PM as Profession
- Trends in Fields of Application – New Frontiers

PMForum ... The Untold Story

# Some major recent Trends in PM Approaches, Concepts & Methodology

- Portfolio Project Management
- Critical Chain PM
- Agile PM
- Complex PM
- Governance of PM
- Program Management, PM for Major Projects, PM for Public-Private Partnerships, etc.



PMForum ... The Untold Story

# Some major recent Trends in the PM Industry

- Growth of PM as Industry
- Growth of PM in IT Sector
- Consolidation in PM Industry
- Rapid growth in PM Consulting & Training
- Growth of PM on Public Programs & Projects
- PM as Turnkey & Specified Service

**Globalization is having major impact on PM Industry & Profession!**



PMForum ... The Untold Story

# Some recent Trends in PM Professional World

- Growth of PM professional societies and member organizations
- Maturing & expansion of PM standards
- Increased demand for PM qualifications
- More & bigger PM events worldwide
- Acceptance of PM as a career path & profession

IPMA international project management association

PMI Project Management Institute

PM Greece

**PMForum** ... *The Untold Story*

## Emerging Fields of Application
## New Frontiers for PM

- Nanotechnology
- Web Science – Networks
- Earth Sciences, Planetary Monitoring & Climate Control
- Future energy
- Future cities – Urban Renewal & Development
- Humans in Space

**PMForum** ... *The Untold Story*

## Evolving Fields of Application
## Old Frontiers for PM

- **Food** – Agriculture & food production
- **Shelter** – Housing, sustainable communities
- **Health** – Disease eradication, medical treatment, services for aging population
- **Education** – More schools for children worldwide
- **Communication** – ICT access in all countries
- **Security** – local, multinational and global security
- **Transportation** – Roads, rail, air infrastructure
- **Power** – supplies & distribution systems

*Globalization + Population Growth + Economic Development*
*= rapidly growing demand for basic services (more projects!)*

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*The Result....*

## PMForum is a Story Unfolding – like the PM Profession itself

- Connecting multiple Worlds of PM
- Promoting Professional PM worldwide
- Establishing Global Leadership Networks
- Global News, Information & Knowledge
- Continuous Education (knowledge sharing)
- Stories – Projects – People – PM

**PMForum** ... *The Untold Story*

*More importantly*

## The PMForum Story

### Is about the People of Project Management!

- Teams of Teams – Advisors & Correspondents
- Readers & Subscribers – News & Stories
- Authors & Experts – sharing knowledge
- Project Managers & Project Teams – showcased in stories

PMForum ... The Untold Story

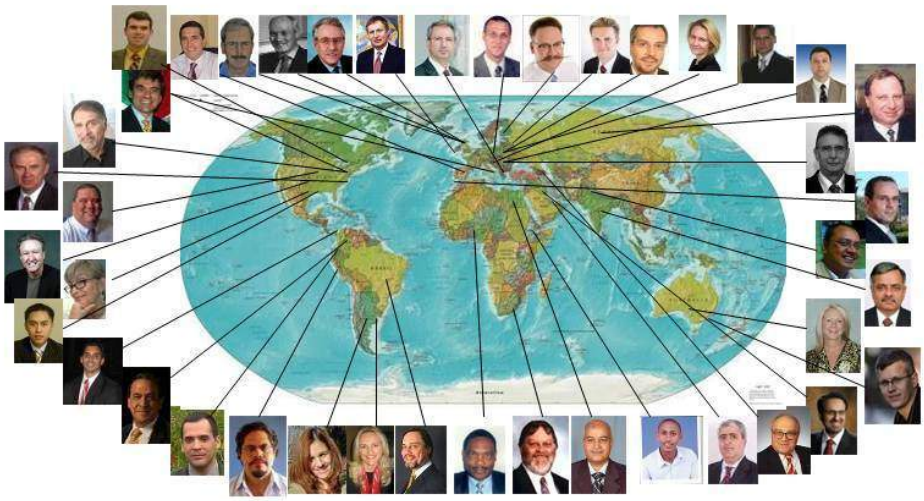
## Global PM Advisors in 11 countries

PMForum ... The Untold Story

## Academic Advisors in 15 countries

PMForum ... The Untold Story

## International Correspondents in 40 Countries





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## PMForum Stakeholders Increasing

Authors
- from dozens of countries

Subscribers
-10,000+ worldwide
- growing monthly

Readers
-250,000/month
- growing rapidly

Stakeholders
- multiple cultures & places
- all hungry for PM

**PMForum** ... *The Untold Story*

## Project Management ... is also full of Stories!

- Projects have a life cycle because they have a LIFE of their own
- All projects involve people – leaders, teams, contractors, employees, families
- Lives of project managers and project teams are intertwined with the lives of their projects
- And every life is full of stories!

***Projects have stories that transform lives?***

**PMForum** ... *The Untold Story*

## PMForum tells the Stories - about projects & PM

- Breaking News Stories from around the world
- Stories from Advisors & Correspondents in over 50 countries
- Stories from local & global organizations
- Stories of big and small projects, local and global, of old and new industries – every project is important to someone

***Here are just a few!***

**PMForum** ... The Untold Story

## The Trinity River Corridor Project
## Dallas, Texas, USA

*Ann Miller*

**3 Signature Calatrava Bridges**

Major new lake, parks
Visitors' center, access
To Trinity River Forest
Recreation, Economic
Development &
Neighborhood Redevelopment

Cost: $500M+USD
Schedule: 16+Years (1998–2014)
Participants: City, State, USG, CoE, TxDOT, DoT, architects, contractors, ++
Stakeholders: General Public, politicians, city/state gov, contractors, labor+many others
Big PM Issues: Scope, Cost, Finance, Risks, Public Communications, Legal, Schedule, Contracting



**PMForum** ... The Untold Story

## Moscow, Russia – World Famous Bolshoi Theatre Reconstruction

*Alexandre Tovb*

Cost: $520M USD
Schedule: 5 Years (2005–2010)
Participants: Gov, Bolshoi, Architects, contractors
Stakeholders: Russia, Moscow, Bolshoi Ballet, public+many others
Impact: global, national, local
Big PM Issues: Quality, Communications, Risks

PMForum ... The Untold Story

## The Sydney Opera House – Preservation & Reconstruction

*Jürgen Oschadleus*

Cost: $350M USD
Schedule: original construction 1957-63; reconstruction 1999+
Participants: Aus, NSW, Sydney, SOH management, Opera & Theater groups, ++
Stakeholders: UNEXCO, Gov, Citizens, politicians, local businesses, visitors
Impact: National, Regional, local (one of world's most famous buildings)
Big PM Issues: Risks, Scope, Cost, Communications



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## London, UK – Preparing for the 2012 Olympic Games

*Miles Shepherd*

Cost: £5.3 – 9.2 B
Schedule: Bid 1997-2005; Implementation 2005-2012
Participants: Governments, agencies, UKOC, 2012 Team, advisors, industry, ++
Stakeholders: UK, London, sports, Olympics Committees, business, public, ++
Impact: GDP increase by £5.9B; 39,000+ jobs
Big PM Issues: Scope, Schedule, HR, Risks, Communications, Contracting, Costs

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# 2010 FIFA World Cup
## South Africa

*Jaycee Krüger*

Cost: Construction R8.4bn
Schedule: 2004 - 2010
Scope: 5 new stadiums, 5 upgraded stadiums, new & upgraded public transport
Participants: RSA gov, politicians, FIFA program team, contractors, labor (70,000 workers), ++
Stakeholders: Tourists/fans, participating teams, local business, general public, viewers worldwide
Impact: 415,000 jobs, GDP +R55.7bn, 40bn global viewers, 487,000 foreign visitors, new infrastructure
Big PM Issues: Schedule, Quality, Financial, Risks, Global Communications, Safety, Security



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# Schools for the Future Programme
## Birmingham, UK

*Bob Owen*

Schedule: 2005 - 2020
Cost: £3.6B + £7.5B up to 2011 (total est £55B)
Scope: Renewal of all 3,500 English secondary schools
Participants: UK & local governments, schools, experts, consultants, contractors, +
Stakeholders: Agencies, citizens, students, schools, officials, politicians, businesses, ++
Impact: Jobs, new and better schools, long term benefits
Big PM Issues: Cost, Risks, Schedule, Public Communications, Scope, Contracting, Quality

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# Transylvania Motorway Project

## Brasov to Bors, Romania

*Florin Gheorghiu*

Cost: $2.2 Bn USD
Schedule: 2004 – 2013, some segments to open in 2010
Scope: 258 miles, A3 four-lane highway to border with Hungary – Europe's largest highway project
Complicated by mountainous terrain – 400 bridges, 70 overpasses, 19 interchanges
Participants: Romanian gov, EU Commission, Bechtel (USA), politicians, local contractors, labor
Stakeholders: State, local cities, politicians, citizens, businesses, suppliers, labor ++
Impact: Time to Hungary reduced from 10 to 3 hours, jobs, subcontracts, economic benefits
Big PM Issues: Risks, Cost/Finance, Schedule, Contracting, Public Communications, Resources



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# Unity Roads Program

## Nigeria

*O Chima Okereke, PhD*

Cost: $330M USD
Schedule: 2008 – 2018
Scope: (I) Rehabilitation, Upgrading & Maintenane of roads; (II) Institutional Reform
Participants: World Bank, Nigerian government, local politicians, contractors, suppiers
Stakeholders: State, local cities, politicians, citizens, businesses, suppliers, labor ++
Impact: Better roads, jobs, economic development
Big PM Issues: Risks (safety), Contracting, Corruption, Quality, Resources, Reporting

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# Vuosaari Harbor Project
## Helsinki, Finland

*Jouko Vaskimo*

Cost: €682.1 Mn (traffic infrastructure + harbor works)
Schedule: 2003-2009
Scope: New cargo port for Helsinki, largest infrastructure project in recent Finnish history
Participants: Port of Helsinki, contractors, labor, suppliers
Stakeholders: Finnish industry, customers of Port of Helsinki, transport & logistics, +
Impact: Improved Nordic logistics, traffic services, competitiveness
Big PM Issues: Legal (PPM contract form), Schedule, Quality



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# Aqaba Port Relocation
## Aqaba, Jordan

*Ammar Mango*

Cost: $3.0 Bn USD (est)
Schedule: 2008+ (planning phase)
Scope: Move Jordan's only cargo port 20 km south to deeper water
Participants: Jordan gov, Aqaba Special Economic Zone, global BOT contractors, +
Stakeholders: Jordanian industry, gov, logistics co, engineers, constructors, suppliers, industry
Impact: Allows Jordan to satisfy increased cargo and transportation needs
Big PM Issues: Cost, Resources, Legal/Contracting (BOT contract form), Schedule, Public Communications

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# National Identity Card Program
## India

*Raju Rao*

**Nanden Nilekani**
Infosys co-founder
Project Director

Cost: TBD
Schedule: 2002-2008 (development), 2009-2012 (full implementation)
Scope: Issuance of unique ID card for India's billion people
Participants: UIDAI, contractors, project teams, suppliers
Stakeholders: All citizens, various government agencies, program participants
Impact: National security, social services, tax collections, voting and elections, etc.
Big PM Issues: Scope, Cost, Resources, Logistics, Teamwork, Coordination,



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# Athens, Greece – New Acropolis Museum Project

*Theofanis Giotis*

Cost: $175M USD
Schedule: 8 Years (2001 – 2009)
Participants: Gov, Architects, Contractors, Universities, Historians, ++
Stakeholders: Greece, Athens, public, historians, art world + many others
Impact: global, national, local
Big PM Issues: Scope, Risks, Quality, Communications, Finance

**PMForum** ... *The Untold Story*

# PMForum is to be a...

- Global Intelligence Service
- Global Network of Networks
- Source of Information, News & Stories about Projects & PM
- Continuous Learning Resource

*A Story about PM People*



**PMForum** ... *The Untold Story*

# PMForum – an unfolding story!

PMFORUM
Connecting the World of Project Management
www.pmforum.org

www.pmforum.org

PMWorldToday
Global Project Management eJournal

www.pmworldtoday.net

**PMForum** ... *The Untold Story*

# *Thank you!*
# *Good luck with your projects!*

***David L. Pells***

*editor@pmforum.org*

*www.pmforum.org*

*www.pmworldtoday.net*

*W01*

# Research Methodological Position for a Doctoral Study on 'Apportioning Liability in Delay Claims'

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## Abstract
Central to successful resolution of delay based claims is the fair and equitable apportioning of parties' liabilities. However, such fairness and equity in apportioning may be fettered by many factors in contemporary practices adopted by both contractors and clients. The principal goals and rationale of this research are inspired by the need to identify and curb such major obstructive factors. Thus, the research study aims to bring about contractually sound, practical improvements to problematic situations in contemporary practices. Such improvements are expected to produce more equitable, efficient, transparent and less contentious outcomes in delay claims resolution. To achieve the aim and objectives, it is considered necessary to establish a firm methodological position for the research study. This paper has strived to establish such position. In this effort, various ontological, epistemological and methodological stand points are considered. Consequently, the paper has concluded the appropriateness of using the naturalist paradigm in this study.

## Keywords
Ontology, Epistemology, Methodology, Positivist and Naturalist Paradigms.

## 1. Introduction

This research aims to critically examine how the apportionment of liabilities in delay claims is practiced in the local context with a view to identifying problematic situations associated with such practices towards developing a framework for improvement. Thus, the research methodology is developed with the following objectives, in response to the key research questions[1]:

i. To investigate how the apportioning of liabilities in delay claims is carried out by practitioners, particularly in the local context;
ii. To find out what problematic situations stem from the approaches and methods currently used by practitioners;
iii. To explore what constructive 'improvements' can possibly be perceived in order to deal with the problematic situations; and

[1] Due to limited space, the key research questions are not discussed here. However, they are based on the Maxwell's (1996) three types of questions for qualitative research, namely, Descriptive Question, Interpretive Question and Theoretical Question.

iv. To assess the extent to which the proposed 'framework' is evident to improve the current approaches and methods in terms of contract documentation,claims administration, and delay analysis methodology.

The research design is the logical sequence that connects the empirical data to study's research questions and ultimately to its conclusions (Yin, 2003). This paper describes how the research design is developed in order to achieve these research objectives. Firstly, the theoretical perspective for the development of research strategy is established. In this, a critical review of typology of major social paradigms is carried out in order to identify the appropriate philosophical position of the research. Consequently, within the Naturalistic approach, the Constructivist paradigm is selected instead of the dominant Positivist or Post-positivist paradigm or Critical theory et al as the principal paradigm to be adopted. This philosophical position is mainly guided by the works of Lincoln and Guba (1985), Guba and Lincoln (1989, 1994), and Denzin and Lincoln (1994).

Once the ontological and epistemological positions have been established, the focus of the paper shifts to the research methodology that is required for addressing the research questions and the answers to be found for them. It observes how the selection of methodology has been constrained by the already considered ontological and epistemological positions. Finally, Naturalistic inquiry paradigm is selected for formulating the overall methodology and inquiry strategy.

## 2. Establishing Methodological Position

Denzin and Lincoln (1994) defined a paradigm as a basic set of beliefs that guide action. Paradigms deal with first principles, or ultimates. These beliefs can never be established in terms of their ultimate truthfulness. Each paradigm encompasses three elements, namely ontology, epistemology and methodology; Ontology raises questions about the nature of reality while epistemology asks 'how do we know the world'; Methodology concerns on how we gain knowledge within the context of the 'selected' nature of reality (Denzin and Lincoln, 1994).

### 2.1 Basic Paradigms

Guba and Lincoln (1994) conceptualized four basic paradigms as belief systems based on the philosophical assumptions of ontology and epistemology to see the world and how it should be studied and understood. These basic paradigms are identified as *Positivism, Post-positivism, Critical Theory et al, and Constructivism.*

With regard to Ontological position, **Positivism** is commonly called "naive realism", whereas **Post-positivism** is identified as "critical realism" (reality is assumed to exist, but to be only imperfectly apprehendable because of basically flawed human intellectual mechanisms and fundamentally intractable nature of phenomena). **Critical Theory et al** are treated as "historical realism". On the other hand, **Constructivism** is based on "relativism", that is when realities are apprehendable in the form of multiple, intangible mental constructions, socially and experiential constructions are not more or less "true", in any absolute sense, but simply more or less informed and/ or sophisticated. Constructions are alterable, as are their associated "realities". Thus, Constructivism differentiates from other three

paradigms as it is guided by 'relativism' while the others are by various forms of 'realism'.

In Epistemological analysis, **Positivism,** which is a dualist and objectivist approach, assumes the investigator and investigated 'object' are to be detached, independent entities, and the investigator to be capable of studying the object without influencing it or being influenced by it. Inquiry takes place as through a one-way mirror. Replicable findings are, in fact, "true". In **Post-positivism** approach, though dualism is largely abandoned, objectivity remains a "regulatory ideal". Replicated findings are probably true but always subject to falsification. **Constructivism and Critical Theory et al** have transactional and subjectivist approach and assume that the investigator and investigated 'object' are to be interactively linked, with the values of the investigator (and of situated 'others') inevitably influencing the inquiry. Findings are therefore value mediated. In this posture the traditional distinction between ontology and epistemology is challenged. What can be known is inextricably intertwined with the interaction between a particular investigator and a particular object or group. Accordingly, Constructivism and Critical Theory et al are different from other two paradigms in their approach to the subjectivist - objectivist dichotomy.

In Methodological analysis, **Positivism** takes an experimental and manipulative approach with carefully controlled (manipulated) conditions to prevent outcomes from being improperly influenced. This methodology thus focuses on verification of hypotheses and uses chiefly quantitative methods. **Post-positivism** emphasizes on and has mainly invested in 'critical multiplism' (a refurbished version of triangulation) focusing on falsification (rather than verifying) of hypotheses. In **Critical Theory et al** the transactional nature of inquiry requires a dialogue between the investigator and the subject of inquiry. That dialogue must be dialectical in nature to transform ignorance and misapprehensions (accepting historically mediated structures as immutable) into more informed consciousness. This methodology aimed at the reconstruction of previously held constructions. As for **Constructivism** the variable and personal (intra-mental) nature of social constructions suggest that individual constructions can be elicited and refined only through interaction between and among investigator and respondents. These varying constructions are interpreted using conventional hermeneutical techniques and are compared and contrasted through a dialectical interchange. The final aim is to distill a consensus construction that is more informed and sophisticated than any of the predecessor construction. Except for that, this also aims at the reconstruction of previously held constructions, similar to Critical Theory paradigm.

## 2.2 Selecting the Paradigm

The above paradigms, as sets of basic beliefs, are not open to proof in any conventional sense and there is no way to elevate one over another on the basis of ultimate, foundational criteria. Guba and Lincoln (1994) argued that any given paradigm represents simply the most informed and sophisticated view that its proponents have been able to devise, given the way they have chosen to respond to the three defining questions appear below:

**(i) Ontological question** – What's the form and nature of reality and, therefore, what is there that can be known about it? If a "real" world is assumed then what can be known about it is "how things really are" and "how things really

work". Then only those questions that relate to matters of "real" existence and "real" action are admissible.

**(ii) Epistemological question**: What is the nature of the relationship between the knower or would be knower and what can be known? (The answer that can be given to this question is constrained by the answer already given to the ontological question; for example, if a "real" reality is assumed as to ontology, then the posture of the knower must be one of objective detachment or value freedom in order to be able to discover "how things really are" and "how things really work").

**(iii) Methodological question**: The question here is how can the inquirer (knower) go about finding out whatever he believes can be known? Again the answer that can be given to this question is constrained by the answers already given to the first two questions; that is, not just any method is appropriate. For example, a "real" reality pursued by an "objective" inquirer mandates control of possible confounding factors, whether the methods are qualitative or quantitative.

In the selection of the appropriate paradigm for the research, the following philosophical assumptions provide answers to the said *three* defining questions:

### 2.2.1 Ontological assumptions

The question here is what's the form and nature of reality and, therefore, what is there that can be known about it? The answer to this can be found in the following considerations.

Central to successful resolution of delay based claims is the fair and equitable apportioning of parties' liabilities. Therefore, parties primarily desire that the 'apportioning of liabilities' is carried out fairly and equitably. However, whether these aspirations of parties are met or not will largely depend on how the apportioning of liabilities is carried out by the practitioners on both sides.

The perception of fair and equitable 'apportioning of liabilities' is mainly constructed by those practitioners' tacit and explicit knowledge of the applicable contract and case law, approaches, notions of fairness and equity, and also choice of analysis methods to be used. The concepts of knowledge, approaches, recognition and implementation of appropriate law and analysis methods, notions of fairness and equity etc. are identified as *constructed* realities rather than objective realities (realism). These are conceived as constructed in mind though they are intrinsically related to 'tangible entities' such as 'delay-events' and similar phenomena. Lincoln and Guba (1985) argued: 'Events, persons, objects are indeed tangible entities. The meanings and wholeness derived from or ascribed to these tangible phenomena in order to make sense of them, organize them, or recognize a belief system, however, are *constructed realities*'. Thus, they are not created as pure objective phenomena; they are related to human cognition rather than to a physical object. They are constructed notions, and in turn resident in the minds of individuals. 'They do not exist outside of the persons who create and hold them; they are not part of some 'objective' world that exists apart from their constructors' (Guba & Lincoln, 1989).

Accordingly, how the apportionment of liabilities in delay claims is practiced, and what problematic situations are deriving from such practices can be perceived only through the individual practitioners' subjective experience, tacit or explicit awareness, and interpretation of what they have implemented in practice. Crotty (1998) suggested that their '*meaning is not discovered, but constructed'*. As this

obtained perception is built around individual cognition, its 'existence' or 'being' is primarily idealist and relative. Therefore, in terms of ontology they can be perceived as 'constructed realities' (Constructivism, Relativism) only and not through Positivist (naive realism) or Post-positivist (Critical realism) or Critical Theory (Historical realism) approach.

Guba and Lincoln (1994) identified ontology with local and specific constructed realities under Relativism-Constructivism paradigm of inquiry. It is suggested that the Constructivist philosophy is pluralist and relativist; they are multiple and often conflicting and potentially meaningful (Guba and Lincoln, 1985). In this instance, the research setting is found to be situated within the specific and localized circumstances of the practices as they are situated in the UAE, in Dubai; also the research inquiry intends to capture information from multiple approaches and methods of practitioners who may construct meaning in different ways even for the same occurrence (Pluralism); each of these approaches and methods, though they can be divergent and mutually conflicting, may still be meaningful as fair and equitable under different circumstances, providing they are implemented aptly and pertinently (Relativism), for example a delay analysis technique which is not consistent with the terms of one particular contract may be consistent with those of another contract.

In the current research, these multiple constructed realities can be studied holistically only. Therefore, using a design that assumes a single, identifiable, isolated, and measurable treatment to deal with them would be less appropriate. Inquiry into such multiple realities will inevitably be divergent, comprehensive, variable, and dynamic so that prediction and control are unlikely outcomes although some level of understanding can be achieved. In view of the foregoing considerations, Constructivist Relativism (Naturalist paradigm) is vindicated over Positivist or Post-positivist Realism or Critical Theory as the approach to the nature of reality (ontology) in the current research settings.

### 2.2.2 Epistemological assumptions

The question here is what's the nature of the relationship between the knower (inquirer) and what can be known? The answer that can be given to this question is constrained by the answer already given to the ontological question. That is not just any relationship can now be postulated (Denzin and Lincoln, 1994).

Patton (2002) argued that in practice human interventions are often quite comprehensive, variable, and dynamic, and this creates considerable difficulty for controlled experimental designs that need specifiable, unchanging treatments to relate specifiable predetermined outcomes. Thus, it is suggested that under real-world conditions where programs are subject to change and redirection, Naturalistic inquiry replaces the fixed treatment /outcome emphasis of the controlled experiment (Positivist approach).

The propositions in the current research settings can hardly be converted into precise mathematical formula expressing functional relationships. Therefore, Positivist or Post-positivist inquiry which is used to verify or falsify *a priori* hypotheses through mathematical relationships is less appropriate paradigm for the current research. Human behaviour, unlike that of physical objects, cannot be understood without reference to the meanings and purpose attached by human actors to their activities. Qualitative data, it is asserted, can provide rich insight into

human behavior (Denzin and Lincoln, 1994). In the current research settings, the human factor is dominant which is informed by the practitioners (respondents) and their activities. That can be understood only through non-mathematical paradigms like naturalist inquiry. In the current research the thing that can be known is firstly the manner that the contemporary practices in local industry deal with the 'apportionment of liabilities'. This is to be known primarily in order to perceive the problematic situation which is the next thing that can be known. Thereafter, in order to know the necessary 'improvements' required for the existing practices, the 'views' of the practitioners who experience the problematic situation are to be captured by the researcher (knower). This knowledge can be captured only through the interaction between the researcher and the respondent practitioners. For that, the 'knower' and the 'object to be known' have to be interactively linked. Thus, the inquiry process cannot be routed through a one-way mirror. Therefore, any approach to treat this as a relationship between detached, independent entities (Positivism) is simply inappropriate.

In view of the foregoing considerations, it can be concluded that what is required is a Naturalistic approach to the relationship of knower to the known (Epistemology) rather than a Positivist approach in the research.

### 2.2.3 Methodological assumptions

The question here is how can the inquirer (knower) go about finding out whatever he believes can be known? Again the answer that can be given to this question is constrained by the answers already given to the first two questions; that is, not just any method is appropriate. The methodological question cannot be reduced to a question of methods; methods must be fitted to a predetermined methodology (Denzin and Lincoln, 1994). Burrell and Morgan (1979) suggested that, if the researcher takes an 'objectivist' standpoint to reckon the social world as a hard and objective reality existing outside to the individual cognition (Realism) then his method of inquiry of research would be seeking to explain and predict what happens in the social world by searching for regularities and causal relationships between its constituent elements (Positivism); he will treat human beings as product of their environment (Determinism) and his research methodology would be aiming to search for universal laws which explain and govern the reality that is being observed (Nomothetic methodology).

However, as we discussed above, the philosophical position applicable to the current research takes a 'subjectivist' standpoint to reckon the social world. It does not reckon a hard and objective reality existing outside to the individual cognition; nor does it assume that there is one objective reality experienced the same way by everyone. Instead, it considers the reality involved is multiple realism and is 'constructed' by participants differently. As Robson (2002) suggests with reference to Constructivism, here the 'reality is socially constructed'. These varying constructed realities are to be compared through dialectical interchange in order to distill a consensus construction that is more informed and sophisticated than any of the predecessor construction. This requires a method of inquiry of research that would focus on different issues in different ways to understand from the inside rather than the outside (Anti-positivism); it will treat human beings as possessing free will to act voluntarily (Voluntarism). Thus, a methodology that focuses on verification or falsification of hypotheses (Positivism, Post-positivism) mainly engaging quantitative methods would not be appropriate in such research setting.

Accordingly, similar to the ontological and epistemological assumptions, it can be concluded that a Naturalistic approach is appropriate to inquire and know in this investigation rather than a Positivist approach in the research inquiry process.

### 2.2.4 Inquiry Strategy Method of Inquiry and Trustworthiness

Having established the philosophical position above for methodology, it requires developing the specific inquiry strategy. For this, Naturalistic inquiry paradigm is selected on similar philosophical position and beliefs as Constructivist Relativism and Interpretive paradigm. [It is noted that Constructivism is identified as one of many Interpretive paradigms (Denzin and Lincoln, 1994). Therefore, it may be suggested that the research's philosophical position is consistent with the interpretive paradigm as well]. Accordingly, in determining the specific inquiry strategy for the current research the methodological considerations presented by Naturalistic inquiry paradigm are regarded for necessary guidance. Lincoln and Guba (1985) suggested that major and sometimes only data collection instrument utilized in Naturalistic inquiry is the inquirer him-or herself, and the sources that instrument utilizes may be both human and non-human. As to the human sources they are tapped by interviews (structured and /or unstructured) and observations, while non-human sources include documents and records, as well as the unobtrusive informational residue (conventionally called unobtrusive "measures") left behind by humans in their everyday activities that provides useful insights about them.

In accord with Naturalistic inquiry paradigm, as for method of inquiry, several of qualitative methods are selected for collecting and analyzing empirical data. From the five approaches suggested by Cresswell (2007), phenomenological study and case study are identified in terms of the primary focus of the study and within qualitative approach. As with phenomenological study the focus is on understanding the essence of experiences about a phenomenon or a concept while case study has focus on developing an in-depth analysis of single or multiple cases. The required information is captured through the practitioners' perceptions, experience and application of 'fairness' and 'equity' in the apportioning liabilities in delay claims. Accordingly, semi-structured interviews, questionnaires, discussions, observations, analysis of pre-existing texts are selected as the principal methods for collecting and analysing data.

Miles and Huberman (1994) proposed a series of approaches in the form of questions for assessing "goodness" of qualitative work. Lincoln and Guba (1985) suggested four basic questions based on truth value, applicability, consistency and neutrality which must be addressed in the validity of any research inquiry. They also argued that those conventional criteria of 'internal' and 'external validity', 'reliability', 'objectivity' etc. used in Positivist approach are inappropriate for the Naturalistic inquiry approach. Instead they suggested 'credibility', 'transferability', 'dependability' and 'conformability' as more appropriate alternative criteria together with techniques such as 'triangulation', 'peer debriefing', 'discrepant evidence', 'thick description' and 'audit trail'. These approaches will form the evaluative criteria for trustworthiness of the research findings and whether the study is persuasive and believable.

## 3. Summary and Further Research

Considerations of ontological and epistemological positions have shown that the Constructivist Relativism is vindicated over Positivist or Post-positivist Realism or Critical Theory et al as the paradigm required in the current research settings. On the other hand, these considerations also constrain the approach to be taken as to methodological position for research inquiry. Thus, a Naturalistic inquiry approach is selected rather than a Positivist approach for the inquiry strategy and process.

Selection of naturalist inquiry paradigm entails engaging variety of qualitative methods in the development of the research. Using such qualitative methods, the research is now to proceed to the next stage of collecting and analysing the empirical data which have to be captured through phenomenological and case studies.

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# Factors Affecting Cost Contingency in International Projects

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## Abstract
Contractors include a reasonable contingency amount as an allowance for potential risks in their bid, especially in international projects, in order to protect themselves against possible failures as the international construction environment is highly influenced by several complex factors such as intense competitiveness due to the existence of numerous competent rivals, unfamiliarity with the country, local conditions, and the client in question, uncertainties in the project environment, etc. The aim of this study is to identify the importance levels of the risk factors that may affect cost contingency amounts in international projects. Review of the literature indicated that there are 59 risk factors, and these factors are categorized into 6 groups, which include; bidding stage-related factors, construction-related factors, finance-related factors, country-related factors, company-related factors, and contract-related factors. Having identified and categorized these factors, a questionnaire was designed and data of 36 construction projects from 14 countries were collected for evaluation of these risk factors.

## Keywords
Risk factors, International construction, Cost contingency, Questionnaire, Turkey.

## 1. Introduction

Construction companies, especially in developing countries, have begun to undertake international projects as a result of the globalization of construction markets. Generally, carrying out projects in international construction markets is riskier than carrying out projects in domestic markets as the international construction environment is highly influenced by several complex factors such as intense competitiveness due to the existence of numerous competent rivals, unfamiliarity with the host country conditions, project environment, the client in question, and unavailability of resources (e.g., materials, labourers, equipments, subcontractors, etc.) in the host country, etc. These factors may likely have an adverse impact on the project performance. Given this risky construction environment, contractors need to identify all potential risks inherent in international projects during the bidding stage, thoroughly assess them, determine the risk level of the project, and include a reasonable contingency amount as an allowance for potential risks in their bid in order to protect themselves against possible failures (Sonmez et al. (2007)).

Determination of the accurate contingency amount plays a critical role in not only obtaining the contract and but also achieving project goals. While low amounts of contingency may bring about significant losses in highly risky projects, high amounts of contingency may cause contractors to lose the job. This study aims to

identify the importance levels of the risk factors that may affect cost contingency amounts in international projects.

## 2. Turkish Contractors in International Markets

There are approximately 100,000 contractors registered with the Ministry of Public Works and Settlement in Turkey. If one considers unregistered companies, this number goes up to 200,000, which is greater than the total number of E.U. contractors (Yemar Report (2009)). Turkish contractors do not only undertake projects in the domestic market but also in international markets including the Commonwealth of Independent States, Africa, the Middle East, Europe, Asia, etc. Turkish contractors have been undertaking projects in international construction markets since the 1970s. They were participating in small-scaled projects as subcontractors in the beginning, yet they are now undertaking prestigious projects as prime contractors. Figure 1 shows the total values of the international projects won by Turkish contractors in the period between 2003 and 2008 (Yemar Report (2009)).

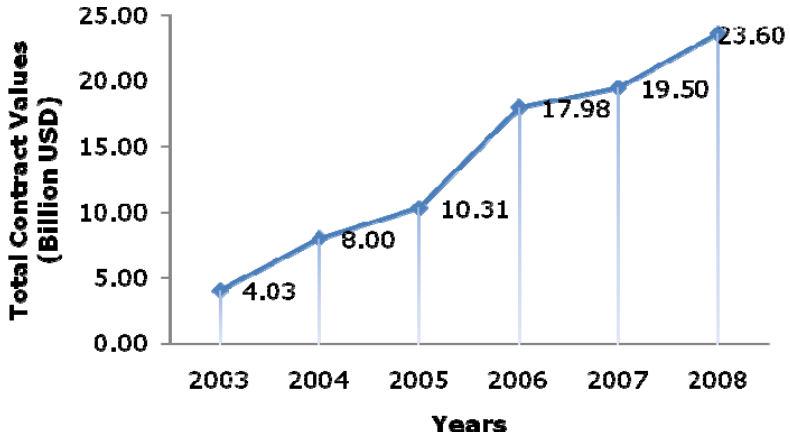


**Fig 1**: Total values of the international projects won by Turkish contractors

Indeed, Turkish contractors have won more than 3,500 projects with a total value of $84 billion in 65 different countries so far (Yemar Report (2009)). As a result of this success, Turkish contractors have ranked 2nd in 2009 in the Engineering News Record's (ENR) *Top 225 International Contractors* list. Table 1 shows the number of Turkish contractors and their rankings in the ENR's *Top 225 International Contractors* list in the period between 2005 and 2009.

| Years | Number of Turkish Contractors | Ranking |
|---|---|---|
| 2005 | 14 | 4 |
| 2006 | 20 | 3 |
| 2007 | 22 | 3 |
| 2008 | 23 | 3 |
| 2009 | 31 | 2 |

**Table 1**: Number of Turkish contractors and their rankings in the ENR's Top 225 International Contractors list

Undoubtedly, the continuity of this success mostly depends on the extent to which Turkish construction companies include a reasonable cost contingency, which is determined by the risk level of the project, in their bid.

# 3. Research Methodology

## 3.1. Questionnaire Design

Review of the literature (Hayes et al. (1986), Gunhan and Arditi (2005a,b), Dikmen et al. (2007), Sonmez et al. (2007), Ozorhon et al. (2007), Bu-Qammaz et al. (2009)) indicated that there are 59 risk factors that may affect cost contingency amounts in international construction projects and these factors are categorized into 6 groups, which include; bidding stage-related factors, construction stage-related factors, finance-related factors, country-related factors, company-related factors, and contract-related factors. These 59 risk factors are shown in the first of column of Table 2.

Having identified and categorized these factors, a questionnaire, which consists of 69 questions, was designed. The questionnaire mainly included two sections. The first section involved 10 questions, which inquired about the context of the respondent company and the project characteristics including experience of the company in the construction industry, number of employees, total turnover in domestic and international markets, project type, project size, client profile, contract type, the host country, and contingency amount used for the project. The second section comprised 59 questions. These questions were meant to explore the importance level of the risk factors presented in Table 2 using a scale of 1-5, where "1" represents the best condition and "5" represents the worse condition.

## 3.2. Data Analysis Methods

In order to test the reliability of the questionnaire, reliability analysis using the internal consistency method was conducted using the statistical package SPSS®. Cronbach's alpha (α) is the most common measure of scale reliability (Field (2005)). The standardized Cronbach's alpha is calculated using Eq. 1.

$$\alpha = \frac{N}{(N-1)} \times \left( \frac{\sigma_x^{\,2} - \sum_{i=1}^{N} \sigma_{yi}^{\,2}}{\sigma_x^{\,2}} \right) \tag{1}$$

where N is the number of risk factors, $\sigma_x^2$ is the variance of the observed total test scores, and $\sigma_{yi}^2$ is the variance of risk factor *i*.

A value of at least 0.60 for Cronbach's alpha indicates that the scale is reliable in exploratory studies (Pallant (2005)). One or more of the variables defining the construct may have to be deleted if it helps to increase the value of Cronbach's alpha (Field (2005)).

Having conducted the reliability analysis, ranking analysis was performed to find the relative importance of risk factors based on the survey data. Since the ordinal data were collected in the questionnaire survey, parametric statistics would not produce meaningful results. Thus, severity index analysis was chosen to rank the

risk factors according to their relative importance (Chen et al. (2009)). Severity index is calculated using Eq. 2:

$$SeverityIndex(SI) = \left( \frac{\sum_{i=1}^{5} w_i \times (f_i / n)}{a} \right) \quad (2)$$

Where; $i$ is the point given to each risk factor by the respondent, ranging from 1 to 5, $w_i$ is the weight for each point, $f_i$ is the frequency of the point $i$ by all respondents, $n$ is the total number of responses, and $a$ is the highest weight, which is 5 in this study.

Five important levels are then transformed to SI values, which are: High (H) (0.8≤SI≤1), High-Medium (H-M) (0.6≤SI<0.8), Medium (M) (0.4≤SI<0.6), Medium-Low (M-L) (0.2≤SI<0.4), and Low (L) (0≤SI<0.2) (Chen et al. (2009)).

## 4. Findings and Discussion

### 4.1. Sample Characteristics

Questionnaires were sent to the randomly selected 50 contractors, which are registered to Turkish Contractors Association (TCA) and operate in international construction markets, and 20 contractors returned 36 duly completed questionnaires including data of 36 construction projects from 14 different countries. This corresponds to a response rate of 40%.

25% of the respondent contractors had more than 41 years of experience in the construction industry, 20% of them had experience between 31-40 years, and 20% of them had experience between 21-30 years, and 35% of them had experience between 10-20 years. While 60% of the respondents employed more than 1,500 workers, only 15% of them employed less than 100 employees. 45% of the respondent companies completed projects with a value of more than $750 million in Turkey and only 10% of the contractors completed projects, whose contract values are less than $50 million. Similarly, the majority of the respondent companies (55%) undertook international projects worth more than $750 million and only 10% of the contractors completed projects with a value of less than $50 million.

42% of the studied projects were institutional and commercial building construction, 40% of them infrastructure and heavy construction, 10% of them residential housing, and 8% of them specialized industrial construction. The contract values of the studied projects ranged between less than $50 million (25%) to more than $750 million (11%). While 40% of the projects were contracted with public sector clients, 42% of them were contracted with private sector clients. 58% of the contracts were lump sum and 42% of them unit price. The host countries of the studies projects include Libya (8 projects), Bulgaria (6 projects), Russia and Saudi Arabia (4 projects in each country), Turkmenistan (3 projects), Algeria and Oman (2 projects in each country), Azerbaijan, Georgia, Jordan, Kazakhstan, Pakistan, Poland, and Qatar (1 project in each country). Figure 2 shows the number of projects and the contingency amounts allocated for each project in percentage of contract value are shown in Figure 2.

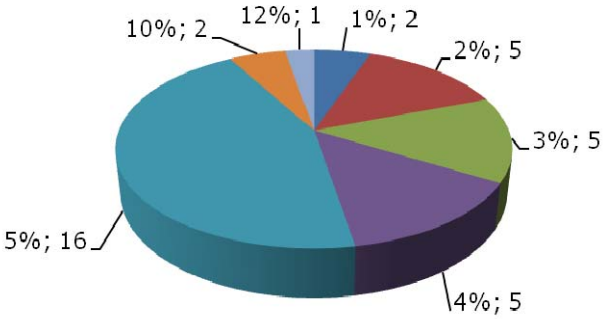


**Fig 2**: The number of projects and the contingency amounts allocated for each project in percentage of contract value

As seen in Figure 2, 5% of the contract values were allocated for contingency allowance in 16 out of 36 projects, which corresponds to 44% of the studied projects.

## 4.2. Reliability of the Questionnaire

With the help of SPSS 16.0, Cronbach's alpha was calculated to test the internal consistency reliability of the generated scale. Cronbach's alpha value is 0.831 for bidding stage-related factors, 0.797 for construction-related factors, 0.687 for finance-related factors, 0.870 for country-related factors, 0.921 for company-related factors, and 0.849 for contract-related factors. All alpha values are greater than 0.6, which indicate that all reliability coefficients are acceptable and the internal consistency of the risk factors included in the scale is high.

## 4.3. Ranking Analysis

Severity index values were calculated using the formula in Eq. 2. Based on the magnitude of the severity indices and average ratings of the risk factors, the ranking results for each risk factor category, namely bidding stage-related factors, construction stage-related factors, finance-related factors, country-related factors, company-related factors, and contract-related factors, and for all risk factors are presented in descending order in Table 2.

Based on the ranking results, 2 risk factors have "High" importance level for cost contingency amounts. These risk factors include "bureaucratic difficulties" and "unavailability of qualified workforce in the host country". Both of these factors are "country-related factors". This finding may result from the fact that Turkish contractors predominantly undertake projects in either developing or undeveloped countries. Since bureaucracy, unqualified workforce, low productivity, unavailability of resources, high inflation rates, etc. are commonly experienced in such countries; it is not surprising that Turkish contractors face problems resulting from the adverse conditions prevailing in the host countries.

According to Table 2, a total of 9 risk factors, which consist of 1 bidding stage-related factor, 1 finance-related factor, 4 country-related factors, and 3 contract-related factors, were recorded to have "High-Medium" importance levels. As expected, 4 out of 9 risk factors of "High-Medium" importance are related to the adverse conditions prevailing in the host country. Moreover, the finance-related

factor, which has "High-Medium" importance level, namely high inflation rate in the host country, is related to the host country conditions to a large extent. 3 of these factors are related to the unsatisfactory contract conditions. This finding may result from that the majority of the studied projects (58%) were performed under lump sum contracts. While lump sum contracts protect the owner from increases in the price, it is very risky for the contractor if there are unfair, uncertain and incomplete clauses in the contract. The survey results indicated that most of the respondent contractors suffer from such clauses in contracts.

The survey results indicated that 35 out of the remaining 48 risk factors have "Medium" importance levels, and 13 of them have "Medium-Low" importance levels. None of the 59 risk factors has "Low" importance level.

| Risk Factors | Ave. Rat.[2] | SI[3] | Rank. by Categ. | Overall Rank. | Imp. Level[2] |
|---|---|---|---|---|---|
| ***Bidding stage-related factors*** | | | | | |
| Design complexity | 2.9 | 0.6 | 1 | 3 | H-M |
| Inadequate site investigations | 2.6 | 0.5 | 2 | 4 | M |
| Incompatibilities between design documents and specifications | 2.4 | 0.5 | 2 | 4 | M |
| Insufficient time for bid preparation | 2.1 | 0.4 | 3 | 5 | M |
| Vagueness of the project scope | 2.0 | 0.4 | 3 | 5 | M |
| Inexperience of personnel working in the bidding department | 1.9 | 0.4 | 3 | 5 | M |
| Unfamiliarity with the specifications and standards prevailing in the host country | 1.9 | 0.4 | 3 | 5 | M |
| Inadequate market investigations | 1.7 | 0.3 | 4 | 6 | M-L |
| Unrealistic budget allocation for mobilization and overhead costs | 1.7 | 0.3 | 4 | 6 | M-L |
| Lack of site visits | 1.7 | 0.3 | 4 | 6 | M-L |
| ***Construction stage-related factors*** | | | | | |
| Poor performance of subcontractors | 2.6 | 0.5 | 1 | 4 | M |
| Adverse weather conditions | 2.5 | 0.5 | 1 | 4 | M |
| Difficulties in procuring materials and equipments that comply with the project requirements in the host country | 2.4 | 0.5 | 1 | 4 | M |
| Tight schedule | 2.1 | 0.4 | 2 | 5 | M |
| Inexperience of the company in obtaining the required construction permits in the host country | 2.0 | 0.4 | 2 | 5 | M |
| Unfamiliarity with the construction technique used in the project in question | 2.0 | 0.4 | 2 | 5 | M |
| Unavailability of subcontractors and suppliers | 1.8 | 0.4 | 2 | 5 | M |
| Poor planning | 1.7 | 0.3 | 3 | 6 | M-L |
| Unavailability of resources | 1.5 | 0.3 | 3 | 6 | M-L |
| Technical and technological complexities | 1.3 | 0.3 | 3 | 6 | M-L |
| ***Finance-related factors*** | | | | | |
| High inflation rate in the host country | 2.8 | 0.6 | 1 | 3 | H-M |
| High fluctuations in exchange rates | 2.4 | 0.5 | 2 | 4 | M |
| Delay in payments | 2.2 | 0.5 | 2 | 4 | M |
| Low % of advance payment | 1.9 | 0.4 | 3 | 5 | M |
| Difficulties in taking credits | 1.7 | 0.4 | 3 | 5 | M |
| Unfamiliarity with the tax system in the host country | 1.5 | 0.3 | 4 | 6 | M-L |
| ***Country-related factors*** | | | | | |
| Bureaucratic difficulties | 3.9 | 0.8 | 1 | 1 | H |

[2] Average Rating on a Scale of 1-5: 1=Very Low, 2=Low, 3=Medium, 4=High, 5=Very High
[3] Severity Index: High (H) (0.8≤SI≤1), High-Medium (H-M) (0.6≤SI<0.8), Medium (M) (0.4≤SI<0.6), Medium-Low (M-L) (0.2≤SI<0.4), and Low (L) (0≤SI<0.2)

| | | | | | |
|---|---|---|---|---|---|
| Unavailability of qualified workforce in the host country | 3.7 | 0.8 | 1 | 1 | H |
| Difficulties in obtaining visa for the employees | 3.4 | 0.7 | 2 | 2 | H-M |
| Poor productivity of labourers in the host country | 2.9 | 0.6 | 3 | 3 | H-M |
| Difficulties in transporting materials and equipments to the host country | 2.8 | 0.6 | 3 | 3 | H-M |
| Bribery | 2.7 | 0.6 | 3 | 3 | H-M |
| Inadequate banking system and difficulties in money transfers | 2.5 | 0.5 | 4 | 4 | M |
| Security problems (e.g., theft, public disorder) | 2.5 | 0.5 | 4 | 4 | M |
| High commissions for construction permits | 2.4 | 0.5 | 4 | 4 | M |
| Instability of economical conditions | 2.4 | 0.5 | 4 | 4 | M |
| Poor attitude of host country | 2.4 | 0.5 | 4 | 4 | M |
| High wages of qualified workforce in the host country | 2.2 | 0.5 | 4 | 4 | M |
| Change of regulations and laws | 1.9 | 0.4 | 5 | 5 | M |
| Poor attitude towards the project | 1.5 | 0.3 | 6 | 6 | M-L |
| ***Company-related factors*** | | | | | |
| Poor productivity due to high turnover of the employees | 1.9 | 0.4 | 1 | 5 | M |
| Poor managerial capabilities | 1.8 | 0.4 | 1 | 5 | M |
| Difficulties in keeping records | 1.7 | 0.3 | 2 | 6 | M-L |
| Poor motivation of the employees | 1.7 | 0.3 | 2 | 6 | M-L |
| Poor health and safety conditions | 1.3 | 0.3 | 2 | 6 | M-L |
| ***Contract-related factors*** | | | | | |
| Vagueness of contract conditions regarding claims due to delays in payments | 2.9 | 0.6 | 1 | 3 | H-M |
| Strict contract conditions regarding delays and cost overruns resulting from design and site conditions | 2.8 | 0.6 | 1 | 3 | H-M |
| Unsatisfactory contract conditions regarding claims due to design changes and additional works | 2.8 | 0.6 | 1 | 3 | H-M |
| Unsatisfactory contract conditions regarding delays in designs | 2.6 | 0.5 | 2 | 4 | M |
| Unsatisfactory contract conditions regarding escalations | 2.5 | 0.5 | 2 | 4 | M |
| High % of retention money | 2.4 | 0.5 | 2 | 4 | M |
| Long guarantee period | 2.3 | 0.5 | 2 | 4 | M |
| Unsatisfactory contract conditions regarding fluctuations in exchange rates | 2.3 | 0.5 | 2 | 4 | M |
| Poor contract conditions that do not comply with international standards | 2.2 | 0.5 | 2 | 4 | M |
| High penalties | 2.2 | 0.5 | 2 | 4 | M |
| Inadequate definition of force majors | 2.1 | 0.4 | 3 | 5 | M |
| Unsatisfactory contract conditions regarding the dispute resolution method | 1.9 | 0.4 | 3 | 5 | M |
| Unclear contract conditions regarding the rights and responsibilities of the parties | 1.7 | 0.3 | 4 | 6 | M-L |
| Vagueness of contract conditions regarding the situations for which penalties will apply | 1.5 | 0.3 | 4 | 6 | M-L |

**Table 2**: Rank of risk factors affecting cost contingency amounts

## 5. Conclusions

Allocation of the accurate contingency amount for the bid prices in international projects plays a significant role in the project success. Review of the literature indicated that there are 59 risk factors that may affect cost contingency amounts in international construction projects. These factors are categorized into 6 groups, which include; bidding stage-related factors, construction-related factors, finance-related factors, country-related factors, company-related factors, and contract-related factors. Data of 36 construction projects completed by 20 Turkish contractors in 14 different countries were collected via a questionnaire survey, which consists of 69 questions. Reliability and ranking analyses were carried out in order to test the reliability of the questionnaire and find the relative importance of risk factors based on the survey data, respectively. The ranking results revealed that 2 out of 59 risk factors have "High", 9 have "High-Medium", 35 have "Medium", and 13 have "Medium-Low" importance levels. None of these 59 risk factors has "Low" importance level. Most of the risk factors, which have "High" or "High-Medium" importance levels, are "country-related factors". This finding may result from the fact that Turkish contractors predominantly undertake projects in either developing or undeveloped countries and adverse conditions such as low productivity, unavailability of resources, bureaucracy, high inflation rates, etc. commonly prevail in such countries. Thus, it is highly expected that Turkish contractors face problems resulting from such adverse conditions prevailing in the host countries. This study identifies the importance levels of the risk factors that may affect cost contingency amounts in international projects and establishes the framework for further studies, which aim to investigate the relationships between the importance levels of the risk factors and contingency amounts, and propose a multi-criteria-decision-making tool for predicting the contingency amount considering the importance levels of the risk factors.

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*AA070*

# Microblogging in Project Management: Improving Project Communication and Documentation with Status Information

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## Abstract
Microblogging represents a significant change in enterprise communication, shifting from a push to a pull model where information consumers subscribe to relevant information sources. Especially scenarios with high degrees in information quantity and complexity may benefit from this approach. This is the case for project management, which can well be supported by microblogging tools. This paper introduces the technology's concept, motivates use cases and discusses two examples as well as available software tools.

## Keywords
project communication, enterprise microblogging, networked communication, project documentation, team collaboration

## 1. Introduction

In recent years, modern Web 2.0 tools are being widely used in business. The successful service Twitter.com shows how the new approach of microblogging – the public distribution of short text messages – simplifies information sharing and collaboration of distributed teams. This paper has been written to help project managers to understand and successfully apply the principles of microblogging to improve project and team communication.

Following the simple principles of Twitter, microblogging is now also being used as a new means of communication in projects within and across professional organizations. Besides the support of information exchange via short messages, tagging – the simple assignment of keywords to pieces of information – becomes the core mechanism to foster project information and knowledge management.

Based on two years of practical experiences with microblogging in the IT and research sectors, this paper shows how microblogging can help to improve project communications substantially. Initially, the core elements and usage patterns of microblogging and the resulting paradigm shift from direct to networked communication will be explained. The benefits of microblogging for project management include higher transparency and responsiveness, support for self-organized and highly mobile teams, continuous documentation and networking between team members and stakeholders.

Further, the paper defines requirements for microblogging services and tools. Based on real-life project cases, the authors explain and demonstrate emerging patterns for communication, collaboration and documentation processes in project

microblogs. A brief comparison of microblogging software vendors and evaluation criteria helps with the selection of appropriate tools.

Finally, the paper discusses the effect of widespread use of microblogging on the communication culture within project teams. A guideline for successful introduction of microblogging within project teams concludes the paper.

## 2. Microblogging and Project Management

### 2.1 Basics of Microblogging

Microblogging is a technology deriving from the public internet. It's most famous example is the free service Twitter, which has defined the understanding of microblogging. This section starts with briefly introducing the concepts of Twitter-like services. Further, it discusses the applicability of microblogging in project scenarios before it finally gives an overview on available software solutions and selection criteria.

Microblogging can be seen as paradigm shift in communication principles (Barnes et al. 2010). Members have their own public microblog where they post short updates without having to address them to a special addressee. Other users can be 'followed' by adding them to one's personal network. An aggregated view of all updates by followed microblogs appears in chronological order on the user's start page. Microblogging services often support a wide range of contribution possibilities. For example, messages to Twitter can be posted via mobile text messages, desktop clients or several third-party applications (Java et al. 2007).

### 2.2 Status-quo of IT-support in project communication

Today, IT-tools are being widely used to support project communication in business environments. While telephone and email are most common, also web-based communication tools, e.g. web document management systems, wikis and weblogs have been introduced especially to support distributed project teams. Happ et. al. (2006) provide an overview of web 2.0 tools in use for project management. The main concern of these web-based tools lies in the central storage and distribution of important, mainly formal documentation.

However, many important pieces of information are being transmitted informally or ad-hoc by means of voice, instant messaging, paper notes or small e-mail messages from one person to another. These mainly small pieces of (micro) information then reside in personal mail boxes, locally stored log files and such like. As a result, they are neither accessible by other team members nor can they be easily retrieved at a later point in time. To overcome this problem, email distribution lists are being used to keep the whole project team informed. This however, commonly leads to the information overload phenomenon.

Hence, there is a need for a new means of communication that overcomes these shortcomings by providing an easy to use, structured, persistent and team-wide accessible virtual workspace for the exchange of short messages. The objective of enterprise microblogging is to fill this gap.

## 2.3 Microblogging in Project Management

Microblogging does not have a single use case. It can be characterised as typical web 2.0 platform technology which does support basic user activities which can be applied by users for their special needs (O'Reilly 2005). Therefore, it is hard to provide a universal definition for microblogging which could be applied to project management. A more promising approach is to discuss certain characteristics which can be observed at Twitter and other existing microblogging services. The following table summarizes the so derived main characteristics of microblogging and discusses their effects in business-related and project-oriented environments:

| | |
|---|---|
| Simplicity | The use of microblogging is simple and easy to learn due to the similarity to SMS, email and instant messaging.<br>Simplicity is the key success factor to achieve a high degree of end user acceptance. The effort for their creation must be minimal since the size of messages is usually very small. |
| Equality and openness | All users in a microblogging platform are communicating on an equal basis. In most cases, everybody can read or write messages. Messages are not directed to single persons but can be read by anybody instead, even by customers or suppliers if they have access to the system.<br>This openness is the key to lowering the effort for information distribution within the team. This can lead to reduced work loads for project managers regarding this task. |
| Self-organised content structures | The users themselves are adding structure to the microblogging content by assigning tags (with prefix #) to their notes. In projects, project leaders or teams regularly define common tags to be used.<br>Through user tagging, content structures are being adapted to changing situations on the fly without extra effort. |
| Task-related messages | Team members usually write short messages about their current project work. This includes status updates (task started, in progress, finished), problem reports, brief documentation of decisions taken, information on current events, etc.<br>Projects require a strong focus on their goals and the tasks defined to achieve these goals. Therefore, the use of microblogs must focus mainly on these tasks. |
| Shortness | Our case data (c.f. chapter 3) shows that microblogging messages contain in app. 75% of all cases less than 200 characters, in other cases messages are somewhat longer.<br>To avoid overloading the project team members with too much information shortness is a necessity. Through this, it becomes much easier for all team members to stay up to date with the ongoing of the project.<br>However, a restriction to 140 signs like on Twitter often is not recommendable for enterprise scenarios. |

| | |
|---|---|
| Conversations | Problem solving and decision making often require the direct and timely exchange of facts and opinions between multiple actors. Therefore, communication in microblogging is often very conversational. Current issues are being discussed in near real-time using the reply feature. This regularly includes valuable contributions from people that have not been addressed initially. |
| Confidentiality | Even if the main principle of microblogging is its openness, an important requirement in projects is to provide a communications space restricted to the project team. This is especially important in cases where non-disclosure agreements have to be obeyed. |
| Informality | Formal communication is being conducted by means of face-to-face conversations, meetings, email and written letters. In project environments, microblogging is often used for the rather informal ad-hoc communication within the team. |

**Table 1**: Characteristics of microblog-based communication in projects

Microblogging bundles the various short messages that have formerly been communicated via other means, e.g. email, instant messages or paper notes. Through this, information that was locked up in personal inboxes before is now instantly available to the entire project team and archived for later reference.

## 2.4 Software Tools for Project Microblogging

Since the launch of Twitter[1] in 2006 there were many similar projects developing microblogging tools for different usage scenarios. Significant activity can be observed in the context of so-called enterprise microblogging tools, which especially focus on the internal use in organisations, e.g. for project management. The market of these tools is manifold, as lots of vendors entered it in 2009 (c.f. Böhringer et al. (2010) for a market overview).

A basic criterion of distinction between the different tools is their business model. There are offerings based on SaaS (software-as-a-service), classical licensing, and open source with some vendors offering several models. It strongly depends on the project context which subscription model might fit best. For a smaller project with limited duration a hosted SaaS solution would be a pragmatic and fast implementation approach. However, for long-time projects or critical microblogging contents (knowledge, confidential data) this model might be too unreliable. Here, behind-the-firewall solutions based on an own installation of a license or open source product might be the best choice. While the advantages of SaaS can be found in the speed of implementation and lower cost for small projects, an own installation offers data security, access control and governance and enables integration scenarios.

Classical SaaS providers of enterprise microblogging systems include Communote[2], Present.ly[3], Socialcast[4], Socialtext Signals[5], Wizehive[6] and Yammer[7]. The three

[1] www.twitter.com
[2] www.communote.com
[3] www.presentlyapp.com
[4] www.socialcast.com
[5] www.socialtext.com
[6] www.whizehive.com

solutions Communote, Present.ly and Yammer are available as behind-the-firewall installation, too. The same goes for open source products like ESME[8] and StatusNet[9]. We suggest using three criteria in order to separate different approaches in functionality of the available tools: information management philosophy, potential for integration and security.

Based on existing market studies (c.f. Böhringer et al. 2010) there can be identified two different underlying information management philosophies: micro-messaging vs. micro-sharing. The representatives of micro-messaging understand microblogging as simplified web-based instant messaging. The focus is on speed and communication. While being very easy to use, these tools focus extremely on timely messages and therefore harden access to older information. On the other hand, micro-sharing focuses on providing reliable mechanisms for information structuring and filtering. Examples include Twitter-like hashtags (i.e. "#PM05") or groups. The figure below compares these two approaches in showing a micro-messaging (Socialcast) and a micro-sharing (Communote) tool. Socialcast has a very simple front-end which only offers a full text search, while the more complex tool Communote leverages a filter column (right) with multiple search options like keywords, tags, authors and time.

**Figure 1**: Micro-messaging and micro-sharing compared

The support of integration scenarios is another important criterion in tool selection. Depending on the project context it might be necessary to integrate microblogging with other software tools like wikis, project plans or portals. Vendors differ in the type of integration support (e.g. none/API programming/ready integration widgets and portlets) and range of available functionality.
Finally, in the context of project management, safety is an important criterion. In choosing a SaaS model, compliance with existing data protection regulations might

[7] www.yammer.com
[8] incubator.apache.org/esme/
[9] www.status.net

be necessary. Further, especially in an emerging market such as enterprise microblogging, it is likely that there will be a wave of consolidation. Therefore an export function seems to be particular important in order to prevent information loss in the event of a service's closure. Encrypted communications, secure RSS feeds and integration with existing authentication systems (e.g. LDAP) are other functional requirements related to security.

## 3. Real World Microblogging Cases

The following chapters illustrated how microblogging is being used in project environments in the IT sector and in research organisations. Other enterprise microblogging use cases are for example published by Ebner & Schiefner (2008), Reinhardt (2009), and Zhao & Rosson (2009).

### 3.1 Microblogging in IT Projects

Communardo Software is a medium-sized software vendor and IT services provider focusing on portal solutions for communication and collaboration for enterprise clients. Communardo has been using their self-developed microblogging platform Communote for app. 18 months, especially to support informal project communication in software development projects but also for team communication in the marketing, sales, human resources, research and internal services areas.
Currently 88 users are writing to app. 150 microblogging groups. More than 20.000 messages have been counted since system launch. On average, every user writes at least one posting per working day. However, the usage intensity varies depending on the role of the user within the firm. The following screen shows an example from Communardo's internal microblogging system:

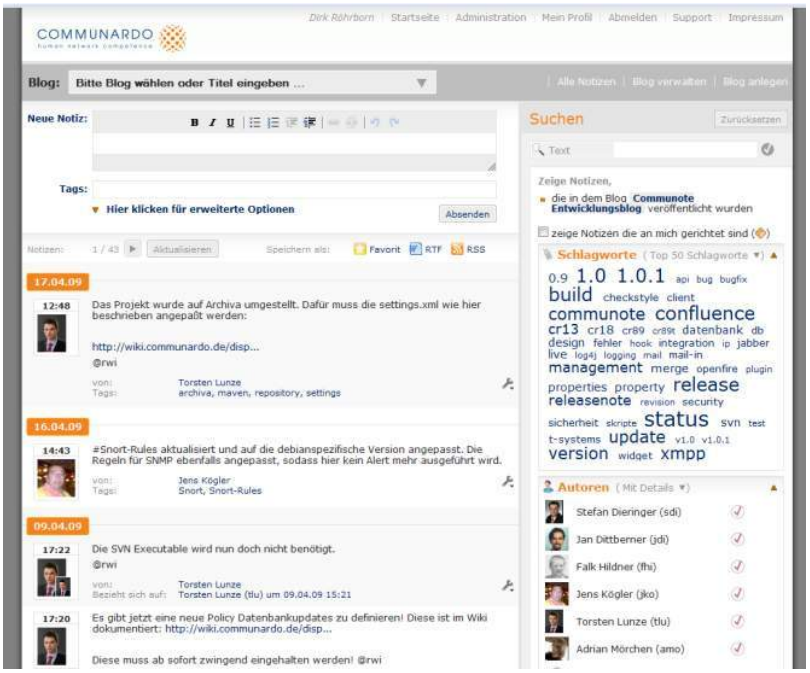


**Figure 2**: Microblogging example from a software project

The use of microblogging has changed internal communication at Communardo. Communote has grown to become the leading project-internal means of communication, whereas the use of email has been reduced significantly. Project wikis and web document management systems are being further used, especially in situations where in-depth documentation is being generated collaboratively. Email is being used mainly for written communication with customers and suppliers as well as internally for personal messages that need to be addressed to specific individuals.

## 3.2 Microblogging in Research Departments

Microblogging is a tool for organising and sharing information snippets and knowledge. Therefore it is especially suited for usage in knowledge-intensive scenarios. Given this, universities are an ideal context for such applications. Research departments are usually project-organised and employees typically are involved in a multitude of parallel projects (individual courses, student projects, practical projects, research projects). A major challenge is the integrated management of various types of information and the creation of a mutual awareness of the knowledge and the current work tasks of colleagues. The business information systems research team at Chemnitz University of Technology leverages microblogging for this task since the beginning of 2009.

Within the first year 57 users consisting of researchers, students and external stakeholders posted 3365 notices in 105 thematic groups. The microblogging tool can be considered to be the central information sharing hub. It thus reduced the team-internal email communication. Microblogging is used by team for two main use cases: The first use case is team-internal collaboration within the various projects. Individual projects will receive a special group, where external stakeholders can be added and user rights can be awarded. These groups are the place for a wide variety of project-related content like discussions, action logs, task delegation, information snippets and link recommendations. The indexing of the content (tagging) is widely used and enables the subsequent access to tagged information resource. The project groups are open to all core members of the research team so that each researcher is informed about the activities of colleagues.

The second application of microblogging in the research group is a special type of project blogs for student projects. For project works, seminar papers and bachelor/master dissertations theses special groups are created with access for the supervisor and the student. This mechanism of information organising is especially useful for the supervisor, who can see all the details of his supervised work in an integrated view and can leverage filtering. This eliminates time-consuming searching and forwarding of emails and memos.

# 4. Conclusions

Microblogging still is a very new technology. While it is the youngest member in the Web 2.0 family, it made significant impact on research and practitioners yet. Gartner (2009) forecasts the diffusion of microblogging in many enterprise systems. Our analysis showed that especially project management is an ideal domain for systems supporting information sharing and structuring. Therefore,

easy-to-use and fast-to-deploy microblogging tools could be a useful part of a project's IT infrastructure.

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*AA076*

# Consulting company practice in providing of project management specialists by masters education program

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## Abstract
IBS is a biggest Russian IT system integrator and consulting company - undoubted national leader in this area. As a project oriented modern consulting company it requires a large amount of advanced specialists with high level of competences in all fields of IT, consulting and management, particularly in project management. To provide such specialists IBS established its own Magistracy with Masters Education program in cooperation with worldwide known Moscow Institute of Physics and Technology (MIPT – "Fizteh") and Moscow Institute of Steel and Alloys (MISA). To meet specific requirements of IBS project and product portfolios not only the master's course on project management, but also wider context of all Masters Education program was developed. Special topics of project management are included in various disciplines of the program on information management, economy and finance, strategic and operational management etc.

## Keywords
Project management, Consulting, Masters Education program, Accreditation, Certification

## 1. Business model of education used by IBS

Almost twenty-year history of IBS clearly showed the shortcomings of traditional education programs of Russia's universities for the specialists in the field of management and information technology. Almost every graduate who join the company showed incompetence to participate fully in the work process. It would take a long period of retraining and additional education, which negatively influenced the financial performance of the company and, last but not least, the morale of the young colleagues.

As the strategic initiative to solve this problem IBS established the system for targeted education and training of university graduates in key areas of information technology and consulting. This education and training system realised in the form of the Master's education programs organised on the base on the innovative model of public-private partnership of IBS and leading Russian state universities.

A key element of realised IBS model of business education, presented at Fig.1, are the production units (departments) IBS, which serves several important functions in the processes of recruitment and training of students.

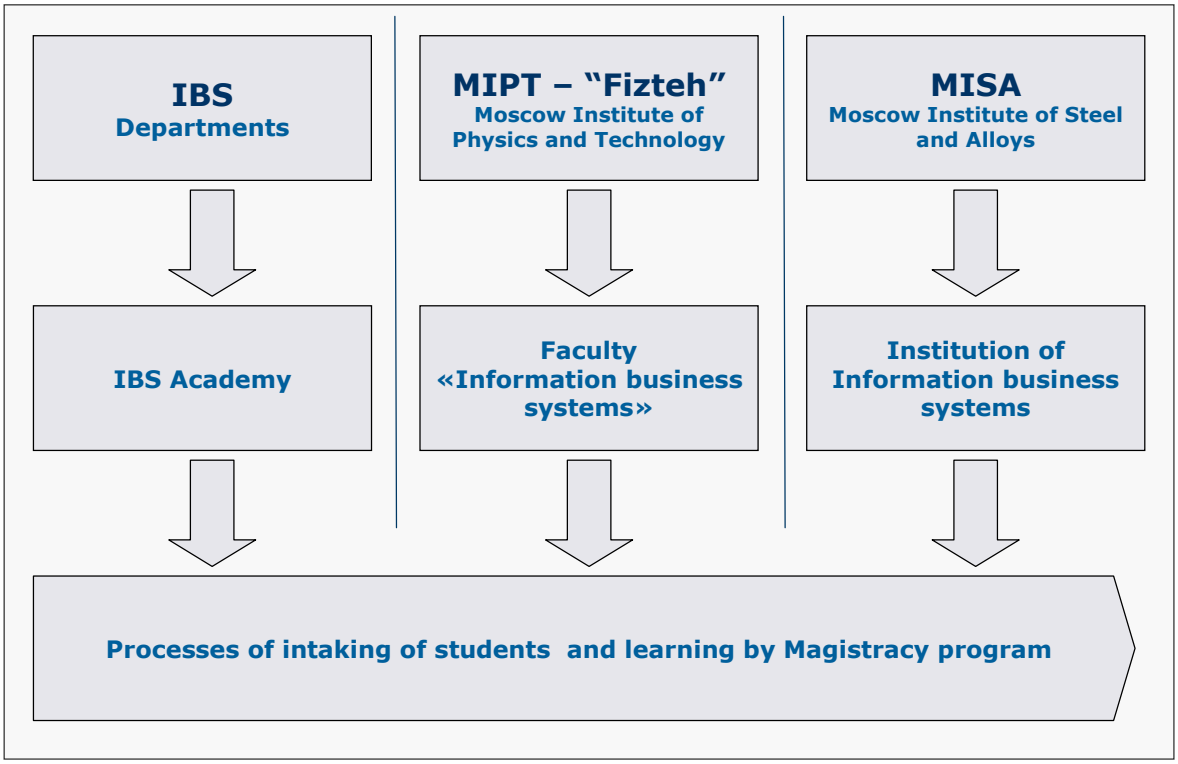


**Fig 1:** IBS Business education stakeholders

Schematically, these processes are as follows:

- IBS departments are forming the requirements for necessary competencies and make an order for the required number of Masters Education programs graduates.
- Specialised department of the company (IBS Academy) consolidates the requirements and orders and, together with the 2 leading Russian universities (MIPT and MISA) creates curricula and programs.
- Corporate faculties (departments or institutions) of business information systems, created with IBS in the MIPT and MISA (leading universities in Russia), are organising and providing education and training process according with the Masters Education programs.
- IBS business departments are actively involved in the education and training process in various forms: by providing a full-time teachers and trainers, by establishing and staffing cathedras of faculties. For example, the cathedra of management consulting almost entirely staffed by experts from IBS Management Consulting Department.
- IBS departments ensure student participation in research and commercial projects, provide materials necessary for preparing of Master's theses. Upon completion of part of education and training, students enrolled in staff of IBS departments.

Thus, IBS Business departments being customers of education and training are fully involved in the education and training process and able to promptly effect on this

process, which is especially important during the formation of Master's education programs.

## 2. Project management as a key competence of any IBS employee

Project management was recognized as one of the disciplines fundamentally important for the consulting business specialties. There are three main reasons for project management is given in IBS as so important (see Fig.2).

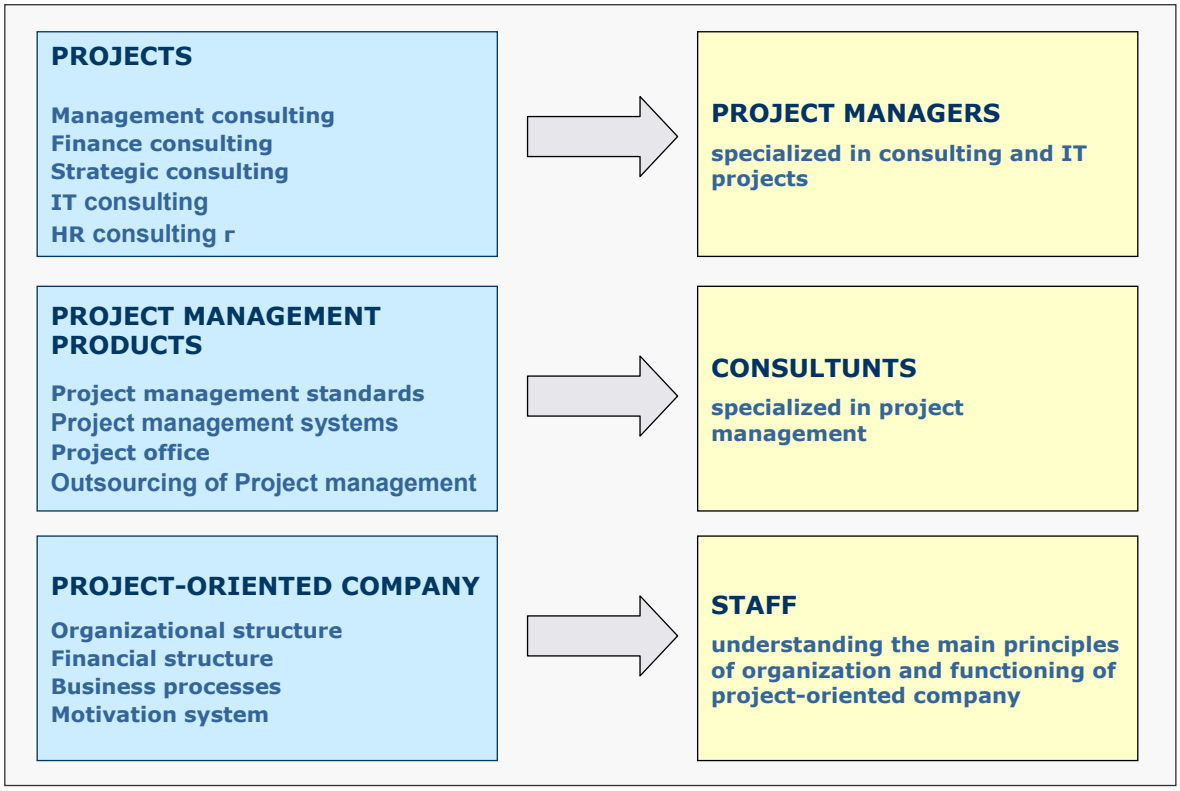


**Fig 2:** Competences in Project Management required for consulting company

First of all, IBS offers services in various areas of consulting - IT consulting, management consulting, financial consulting, strategic consulting, HR-consulting - realising annually several hundred projects of various scale and complexity. This means that one of the most in-demand positions in the company is professional project managers. However, taking into account the specificity of business, except those general knowledge and skills they have to have more and more specialisation in the field of consulting and information technology.

In addition, project management is not only a way of doing IBS business, but it is strictly IBS business – in the company's portfolio there are a number of products in the field of project management. This requires appropriate knowledge, skills and experience of the consultants associated with the development and implementation of corporate standards and project management systems.

Finally, knowledge of and ability to use to certain extent of project management methodology, approaches and tools, understanding of the basic principles of

organization and functioning of project-oriented company is important for all IBS staff, since all the company's activities are implemented in the form projects.

Unfortunately, much of the criticism for the incompetence of university graduates is regarding their poor education in project management. This, in particular, is due to the fact that the curricula of most universities in this field in its infancy, and the specialty itself "Project management" is still not recognized by the Russian Ministry of Education and State Higher Attestation Commission.

Due to this situation and based on the requirements for the competence of the IBS staff in project management, not only the course of project management was formed, but also the general context of the entire Master's program. Special issues of project management are included in the various disciplines in information technology, economics and finance, strategic and operational management, etc.

## 3. Project Management course for Masters Education program

The aim of the course "Project management in modern company" is the formation of students' holistic comprehensive understanding of methodology, instruments, tools and techniques of modern professional project management, international and national standards and on the basic principles of their use in the project-oriented companies, as well as on approaches to implementing project management systems on the basis of the enterprise project management standard.

The overall logic of the course, presented on Fig.3 in the form of "roadmap" is constructed in such a way as to consistently provide answers to the most important questions raised by many experts, involved in project oriented business activities.

First of all, this is the question "Why - project management?" Answers are described in the introduction part of the course. There are analyses of the main advantages, reasons and factors of success of professional project management, its current state as a professional discipline in the world and in Russia.

Then we try to give a sufficiently short answer to the question "What project management is?" This is dedicated to the first part of the course, which highlighted two sections. The first section describes the main provisions of the methodology of project management, international and national standards in this area, as well as a glossary of project management. The second section provides a brief overview of the development of project management models.

Next question - "How does the project-oriented company organized?" – is devoted to the second part of the course. It examined the role and capability of project management in the practice of modern companies. Material of this part of the course is based on experience and research of the IBS. Various models of project-oriented companies are considered - organizational, process, economic (Sadkov and Tsipes (2008). The key themes of this part are also are issues of harmonization of project and process approaches (Tsipes and Tovb (2005, 2009-2)), the role of projects in the strategic management of the company (Tsipes and Tsiperman (2006, 2008)), assessment of project-oriented activities (Tsipes (2004)), Project Management Office.

If project management is not seen as speculative doctrine, but as a practical tool, it is very important to find the answer to the question "How force it to work?" In the third part of the course the principles of development and implementation of a corporate standard for project management are discussed, covering all major levels of management - from policy to operational standard. As the through prevailing case, here we consider the project management standard of IBS company, the actual which evolving since 2000 (Tovb and Tsipes (2005)).

And finally, last question - "How does it work?" - is devoted to the fourth section of the course. Here, the general principles and practical examples of the development and implementation of project management systems in the Russian and foreign companies. Majority of the examples drawn from the IBS practice on development and implementation of project management standards and systems at various companies (Tsipes and Tovb (2007)).

Working program of the course includes 32 hours of lectures and 46 hours of workshops, case studies and master classes. Especially for this course is designed textbook (Tsipes and Tovb (2009)) and a set of instructional materials totalling over 500 pages.

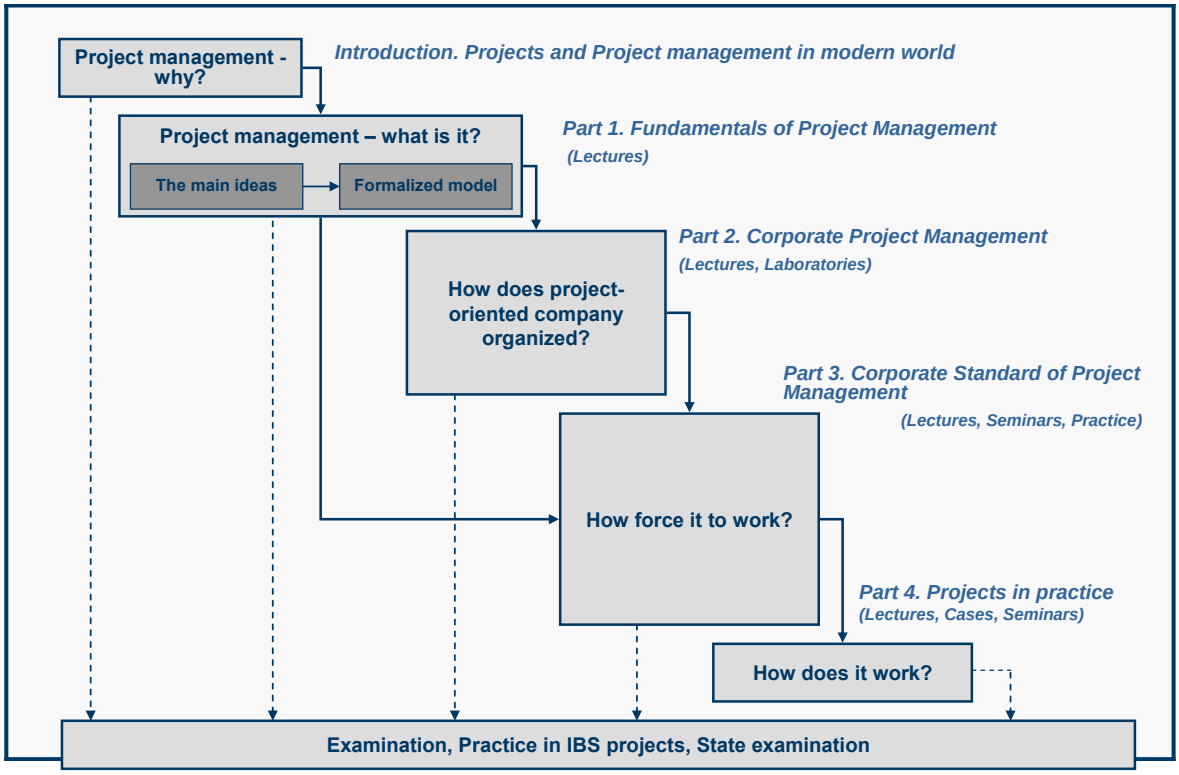


**Fig 3:** Roadmap of educational course "Project management in modern company"

## 4. Project management course in the general context of Masters Education program

Project management course is in the first semester. Throughout the first year of study, students also receive additional education and training on the project management methodology and tools in related courses. The overall structure of

master's training program consists of six blocks of disciplines, which are closely related and strongly linked to the course "Project management in the modern company" (see Fig.4). Consider some of these links.

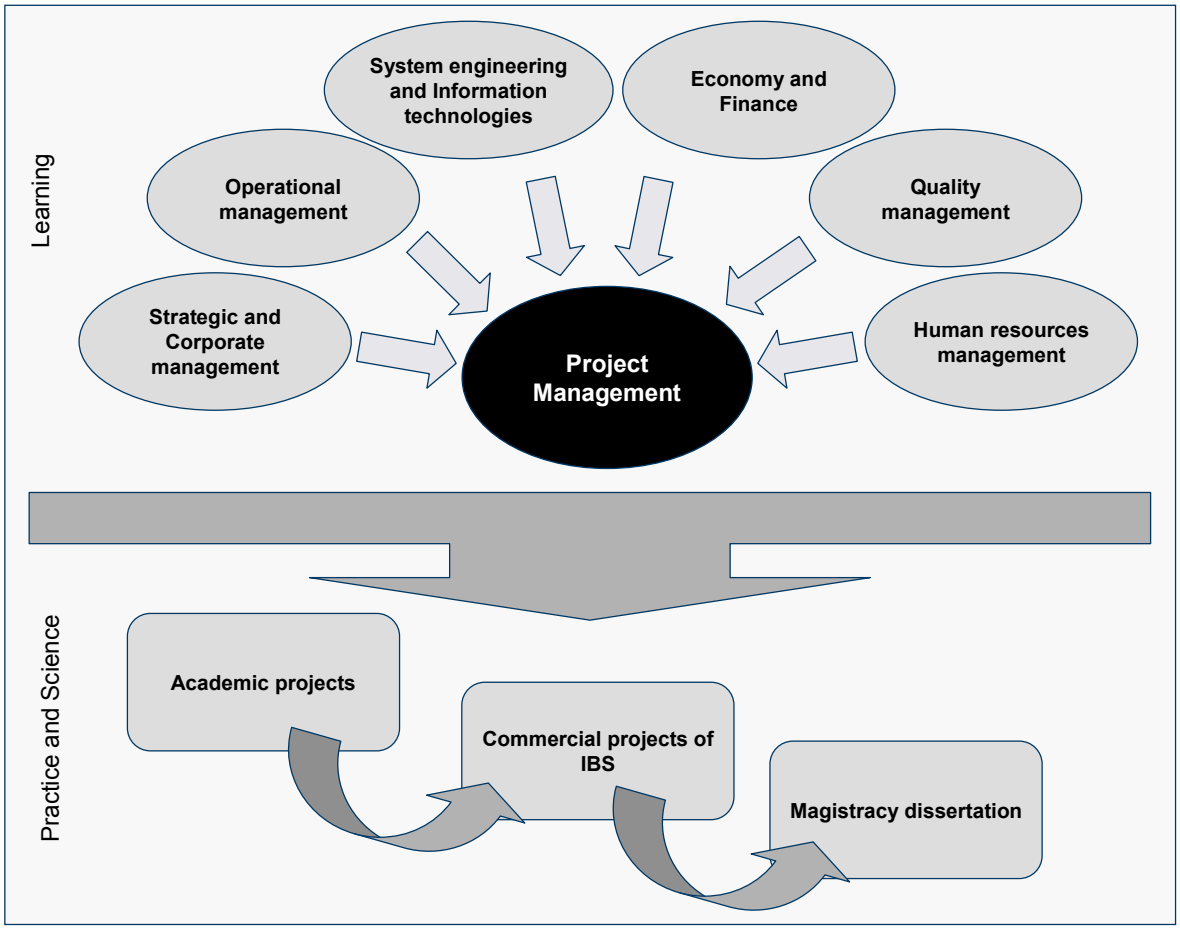


**Fig 4:** General structure of IBS Master's education program

Course of the strategic management and corporate governance allows more deeply immerse in issues of strategic project management. In particular, this course considers in details modern technology of strategic management based on Balanced Scorecard methodology, possibilities and ways of its application to governance of branch of industry and corporate programs and portfolios of development projects.

Operations Management Course focuses on situations where it is necessary to combine various organizational, methodological and software tools of the project and process management in a single system in accordance with unified corporate rules and regulations.

Students are receiving a plenty of information on project management in the course unit "Information technology". It details the specific IT industry standards for project management, especially for organization and life cycle of IT projects, the principles of activities of IT service unit in modern organisation as a unit that combines project and operational activities, etc.

Other blocks of disciplines that are shown in Fig.4 can better address the project cost management, project human resource and personnel management, project quality management, encompassing a wider context of corporate governance and management.
Much attention in the program is paid for the establishment and development of students' practical skills in project management and for work in project teams (see Fig.4). The first practical skills acquired in the scientific research projects carried out by students during the first year of training. In the second year students as IBS interns are already working in commercial projects of the IBS company. The results of these projects are the basis for preparations of master's theses, including theses on topics of project management. Typically, the dissertation research directly related to the needs of IBS in the development and improvement of product portfolio.

Control of education and training is carried out in various forms, and the final is certification for entry level of knowledge and skills in project management as part of the Master's degree state controlled examination.

IBS Master's education and training program was accredited by Russian Management Association SOVNET and received its official confirmation of compliance to IPMA ICB version 3 and SOVNET NCB requirements.

All students who successfully passed the Master's degree state controlled examination and defended his master's thesis, and receive an appropriate SOVNET certificate.

## 5. First results and lessons learned

IBS Masters education and training program operates from 2007. For three years recruitment has increased 2-fold (from 40 to 80 people), and the rate of contest (entrance exams and interviews) - more than 3 times. Plan for the year 2010 is to intake 140 people to Magistracy.

Today, two generations of graduates of the IBS Academy are working in the company – as a consultants and interns (trainees). Expectations of IBS departments in project management competencies of young staff are mainly met. Being students they can easily be included into the project teams and do not experience serious stress from work in a matrix organizational structure, where they need to be engaged in several different concurrent tasks.

It is too early to made definitive conclusions, but it may be noted for sure that we can see significant success of young employees in projects related to consulting in the field of project management and clear faculty of future project managers.

The experience gained has allowed us to identify specific ways to improve the IBS Masters education and training program in project management. Main point among these is the increase of practical side of program and amount of materials from the actual practice of the company.

## 6. Acknowledgments

We are sincerely grateful to all big team, carrying out the IBS Master's program, for the invaluable assistance rendered to us during the preparation and development of the course "Project management in modern company, and, above all, prof. A. Silantiev, prof. M. Nezhurina, Dr. I. Shcherbinina, Dr. V. Babeshko, Dr. N. Echkalova and all other colleagues.

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*INV-1*

# IPMA Moving Forward

Brigitte Schaden
*(President of IPMA, Austria)*

# IPMA – International Project Management Association – www.ipma.ch

- Mission:

  IPMA is a world leading non-profit making project management organisation. IPMA represents 50 national project management associations internationally

- Legally based in Switzerland
- Founded in 1965
- Offices in Nijkerk, Brussels, Warsaw and Beijing

# IPMA – International Project Management

- IPMA has spread from **Europe** to **North** and **South America**, **Asia**, **Africa**, the **Middle East** and **Australia**, and the number of member associations is steadily growing.
- Through IPMA, project managers from all cultures and all parts of the world can network, share ideas and bring project management forward in good co-operation.
- IPMA actively promotes project management to businesses and organisations around the world. In order to increase the recognition of the profession
  - IPMA certifies project managers
  - Awards successful project teams and
  - Provides a number of pm-publications

IPMA

# Award Gala - IPMA World Congress 2009

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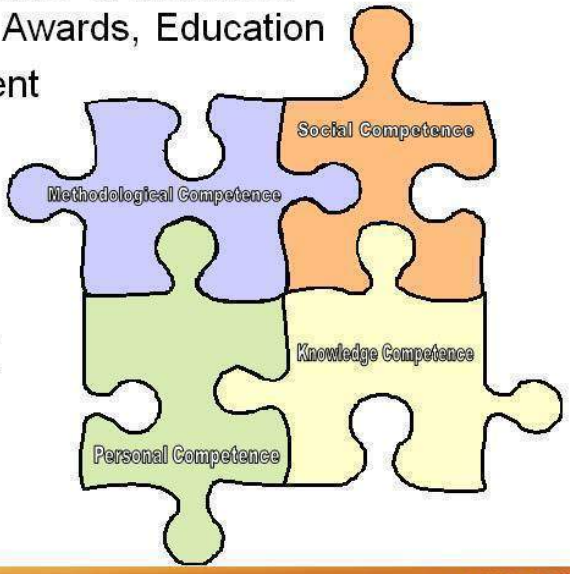
# IPMA – International Project Management

- IPMA's Strategy – a programme of Individual Certifications, Publications, Awards, Education and Research & Development

- Qualifications:
  - knowledge
  - experience
  - and competency based

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# IPMA - NING Family

- Communication
- Networking
- Sharing Knowledge

- Blogging
- Being up to date
- Sharing Pictures

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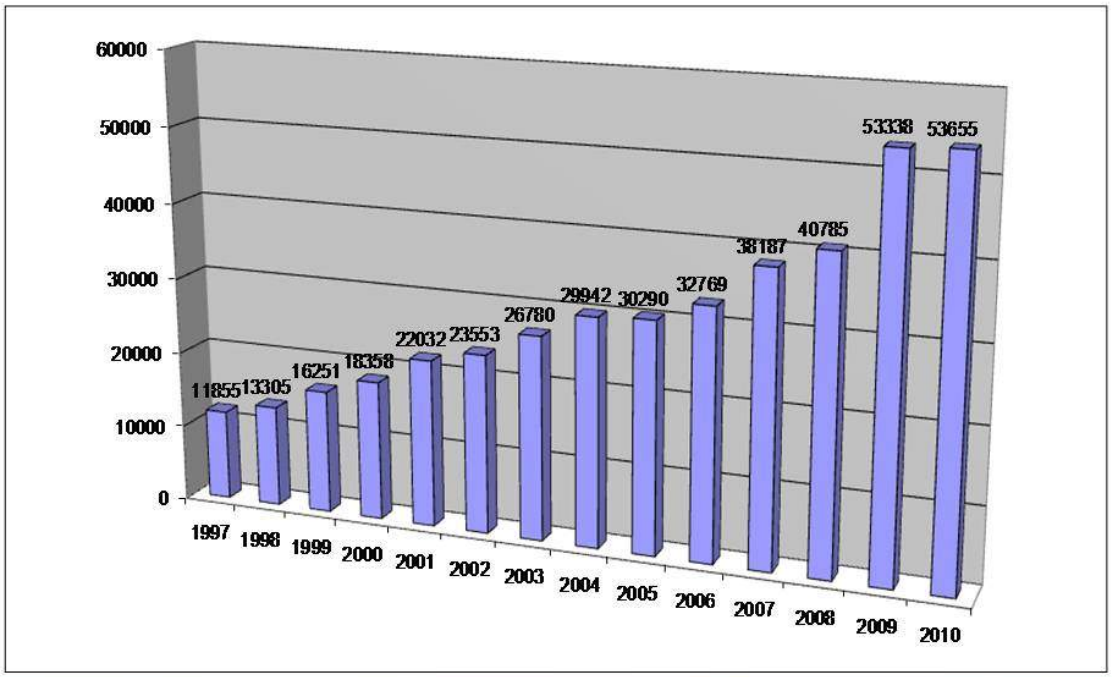
# IPMA Growth 1997-2010 (members)

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# Tomorrow's requirements - already here this afternoon!

- Mastering IT
- Language skills
- Ability to work in a cross cultural environment
- Thriving in virtual organisation – working around the clock - around the globe
- Working in matrix contexts, less and less in the line organisation
- Business understanding
  - Knowing our customers, suppliers, competitors, internal processes, logistics etc.:

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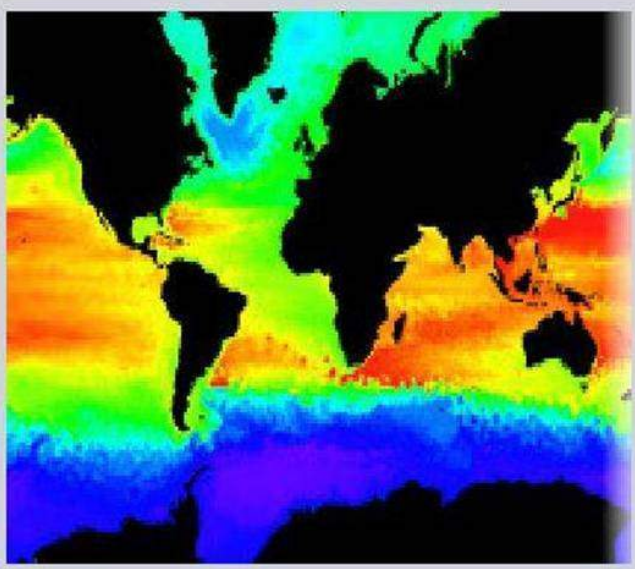
## Megatrends – the world's toughest questions: 1 - Climate Change

SIEMENS



- The average surface temperature of earth has risen by 0,76° C since 8th century
- eleven of twelfe of the warmest years since recording of temperature were between 1994 and 2005
- the greenhouse gas emission has increased massively during industrialization. Today's CO2 concentration in the atmosphere is the highest since 350.000 years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## Megatrends – the world's toughest questions: 3 - Urbanization

SIEMENS

- 2007: for the first time in history, more people live in cities than in rural areas
- today: 280 million people live in megacities (> 10 million residents)
- 2030: 60 % of the world's population will live in cities
- urban conglomerations contribute a high share of a nation's economic output: Tokyo provides 40% of Japan's GDP, Paris generates 30% of France's GDP


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## Success Factors

SIEMENS

- intercultural cooperation in all directions
- Quality Gate methodology for improved process control
- cross country deliverables need advanced logistics
- build an atmosphere of trust

PMO Siemens Global Project Management Page 7 Dr. Jürgen Schloss, CT O PM

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## Future project management: Economic realities

- High cost of capital
- Available free capacity
- Limited financial flexibility
- Talent available

- **Recession will create financial benefits for companies who start planning for future investments now**

15 June 2009
15 IPMA World Congress 2009, Helsinki

PÖYRY

## Future project management: Growth areas

- Green agenda is moving forward
- Investments required for mitigation of climate change
- Technological breakthroughs

- **Environmental and climate change agenda will fuel next growth cycle**

PÖYRY

IPMA

Superior
**Project Management Competencies**
is the (- only?) key to survive in this ocean of threats and opportunities

# Controlling the variety

*„The secret of success is not predicting the future, it is creating an organization that will thrive in a future that cannot be predicted."*

M. Hammer

Ashby's law (The Law of Requisite Variety)
*"If a system is to be stable the number of states of its control mechanism must be greater than or equal to the number of states in the system being controlled."*

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# Portfolio

- Latin „*portare*" – *to carry* & „*folium*" - the leaf
- A collection/accumulation/mix of objects of a certain type

# Project portfolio

- A project portfolio is the amount of all projects within an organization. These projects are jointly coordinated to enhance the benefit of an organization in comparison to an independent examination of each project.

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# Project portfolio

It is recommended to bundle those projects of organizations which meet the following criteria/circumstances:

- The projects are within an organization or belong to a part of an organization
- They are comparable
- There exists a dependency/connection/relation between the projects (as regards content, resources or project owner)
- Together (integrated) they generate synergies/potentials

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# Project portfolio management

## Duties/Responsibilities/Functions:

- Permanent planning
  - Definition of projects and programs to enhance the realization of super-ordinate organizational goals and objectives
  - Evaluation of submitted projects
- Prioritization
  - The approval, deferral and rejection of project proposals
- Comprehensive control (overlapping)
  - comprehensive project- and quality management of comprehensive project- and quality management functions as well as
  - comprehensive information- and knowledge-management
- Continuous surveillance of all projects within an organization

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*„There is nothing so useless as doing efficiently that which should not be done at all."*

*Peter Drucker - writer, management consultant*

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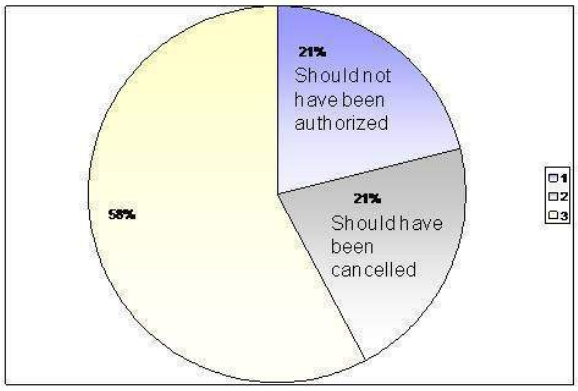
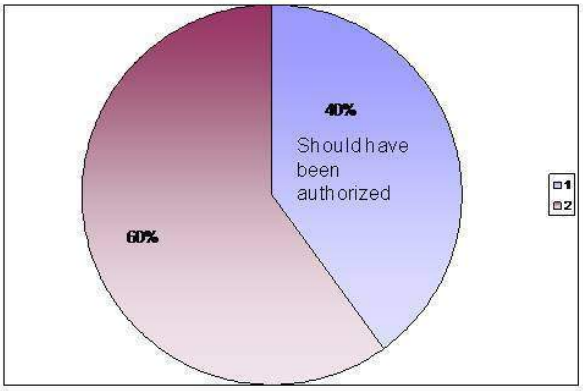
# McKinsey Global Survey (2007)

Authorized Projects




Rejected Projects

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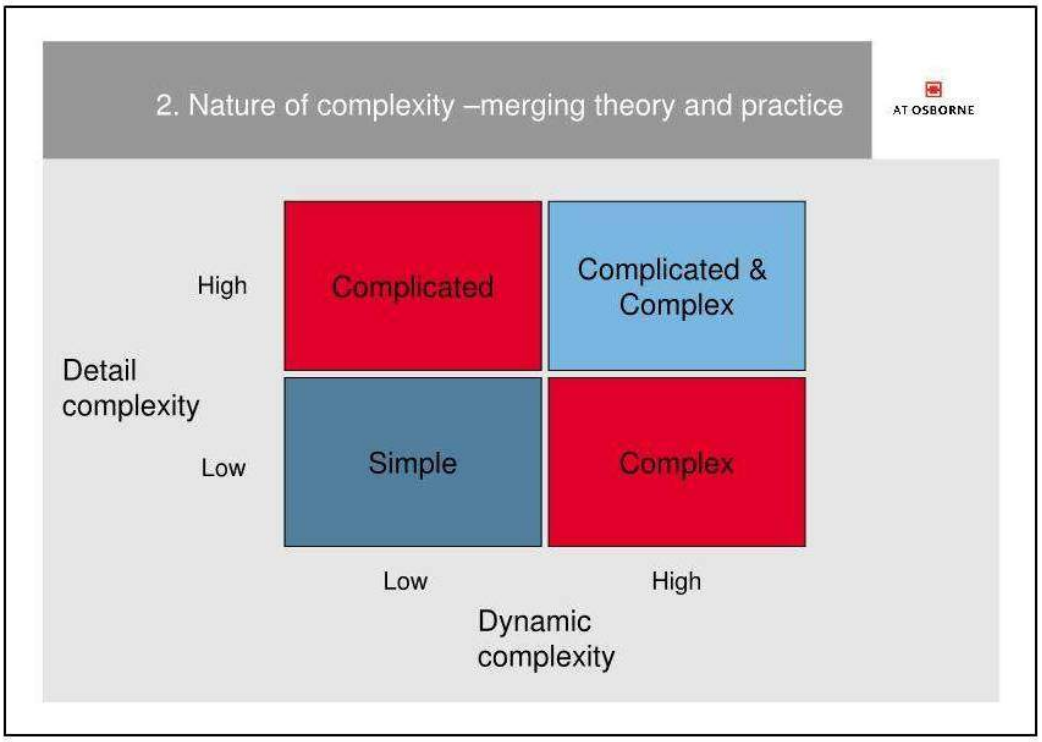


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## Project Management Certification

IPMA CERTIFICATION

- Formalized verification of your knowledge level
- Assessment of project managers' competence in management of projects, carried out through assessment of knowledge, experience and leadership behaviour

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## Benefits of PM Certification for the project management personnel

- Proof of their competence
- An internationally acknowledged certificate of their professional competence
- Personal advantages for their career path and in competition
- More success in projects
- To stimulate competence development (Certification is also a learning process)

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## Benefits of PM Certification for organisations - 1

- Instrument for focusing on PM training efforts
- To document to the market that the organisation has professional project managers
- To visualise the career process for project managers in the organisation
- To make the competence visible

## Benefits of PM Certification for the clients

- More certainty to get the state-of-the-art services from project, programme and portfolio management professionals
- Strengthening employability

IPMA

## Benefits of PM Certification for organisations - 2

- To make the organisation more attractive
- To set up demands for PM jobs
- Customer requirements
- To match the growing demand for verifying maturity both from the vendors and from the clients side (bidding processes)
- Instrument for ensuring quality in PM

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# Project Management Certification & ICB 3

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# PM Certification Processes

| Title | Capabilities | Certification Process | | | Validity |
|---|---|---|---|---|---|
| | | Stage 1 | Stage 2 | Stage 3 | |
| Certified Projects Director (IPMA Level A) | Competence = knowledge + experience + personal attitude | Application, curriculum vitae, self assessment references project list | Optio-nal | Project report | Interview | 5 years |
| Certified Project Manager (IPMA Level B) | | | e.g. work-shop, semi-nar | | | |
| Certified Project Management Professional (IPMA Level C) | | | e.g. work-shop, report | Exam | | 5 years |
| Certified Project Management Associate (IPMA Level D) | Knowledge | Application, curriculum vitae, self assessment | Exam | | | 5 years |

IPMA

# IPMA 4 certification levels

- Level A: **Certified Projects Director**
  Shall be able to manage complex project portfolios or programs
- Level B: **Certified Senior Project Manager**
  Shall be able to manage complex projects
- Level C: **Certified Project Manager**
  Shall be able to manage projects with limited complexity and/or to assist the manager of a complex project
- Level D: **Certified Project Management Associate**
  Shall have the knowledge in all competence elements and be able to apply it.

IPMA

# Entry Requirements

**IPMA Level A**
**Certified Projects Director**

Has at least five years of experience in portfolio management and/or programme management with strategic relevance, of which three years were in responsible leadership functions in the management of complex portfolios or programmes and has two years of experience in managing projects.

**IPMA Level B**
**Certified Senior Project Manager**

Has at least five years of project management experience, of which three years were in responsible leadership functions of complex projects.

IPMA

# Entry Requirements

**IPMA Level C**
**Certified Project Manager**

Has at least three years of project management experience in responsible leadership functions of projects with limited complexity. (entry requirement).

**IPMA Level D**
**Certified Project Management Associate**

Experience in the project management competence elements is not compulsory; but it is an advantage if the candidate already has applied his project management knowledge to some extent (entry requirement).

IPMA

# Process Steps for each IPMA Level

| | | Level | | | |
|---|---|---|---|---|---|
| Stage | Step | A | B | C | D |
| 1 | Application form | R | R | R | R |
| | Curriculum vitae | R | R | R | R |
| | Self-assessment | R | R | R | R |
| | List of projects/programmes/portfolios | R | R | R | O |
| | Report proposal | R | R | O | N/A |
| | People to be contacted for references (referees) | R | R | R | O |
| | 360-degree assessment | O | O | O | N/A |
| | Exam | O | O | R | R |
| 2 | Report | R | R | O | N/A |
| | Competence development plan | O | O | O | O |
| 3 | Workshop | O | O | O | N/A |
| | Interview | R | R | R | N/A |
| | Feedback | O | O | O | O |

Legend:
R = Required
O = Optional - for the CB to decide
N/A = Not applicable

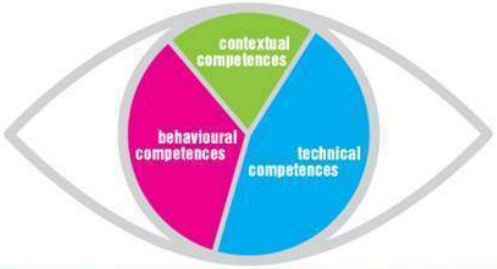
IPMA

# The ICB 3

IPMA

# The eye of competence

| | | | | | |
|---|---|---|---|---|---|
| 1.01 | Project management success | 2.01 | Leadership | 3.01 | Project orientation |
| 1.02 | Interested parties | 2.02 | Engagement & motivation | 3.02 | Programme orientation |
| 1.03 | Project requirements & objectives | 2.03 | Self-control | 3.03 | Portfolio orientation |
| 1.04 | Risk & opportunity | 2.04 | Assertiveness | 3.04 | Project, programme & portfolio implementation |
| 1.05 | Quality | 2.05 | Relaxation | 3.05 | Permanent organisation |
| 1.06 | Project organisation | 2.06 | Openness | 3.06 | Business |
| 1.07 | Teamwork | 2.07 | Creativity | 3.07 | Systems, products & technology |
| 1.08 | Problem resolution | 2.08 | Results orientation | 3.08 | Personnel management |
| 1.09 | Project structures | 2.09 | Efficiency | 3.09 | Health, security, safety & environment |
| 1.10 | Scope & deliverables | 2.10 | Consultation | 3.10 | Finance |
| 1.11 | Time & project phases | 2.11 | Negotiation | 3.11 | Legal |
| 1.12 | Resources | 2.12 | Conflict & crisis | | |
| 1.13 | Cost & finance | 2.13 | Reliability | | |
| 1.14 | Procurement & contract | 2.14 | Values appreciation | | |
| 1.15 | Changes | 2.15 | Ethics | | |
| 1.16 | Control & reports | | | | |
| 1.17 | Information & documentation | | | | |
| 1.18 | Communication | | | | |
| 1.19 | Start-up | | | | |
| 1.20 | Close-out | | | | |

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# The ICB 3

- is useful for the (self) **assessment** of the project, programme and portfolio management competence, undertaken by the candidates, the assessors and other persons
- can serve as a basis for the preparation of project, programme and portfolio management **handbooks** and other standard documents in practice
- can be used as a guide for developing **education and training** material
- is appropriate as a framework for **research**
- is suitable as a **general reference document** for people seeking information about applied project management.
- **!! is neither a textbook nor a cookbook!!**

IPMA

# IPMA certification advantages

- How the knowledge is acquired is irrelevant
- Assessment by human beings (assessors)
- Assessment of behaviour
- Feedback regarding areas for improvement
- 4 levels of certificates
- National language (cultural diversity)

IPMA

# PM Certification trends

- More mutual recognition
- Customized process
- Same process in all countries

IPMA

GAPPS
Global Alliance for Project Performance Standards

The purpose of the GLOBAL ALLIANCE FOR PROJECT PERFORMANCE STANDARDS initiative is to develop agreed frameworks as a basis for review, development, and recognition of local standards that will facilitate mutual recognition and transferability of project management qualifications.

It is intended that the framework and associated standards be freely available for use by businesses, academic institutions, professional associations, and government standards and qualifications bodies globally.

IPMA

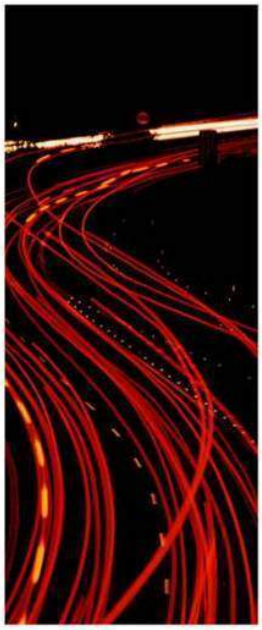
## Survey of the Deutsche Bank Research

- In 2020 the project management industry will account for 15% of the value added
- In 2007 it accounted for 2% of the value added

IPMA

## The future…

- Mutual recognition
- Co operations and alliances
- Cultural diversity
- Public sector, governments, EU, World Bank, etc.
- Certification:
  - Bidding systems, customer requirements
  - Qualification, career path



## Top Ten Trends in Project Management (1-5)

- Investment in PM training as counter-effect in economically difficult times
- Better and faster decisions on and in projects
- Critical thinking as a core PM competency
- Increasing relevance of the PMO
- Mutual dependencies between PM and business analytics

*ESI International: Diane Johnson*

IPMA

## Top Ten Trends in Project Management (6-10)

- Project managers are taking over leadership functions in organizational change processes
- Challenges regarding the communication of virtual teams
- Acquisition of PM certifications
- Controlling the overlapping functions between project managers and business analysts
- Effects of „Talent Management" on ROI

*ESI International: Diane Johnson*

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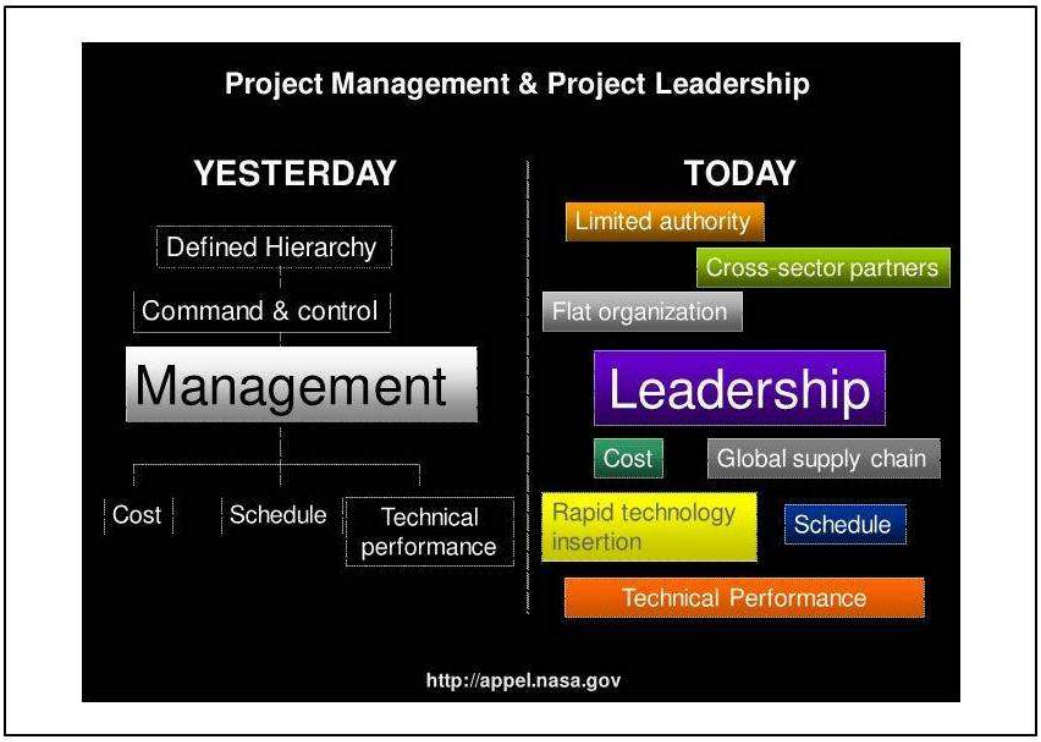
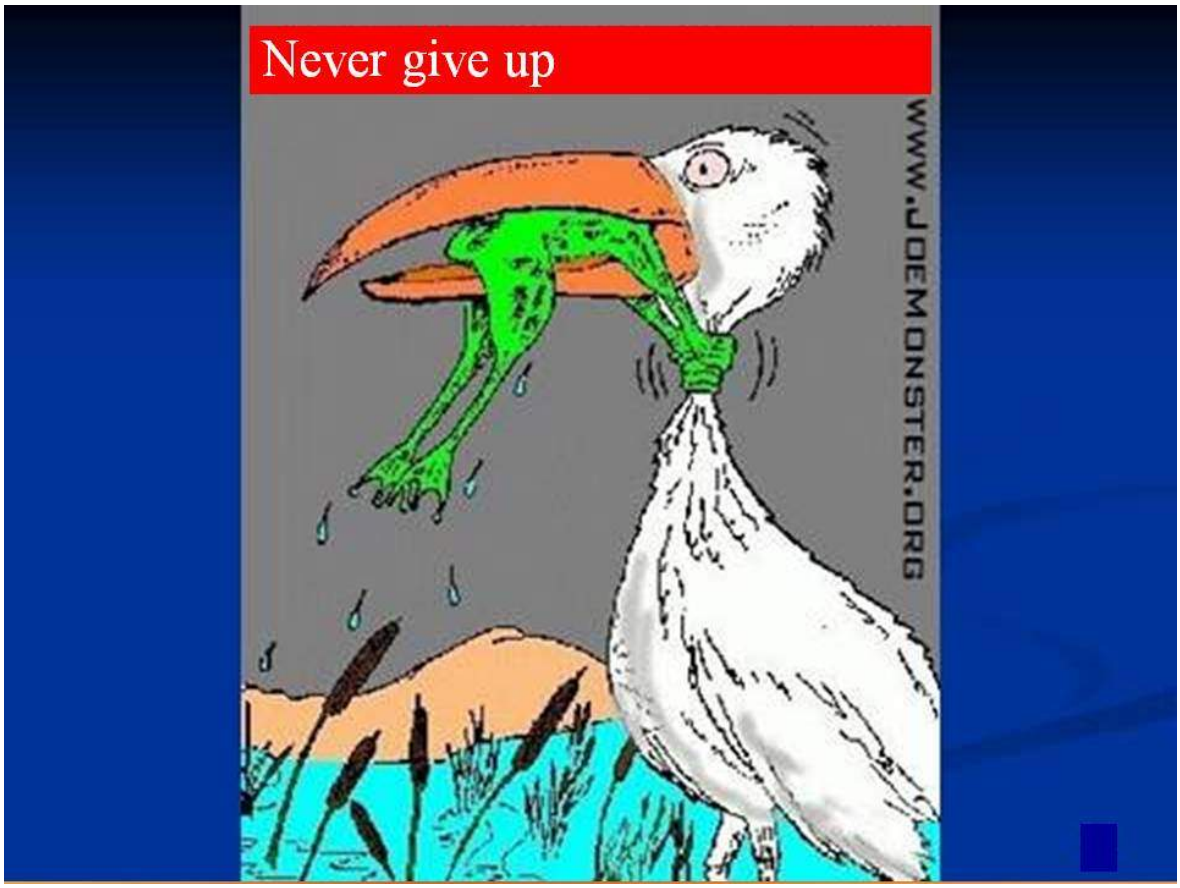


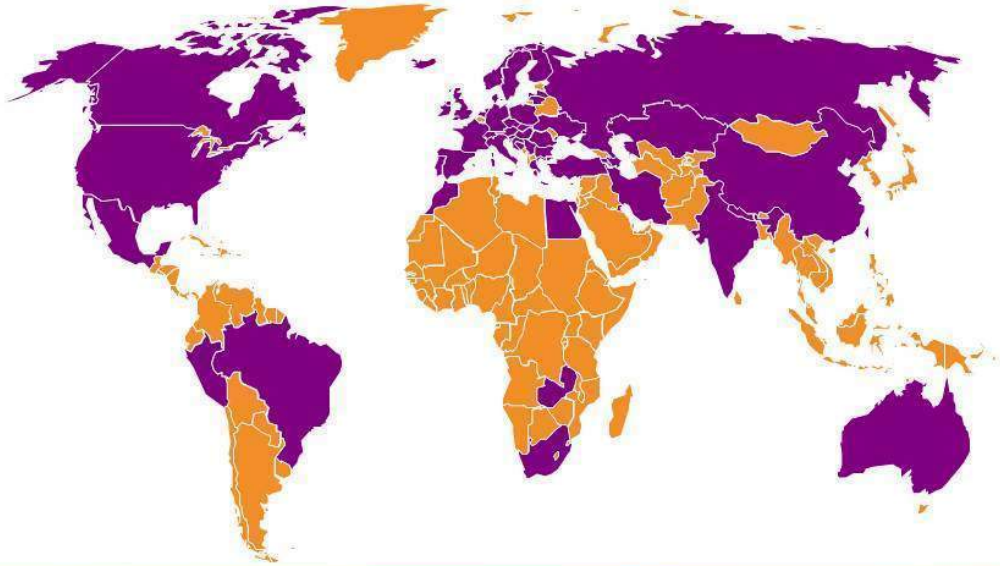

IPMA

Sven Göran Eriksson about leadership:

*„One should never believe, that one knows everything about football"*




## IPMA's World



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*AA063*

# Limits to professional Project Management

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## Abstract
This paper considers some of the factors influencing the development of professional project management. Some important limiting factors are identified. It is intended thereby that:

- A more realistic context will be used for developing the profession
- Plans for the profession's development will be more robust
- The global cost-benefit of project management will be enhanced

The content derives from extensive relevant personal experience as well as from wide reading of relevant texts. The topic is broken down into four main elements: external, internal, inherent and future.
The paper is designed for presentation rather than as an academic record of research, although reference is made to previous publications.
Although trends and limits are suggested, no firm conclusion is drawn. Rather, further consideration along similar lines is proposed.

Keywords: professional, constraints, project management, future.

## Keywords
Project management, Mediterranean, Conference, Greece

## 1. Introduction

This paper derives from lengthy involvement by the author in professional organisations in the UK. I am a chartered professional member of two organizations and am a non-chartered member of other professional organisations. In addition I have been involved in many of the activities preparing the premier UK project management organisation, APM, for chartered status, a step that will significantly raise the professional standing of project management in the UK. I have also taken a leading role in the development of national project management qualifications for the UK.

Although it takes therefore a UK centric view the paper is informed by experience of managing projects and teaching project management to a variety of curricula internationally including in countries bordering the Mediterranean, as well as by wide reading on the topic.

## 2. External context

Ur in Mesopotamia, modern Iraq, is often called the oldest city in the world. Dating back some 5,500 years it is full of projects such as ziggurats, temples, elaborate burial chambers and drainage works. Minoan civilization here in Crete emerged about the same time and we will all I hope learn more of their masterful, and seemingly more peaceful projects, whilst we are guests on this island.

The great pyramid at Giza in Egypt is younger at about 4,700 years old. Its construction is supposed to have required some 130,000 workers over the full 23 year reign of its creator Cheops. Did this need project managing? Even more demanding was the creation of the Ajanta Caves in India filled with exquisite craftsmanship. Said to be the greatest project in the history of the World, these were started about 2000 years ago and took some 500 years to build. Were professional project managers used? Jet Magsaysay, (July 1999)

In the UK we have Stonehenge, one of the most recognised monuments in the World. This dates back 4,000 years when stones weighing over 45 tons were erected and some brought from 385km away. Earthworks around the same site are much earlier, with one long barrow burial mound dated as from 6,000 years ago. Clearly long distance and astronomical surveying was an important part of the skills required at the time. Were these surveyors also the early project mangers?

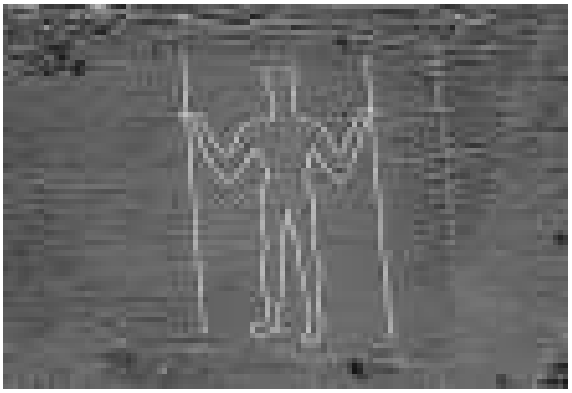

**Figure 3 The Long man of Wilmington, Sussex, UK**

Is this 70 metre high figure cut into the chalk hillside at Wilmington, Sussex, said by some to be a surveyor in fact the first representation of a professional project manager?

Proceeding from this ancient speculation we arrive at 1680 CE. According to the first English novelist, Daniel Defoe, this is the year of the "birth of the monster" of projecting humour. He admits that no age has been altogether without something of this nature but considers this date as the start of a new type of enterprise. He is more polite elsewhere in the referenced text, saying that "about 1680 began the art and mystery of projecting to creep into the world." Defoe, Daniel, (1697).

Figure 4 Daniel Defoe, 1659 – 1731

Incidentally, Defoe also characterises the building of the tower of Babel as complying with the true definition of a project, ie a vast undertaking, too big to be managed, and therefore likely enough to come to nothing. He also says of unsuccessful projects what we have often heard since "it only miscarried, or else it would have succeeded" a view which professionalism is surely trying to make obsolete.

Over the centuries we have seen great projects undertaken successfully with no public recognition of unique separate qualities required of their managers. In such fields as military fortifications and civil engineering these management skills were considered part of the primary profession.

This raises a current issue. How can professionalism of project management be harmonised between those seeking it primarily as a portable trans-sector skill and those who intend to practice purely within one application area, such as IT or construction? In this latter group we can list relevant professional organisations with project management subgroups in surveying, engineering, architecture and computing. We should note also that a programme and project management Diploma qualification is offered by the UK Chartered Institute of Management, and that this can help towards achievement of Chartered Manager status.

Interestingly the UK Government issued in 2003 the National Occupational Standards for Project Management which is cross-sectoral and provides the basis for qualifications from about Diploma level to Masters level. APM was directly involved in this initiative as were some of their senior members. ECITB (2003)

## 3. Internal

Within the project management discipline we have the well known players such as IPMA, PMI and powerful country specific agencies such as the UK's Office of Government Commerce who issue their own standards as well of course as national

project management organizations such as PM-Greece. In the last few decades considerable progress has been made towards professionalisation. The number of project managers worldwide certificated to either PMI or IPMA standards in 2007 was considered as 325,000. Chritophe Bredillet and others (2010)

From IPMA, the ICB sets out the knowledge and experience expected from the managers of projects, programmes and project portfolios. It contains basic terms, practices, methods and tools for professional project management, as well as specialist knowledge and experience. IPMA (2010). The baseline competences are allocated under three headings: technical, behavioural and contextual. These are then used to define four levels of project management competence to which some 90,000 people are now certificated according to the IPMA, 2009 4th Quarter Newsletter.

**Figure 5 IPMA PM certification levels**

This certification pattern is followed by most member associations including by APM in the UK.

Progress to highest professional status for a profession may be said to follow five steps which could well take more than 10 years. These are:

1. Organised – a recognised community of practitioners
2. Qualified – a qualification regime applies
3. Governed – the field is governed by a framework of institutions
4. Public – the profession meets its public obligations
5. Statutory – the profession is regulated by law for the benefit of the public

As part of its strong push up this progression of increasing professionalism the APM has defined five dimensions of professionalism as the focus for much of its effort. Association for Project Management, (2010) These are:

**Breadth**
The APM Body of Knowledge defines the knowledge needed to manage any kind of project. It underpins many project management standards and methods including the National Occupational Standard in Project Management.

**Depth**
The APM Competence Framework provides a guide to project management competences. It is part of your professional toolkit; mapping levels of knowledge

and experience to help you progress your skills and abilities. It is linked to the APM Body of Knowledge 5th edition and the International Project Management Association (IPMA) - International Competence Baseline (ICB v3.0). APM (2008)

**Achievement**
APM qualifications take your career in new and exciting directions. They are recognised across the profession and aligned with IPMA's 4 level Certification Program.

**Commitment**
Continuing Professional Development helps develop your project management practice. A targeted development plan will enhance your project management career.

**Accountability**
The APM Code of Professional Conduct outlines the ethical practice expected of a professional. Becoming an APM member shows your commitment to the Code and sets you apart from others.

It should be noted in relation to sector specific project management that APM, with 17.500 individual members has formal relationships with such organisations as the Royal Institution of Chartered Surveyors. One of the RICS's faculties is Project Management in the built environment which has 30,000 members, albeit these can opt for up to four faculties each.

Professionalism standards are difficult to transfer internationally. For example, recent research highlights differences in behaviour between two European countries, The Netherlands and France. The Dutch culture, focusing on consensus as a decision making process, is contrasted with the French métier culture, focusing on the quality of the result rather than on process control. The referenced paper explores how this difference impacts on project management practice. Jaqueline de Bony. (2010) Increasing professionalism globally must therefore pay full regard to national cultural differences.

Of significance in the issue of the penetration of project management in any society is the number of qualified project managers. This has been analysed for 2007 by country in relation to various measures including GDP. Greece is among the High-GDP countries for which correlations of project management deployment, ie the ratio of the number of qualified project managers to the population is negatively related to Hofstede's power distance and uncertainty avoidance scores. On power distance Greece scores 60 in a range of 11 (Austria) to 104 (Malaysia and Slovakia) whilst on the uncertainty avoidance measure Greece has the highest score of 112 in a range of 8 (Singapore) to 112. Other cultural variables, such as individualism and masculinity/femininity were found to be not significantly correlated. The conclusion of this paper also is that project management deployment policy in a country should take into consideration the correct cultural dimensions. Despite the high Greek uncertainty avoidance score, it would still seem that Greece had then considerable potential to increase its certified project management deployment. If it were to achieve the same penetration as say Portugal the number of certified project managers would increase sixfold. Chritophe Bredillet and others (2010)

Related research has examined the use of standards in project management covering process standards as well as competence standards. This finds that

standards are rarely used in project management organisations. Where used it is mainly to harmonise terminology. They are seldom used as an unmodified template but more often applied in part or as a pool of ideas. Major problems are that their implementation leads to too high costs and the lack of acceptance amongst practitioners. Professional standards will therefore need to be user friendly and be well marketed to the user community. Frederik Ahlemann and others (2009).

## 4. Inherent

An important point regarding professionalism is the difference between membership of a professional body and being a registered professional. Some professional bodies do not maintain a register of professionals with particular competences, merely keeping a list of members fulfilling the core requirements.

Typical activities of a professional body are:

- Define the core body of knowledge
- Define route to professional status
- Certify organisations as well as individuals using assessment panels
- Re-accreditation practitioners, typically using a continuous personal development process
- Serve the public as well as members
- Ensure fee and open competition in the practice of the profession
- Protect the independence of practitioners
- Educate practitioners' customers
- Comply with a governance process to maintain and govern standards
- Apply a research capacity to develop the Body of Knowledge, standards, qualification and best practice in the light of changes such as in technology and regulations
- Maintain and enforce codes of conduct
- Approve education and training products
- Cooperate with relevant organisations nationally and internationally
- Provide leadership and obtain recognition as representative of their profession.

One difficulty to be addressed in relation to project management is the variety of roles and specialisations in the profession. This includes project team member, project manager, project sponsor, projects director, PMO manager and risk management, procurement, earned value, planning and cost control. Any comprehensive certification system should allow for recognition of these roles and subjects as well as for differing grades of programme and project manager.

Another feature of project management, as for any management qualification, is the distinction between personal based competence and functional competence. This may also be described as the difference between task behaviour and contextual behaviour. The latter which is difficult to measure directly may account for some 30% of the variance in managerial performance. Divine Kwaku Ahadzie and others (2008). These attributes of competency have some similarity with Machiavelli's use of the terms Virtu as examined by Miles Shepherd (2006).

All good schemes of professionalism require the use of codes of conduct and ethical behaviour. However it should be recognised that there are major difficulties in applying codes where the country concerned suffers from poor governance standards. In this respect the Global Governance Index is relevant. This takes into account for each country measures of:

- Voice and Accountability
- Political Stability and Absence of Violence
- Government Effectiveness
- Regulatory Quality
- Rule of Law
- Control of Corruption

There is little progress that one emerging profession can achieve in a context that is hostile to professional behaviour.

## 5. Future

Even after taking into account the various considerations and constraints noted above, planners for greater professionalisation of project management should consider future uncertainties. As project managers we often need to test our models of long term projects against future scenarios. Substantial further professionalisation of project management requires a time horizon of at least 10 years. Some of the uncertainties likely to arise over this timescale are noted below.

- Project management taught to secondary level at all schools.
- Project management becomes the major subset of general management.
- Operational business is increasingly seen as just a phase of a longer project.
- What are now considered complex project management procedures and calculations become widely understood and available to non specialists. Note that Tom Peters, the well known management thinker, is quoted as saying one hundred percent of everyone's' time should be taken up by projects. Jet Magsaysay (1999)

- The common project management concepts and terminology as used in ICB and PMBoK are superseded by substantially different multi-cultural and language variations, for example in non-Indo European languages.
- Artificial intelligence replaces much project management decision making.

- Widely adopted cultural change to simple sustainability with few major projects, many of these focused on low impact technology.
- Inter-country cooperation breaks down with few effective international institutions.
- Nations and international agencies no longer form the basis of cooperation and conflict which are instead based on widespread groups not linked to countries.
- Military force becomes the major agent of change.
- Disaster and disease lead to a major reduction in world population.

Any plans for increased professionalisation should be tested against scenarios additional to ones that are either stay-as-you-are or just more-of-the-same. These additional scenarios should take account of such factors as those listed above.

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*AA016*

# Client's Critical Success Factors in Outsourcing of Construction Projects
# Case Study: Tehran Municipality

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## Abstract
To counter the competitive forces in the market, many firms re-evaluate their work by focusing on core competencies and increasing their outsourcing. Due to the project based nature of the construction industry identifying and evaluating key success factors will help top managers in implementation of successful outsourcing. These organizations primarily aim to finish their projects based on a defined scope of time, budget and quality, while accepted by the final customer.
In this paper, a conceptual framework was defined based on literature review and interview with experts' panel. Key factors related to the success of outsourced project were evaluated quantitatively in one of the largest project-based Iranian organizations, by using a questionnaire for one of their recent construction projects. Results show that successful implementation of outsourcing strategy in construction projects is strongly influenced by the level of coordination with the contractor, the contractor selection, clear project objectives, well defined technical tasks and client's top management support.

## Keywords
Outsourcing, Client, Contractor, Project management, Critical success factors

## 1. Introduction

With more competition in business environment, the necessity of utilizing other organization's competencies and skills is appreciated to provide maximum demands and requirements of clients with the minimum total costs. So besides increasing competition power of organization and agility of organization's activities, the possibility of increasing innovative potency and gaining competitive advantages will be provided.

Different definitions for outsourcing have been submitted. According to Aalders' definition, decision of an organization in respect of offering and/ or sale assets, human resources and services to a third party is called outsourcing in which the contractual party undertakes to provide and manage the required assets and services in the contract against defined income and in a certain time (Aalders (2002)). Nowadays industrial and business managers try to use outsourcing strategy; however, they encounter various challenges and problems. Managers and their consultants are trying to identify these problems to use outsourcing in a more effective manner (Thomas and Fernandez (2008)). Although widespread studies in respect of outsourcing literature have been conducted, still a comprehensive procedure for outsourcing decision making has not been developed (Vining and

Globerman (1999)). In this circumstance development of a comprehensive and systematic approach for decision making in respect of outsourcing and way of performing could be very effective in reducing risk of such decision. If set of factors most influencing on success of outsourcing of projects become demonstrated, both clients and contractors with awareness of those factors will be able to more effectively cope with the challenges in the projects and be influential on successful conduction of them. Success of a project is an abstract concept and the recognition of success or failure of a project is very complicated (Chan (1996, 1997)). However, project success concept could be assessed by performance measurement defined with various factors in different contexts.

Key success factors are the concepts that should be considered precisely to ensure success of a manager and a project. In other words, key success factors are limited complex of factors that their existence ensures the survival and success of an organization or an outsourcing project (Clarke (1999)). Since 1960 decade project management researchers have endeavoured to identify the factors resulting in project success. Perhaps it could be said that key success factor approach is the best identified approach for restraining human and organizational aspects of projects (Fortune and White (2006)).

Researches on project success factors show that preparation of a comprehensive list of these factors suitable for all projects is impossible. Because of unique features of each project, success factors differ from one project to another (Westerweld (2003)). This issue is true for outsourcing projects, too. In this regard many researchers endeavored to identify these factors in special contexts and with various approaches. Regardless of approaches and contexts, the mentioned key success factors are shown in the below table:

| **key success factors** | **key success factors** |
|---|---|
| Actual schedule | Top manager's support |
| Risk identification and assessment | Clear and actual objectives |
| Project sponsor/hero | Adequate budget |
| Organizational structure/ culture | Involvement of consumer/ client |
| Appropriate performance of suppliers/contractors/ consultants | Adequate resources/ allocated appropriately |
| Training | Effective change management |
| Political stability | Competent project manager |
| Project size/ complexity/ period of project | Skilled/ eligible team |
| Environmental influences | Appropriate leadership |
| Selection of right method/ tools | |

**Table 1**: Review of proposed success factors in project success factors literature (Fortune and White (2006))

Pinto and Slevin (Pinto and Slevin (1986)) studied project success factors from several approaches in their ten-factor model of project success. Fig. 1 shows the framework of project performance on the basis of ten project success factors.

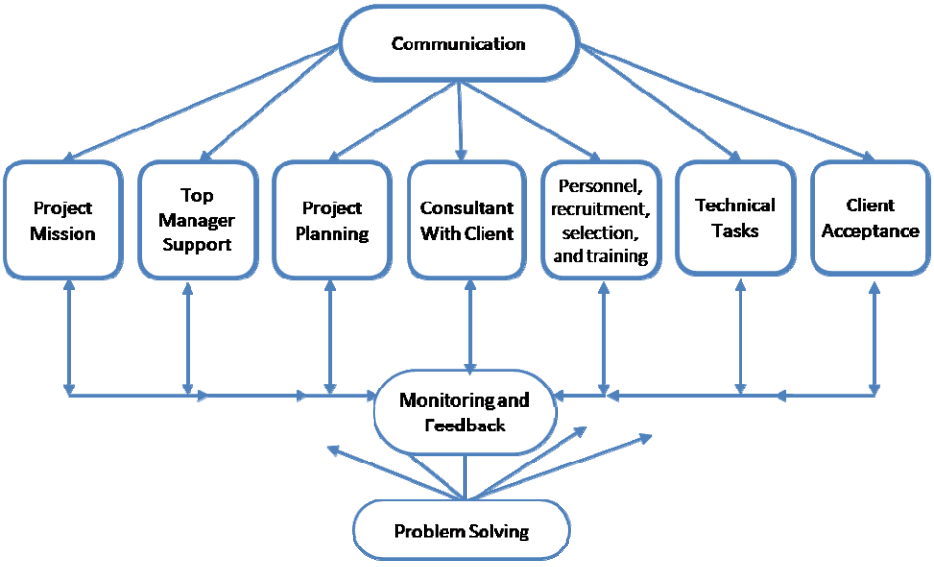


**Fig 1**: framework of ten-factor model of project performance (Pinto and Slevin (1986))

Pinto and Slevin in their proposed model considered success factors and their relation and correlation with the project success from the sight of project team including project team members and project manager. The proposed models of Pinto and Slevin were developed in great construction projects environment. In Pinto and Slevin's Model, seven factors: top manager support, project mission, planning, consultant with client, personnel, technical tasks, client's acceptance are influential subsequently and procedurally on project success during life cycle of the project, and three factors of communication, problem solving and monitoring and feedback are simultaneously influential on success in all stage of project from the contractor's sight. In table 2, the definitions of ten success factors are shown.

| | |
|---|---|
| 1. Project Mission | Clearly defined objectives and general guidelines |
| 2. Top Management Support | Willingness of top management to provide required resources and adequate authority/power for project success |
| 3. Project Planning | Elaboration of activities |
| 4. Consultant with Client | Communication, consultant and listening actively to all vital members |
| 5. Personnel | Recruitment, selection and training of required personnel for project team |
| 6. Technical Tasks | Availability of required technology and expertise for performing all defined technical activities |
| 7. Client Acceptance | Act of selling the final project to final consumers |
| 8. Monitoring and Feedback | Comprehensive control in each steps of execution process |
| 9. Communication | Providing adequate network and data for all key parties in execution of the project |
| 10. Problem Solving | Ability to manage unforeseen crisis situations and deviation from plan |

**Table 2**: Factors definition (Pinto and Slevin (1986))

The ten-factor Model of Pinto and Slevin created a new approach in project success factors context which, since then, has known and utilized as a reference in researches of this field (Anderson et al. (2006), Belout and Gauvreau (2004)) . One

of the research fields in project management is study of client and contractor relationship in outsourcing of construction projects that most researches in this field focused on feasibility, advantages and disadvantages of outsourcing (Bryde and Robinson (2005)). Currently there are few researches which clearly distinguish between clients and contractors' role in outsourcing project success (Bryde and Robinson (2005)), and in the related literature, the necessity of systematic research has been mentioned (Chan et al. (2003)).

With regard to construction projects' role in industrial developments of countries, successful conduction of these projects has a great role in economical growth of countries. Since the Pinto and Slevin's Model has been developed in construction project environment, it is appropriate to be used in this research. The ten-factor model of Pinto and Slevin is considered as a primary model in conducting of this research and the endeavor is to study key success factors in outsourcing of Construction projects from the client sight for Tehran Municipality as case study.

## 2. Research Method

The research method of this paper is case study and applied research type. For assessment of key success factors in Construction projects, first introduced factors in Pinto and Slevin's Model were selected as initial model in semi-structured interview sessions with experienced experts, in order to identify the success factors from the client approach in these interviews. The relation between factors obtained from interview with experienced experts and project success are examined through distribution of questionnaire. In this theoretical model, success means completion of a project in a defined time, quality and cost which finally being approved by client.
Since the objective of this paper is to identify the key success factors in outsourcing of construction projects, the dependent variable is success of outsourcing of construction projects.With regard to dependent variable and result of interviews with experts, independent variables of this research are key influential factors in success of outsourcing of construction projects: Mission and objectives of project (M), support of client's top manager (S), selection of contractor (C), technical and specialty tasks (T), communication management with client (R).

Since Tehran Municipality is one of the best samples of utilizing outsourcing strategy in construction projects in Iran, the domain of this research is Tehran Municipality. In this research key success factors of outsourcing of construction projects are identified and assessed in Tehran Municipality as a client of construction projects. Statistical population of this research is managers, supervisors, and technical experts of construction department of Tehran Municipality. The studied projects were ones which have been completed and were of the most recent experience of statistical population.

### 2.1 Data Collection

In this research the method of sampling is according to clustering and Snowball methods. Tehran Municipality includes 22 zones. So initially 5 zones of these 22 zones were selected by random sampling. Then in each zone, by the Snowball sampling, three of informed people in construction department were selected randomly for interview and they have been asked to introduce the other informed people. These interviews continued until saturation of information. Due to the

request of this organization to not disclose the name of projects and the interviewees in the research, their name will not be mentioned.

In continue and in the section of quantitative research, after designing the questionnaires as for results of interviews, the questionnaires were distributed among all managers, supervisors and experts of construction department of these selected zones of Tehran Municipality. The total number of distributed questionnaire was 115 and 88 people of the statistical sample answered to questionnaire. With regard to the framework of model, the data collection tools in this research are interviews with the related expert panel and also questionnaires.

## 2.2 Validity of Research Measurement Tools

In this study for consideration of validity, content validity and face validity were evaluated. In the face validity we consider whether the experts verify that the tools are measuring what is inferred from their name (Khaki (2000))? To measure the face validity, the questionnaire and its content were considered by ten experts and their comments were applied.
Content validity shows that how the description of dimensions and components of concept is (Khaki (2000)). For designing of the questionnaire, with regard to strong history of models and also with consideration of main models' variables, the endeavor was to apply element measurement indexes which are based on appropriate theoretical and their practical application in numerous researches and tests.
Since in this study, the questionnaires were provided with regard to expert panel's opinion, its validity were evaluated by one of the common methods for measurement of the questionnaire's content validity which was introduced by Mr. Lawshe in 1995. In this method, before distribution of questionnaires, its content validity was considered by ten of experts through mentioned method, and its content validity ratio (CVR) was calculated 0.74. Considering the number of experts (10), the calculated content validity ratio is more than the least content validity ratio (0.62).

## 2.3 Reliability of Research Measurement Tool

In this study, also, the test–retest method is used to estimate the reliability. Based on test–retest method Cronbach's Alpha coefficient was estimated equal to 0.819 which is above 0.7 and within the acceptable criteria.

## 3. Presentation of Results

Based on multivariate linear regression, the direct effects of independent variables on dependent variable are presented in the form of Table 3.

| Relation Direction | Estimation of Standard Parameter | Estimation of Standard's Error | t |
|---|---|---|---|
| From Project's Mission and Objective to Project Success | 0.596 | 0.083 | 6.888 |
| From Client's Top Management Support to Project Success | 0.456 | 0.081 | 4.757 |
| From Contractor Selection Method to Project Success | 0.633 | 0.057 | 7.584 |

| | | | |
|---|---|---|---|
| From Technical and Specialty Tasks to Project Success | 0.489 | 0.081 | 5.195 |
| From Communication Management with Contractor to Project Success | 0.749 | 0.075 | 10.469 |

**Table 3**: Direct effect of independent variables on dependent variables

## 3.1 Result Interpretation of the table of direct effects of independent variables on dependent variable

Value of t indicates that the assumed paths from independent variables of model to dependent variable, including project's mission and objective, client's top management support, contractor selection method, technical and specialty tasks and communication management with contractor on project success is meaningful. Therefore, the correspondent assumptions regarding each path are verified.

The total amount of Linear Correlation explaining project success through forecaster variables of mission and objectives of project, client's top management support, selection of contractors, technical tasks and communication management with client was 0.860.

## 4. Conclusion

Hypothesis' Test Results are as below:

- *Hypothesis I) Project Mission and Objective have effect on Project Success.*

The statistical result hypothesis indicates that the mission and objectives of the project has a positive and direct effect on project success. In fact, by clarifying mission and objectives of the project for contractor, the probability of project success will increase.

The intention of mission and objectives of project structure is the circumstances in which the project objectives are not only clear for client, but also clear and understandable for the contractor. Project success is defined as performing a project within determined time, quality and cost that ultimately being approved by client (Pinto and Slevin (1986)).

Comparison of test results of hypothesis with Researches of King and Cleland (king and Cleland (1983)), Baker et al. (Baker et al. (1983)), Pinto and Slevin (Pinto and Slevin (1986, 1988)) and Morris and Hough (Morris and Hough (1987)), which have accepted the direct and positive relationship between project's mission and project success, indicates that this hypothesis test results are consistent with previous research results.

- *Hypothesis II) Client's top management support has effect on Project Success.*

Client's top management support structure means type and size of support which the contractor expects from client's top management (Pinto and Slevin (1986)). The client's top management support can comprised of cases like project finance (on time payment to contractor) or support and leadership of system in determining and allocating projects and solving substantial problems.

Comparison of test results of hypothesis with Pinto and Slevin's researches (Pinto and Slevin (1986, 1988)), which have accepted the direct and positive relationship between top management support and project success, indicates that this hypothesis test results are consistent with previous research results.

- *Hypothesis III) Contractor selection has effect on Project Success.*

Contractor selection structure refers importance of method of selecting appropriate contractor, like recruitment, for outsourcing of project.

Comparison of test results of hypothesis with researches of King and Cleland (king and Cleland (1983)) and Pinto and Slevin (Pinto and Slevin (1986, 1988)), which have accepted the direct and positive relationship of recruitment, selection and training of personnel with project success, indicates that this hypothesis test results are consistent with previous research results, of course from Client's perspective.

- *Hypothesis IV) Technical and specialty tasks have effect on Project Success.*

Comparison of test results of hypothesis with researches of King and Cleland (king and Cleland (1983)) and Pinto and Slevin (Pinto and Slevin (1986, 1988)), which have accepted the direct and positive relationship of technical tasks and availability of required technologies with project success, indicates that this hypothesis test results are consistent with previous research results, of course from Client's perspective.

- *Hypothesis V) Communication management has effect on Project Success.*

Communication management with contractor means a reciprocal and continuous relation and communication with contractor (Pinto and Slevin (1986)).

Comparison of test results of hypothesis with researches of King and Cleland (king and Cleland (1983)) and Pinto and Slevin (Pinto and Slevin (1986, 1988)), which have accepted the direct and positive relationship between communication management with contractor and project success, indicates that this hypothesis test results are consistent with previous research results.

## 5. Summary

In this research, the endeavour was to consider and identify the effective factors on success of outsourcing of construction projects with use of comprehensive model of five-factor presented in theoretical framework. To do this research after semi-structured interviews with construction department's experts of selected zones of Tehran Municipality zones, a questionnaire was developed and sent to 150 other informant people in construction divisions such that at last 88 analysable questionnaires was received.

These research constraints were that the ten factors model of Pinto and Slevin was the input of interviews. So the output of these meetings was influenced by this selection and all interviewees was consider as same.

To achieve the final model, after reviewing the existed literature and interviews with experts, the model variables were analyzed. At last the model was finalized

and the result was that these five factors (communication management with contractors, contractor selection method, project's mission and objectives, technical and specialty tasks, and client's top management support) affect on outsourcing projects' success from client perspective and need more special and continuous attention from client's managers.

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# Project Management Societies and Profession

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## Abstract
This paper argues that professions are a form of occupational control. Traditional professions have exercised this control based on a common acceptance of their contribution towards society. However, newer professions, including Project Management, may not share the characteristics of traditional professions but have been able to exercise occupational control by exerting power, influence and status through professional bodies and their occupational strategies. As the use of projects has grown, so too has the view that project workers may be regarded as professionals and join organisations that mimic the structure and ambitions of professional bodies. The influence project management associations can exert can be seen as unhelpful to the overall development of the discipline being seen as restrictive if not coercive. This paper examines three models from which a set of key characteristics needed to establish occupational control is drawn. The main implications for the potential of project management as a profession are centred on adjusting occupational strategy and control.

## Keywords
Profession, Occupational Control, Occupational Strategy

## 1. Introduction

Many observers view project management as the dominant approaches to the organisation of work (see *inter alia* Lundin and Söderholm 1998, Cicmi and Hodgson 2006). A wide range of industry sectors make use of projects (Winch 1996, Morris et al 2006, Cicmil & Hodgson 2006). Project management has spread from its traditional base in defence, oil and gas, construction and engineering into sectors as diverse as education, IT, media, health care, and social services (Hodgson 2002). More and more employees find themselves redefined as 'project workers'. One result of this 'projectification' of work is that participants may consider themselves to be part of a profession and as a consequence, join organisations that mimic the structure and ambitions of professional bodies (Midler 1995). Certainly the expansion of the project form of management has coincided with a remarkable period of growth in the membership of project management associations (PMAs) and this growth underscores the importance attached to project management (Morris et al 2006). The rise of 'projectification' has reignited the debate about the potential for project management to develop into a profession, a positioning with implications for the roles of both practitioners and professional societies.

A number of fundamental questions need to be addressed: '*Is project management a profession? Can project management develop into a profession? What role can*

*professional bodies play in the growth of the project management profession and professionalism in project management?'* These are not necessarily new questions. However, the status of project management is disputed with some (e.g. Turner [no date given] and 1999) claiming that project management is already a profession while others take the opposite view. There is also doubt that the achievement of 'profession' status is either desirable or achievable (e.g. Hodgson 2002). The purpose of this paper is to provide insight into the potential for project management to develop into a profession.

## 2. Project Management, Professional Bodies and Professionalism

In modern times, the role of knowledge has been at the centre of the debate around professionalism and project management (e.g. *inter alia* Abbott 1988, Evetts 2003, Cacciatori and Jacobides 2005, Siegrist 2002). The development of project management bodies of knowledge (BOKs) has led some observers to claim professional status for the discipline. However, the lack of a coherent underlying theory has been seen as a major stumbling block for the more traditionally minded. For example Koskela and Howells (2006) argue that 'the development of a body of theory is typical of a well-established profession' and Turner (1999) claimed that for project management to become a mature profession it is necessary to develop the theoretical basis of the subject through professional institutions. Morris et al (2006) discuss the relationship between professions and knowledge in the context of project management and conclude that a distinctive and discrete knowledge area plays a significant role in the growth of a profession. In a study on the development of project management as a profession, one key aspect that Fugate and Knapp (1998) found was that all well-established professions, such as law, medicine and accounting, have unique of bodies of knowledge. Zwermann et al (2004) conclude that mastery of an 'esoteric and distinctive body of knowledge', is a key requirement in the quest for professional status. Koskela and Howell (2006) claim that the lack of a well grounded theory is a major contributor towards the frequent project failures. For some, reliance on the theoretical is a key factor distinguishing a profession from a craft.

In his examination of project management as a profession Hodgson (2002) concludes that attempts to construct project management as a profession are dependent upon its development as a discipline, not only in the sense of a 'field of objective scientific study' but also as a 'form of training and control'. For Hodgson, a key element is the strict enforcement of a body of knowledge with consistent terminology specific to project management that eventually marginalises the 'non-professionals' who do not conform to the project management model. This conclusion has significant implications for the perception of project management as a form of occupational control.

A major challenge in both the research and practice of project management is the lack of consistency and uniformity in terminology. Although there is general consensus on the common features of projects and project management, use and understanding of terminology varies widely and there is no single and consistent all-encompassing definition (Pinto 2007). For example, the definition of 'project' in British Standard 6079 differs markedly from that of APM (2004). The diversity of terms and concepts within the discipline may be drawing to an end as the International Standards Organisations develops an overarching International Standard (ISO 21500).

At present, it is clear that the main professional societies define project management terms differently (e.g. Archibald 2003, PMI 2006, 2008). Such inconsistency has implications for communication in research and practice since definitions are often linked to mindsets and philosophies (Martinsuo and Lehtonen 2007). Of course, it could also be argued that a progressive profession with an emerging and ever evolving knowledge base would have differences in terminology and these would be normalised as international agreement was achieved.

It is evident that development of project management associations (PMA) is partially hinged on the relationship between a unique body of knowledge and professional growth. Some claim that the reification of project management embeds a technicist view that hinders development and distorts views of its effectiveness (Cicmil and Hodgson 2006). Furthermore, critics point to the diversity of language indicates a lack of maturity of the discipline and thus its unsuitability for consideration as a profession.

## 3. Contrasting Views of Professions

In parallel with the emergence of 'projectification' over the past 20 years or so, the concept of professionalism has undergone substantial and critical revision (e.g. Dingwall and Lewis 1983, Durkheim 1992, Evetts 2003 and Freidson 1994 among many others). Competing and changing views of the nature and value of professionalism have emerged but its appeal remains strong (Fournier 1999).

The distinction between professions and trades has been noted since the time of Cicero and was also noted by Shakespeare. More recently, Abbott (1988) set out the characteristics of professions, drawing on work by Bourdieu (1984) and Moline (1986). Moline's discussion of the differences between a professional body and a trade organisation identify the 'ideal' profession, examples of which might be Medicine or Law. Emerging from these considerations is a notion that there exists a spectrum of occupational form that extends from the uncoordinated, individual tradesman on the one hand, through informally controlled trade bodies, state controlled registration schemes, what Etzioni's (1969) calls 'semi professions' to traditional professions on the other. Evetts (2003) traces the development of modern concepts of 'professions' and concludes that the different interpretations may be grouped under the categories of professionalism as normative value system based on (presumably) positive contributions towards society and social order; and professions as ideology; rooted in occupational control.

Critical studies in the 1950s and 1960s tended to interpret most forms of professionalism as the result of occupational power and market monopoly (e.g. Freidson 1970). This view of profession through occupational control has, as Evetts (2006) argues, been largely replaced by a return to traditional views of professionalism as normative value system. She also notes other directions in the analysis of professions: these more cautious views recognise the underlying perception of professions as knowledge based service occupations driven by new knowledge areas. The reasons for this change are diffuse but seem to originate from concept that the differences between occupational groups, and especially professions, is more one of degree than kind (Evetts 2006). Thus the idea of ranking professions, semi professions (Etzioni 1969) and crafts is seen as unproductive.

Other views of professions include the 'traits' approach and the control view. The former views professions as occupations that have particular 'traits' that distinguish them from other occupations. Various authors list these traits (e.g. Roach Anleu 1992, Hugman 1996) which usually include formal educational and entry requirements, control over a discrete body of knowledge and related skills, autonomy over the terms and conditions of practice, a code of ethics and a commitment to service ideals. This view is problematic since it was difficult to determine the differences between professions and expert occupations (Wilensky 1964 and Etzioni 1969).

The control view sees professional institutions as governing most or all of the traits, thus erecting barriers to entry through prescribing entry requirements. By controlling these barriers, they also control continued access to professional standing through continuing educational requirements, credentialing activities, ethical behaviour and (sometimes) performance standards. Thus according to Hugman (1991) power is at the centre of understanding professionalization while for Aldridge (1996), this relates the power of the occupational group to the demand for its service in the market place (1996 p201). Claims to professional status are thus strategies for exerting organisational control (Aldridge 1996, Roach Anleu 1992).

As observed by Morris et al (2006), project management draws little of its legitimacy by reference to its contribution to the public good, to an ideal social service, or by adherence to an overarching ethical code. It therefore seems reasonable to conclude that any form of professionalism in project management would be achieved through occupational control and therefore, it is crucial that the project management associations have strategies to achieve professional status. As discussed later in this paper, the potential exists to exert considerable influence on stakeholders and society at large; thereby elevating the status of project management as a profession. Conversely, this also underscores the vulnerability to changing perceptions and influence over the key stakeholders.

There are a number of models that explore the concept of occupational control. These include: the Neo Weberian model, Johnson's typology of occupational control models, and the Cruciality/Mystique model. These are briefly discussed and the implications for project management are highlighted.

## 3.1 Neo Weberian Model

This model adopts a market oriented approach based on social closure on market forces in which professionalization is viewed as an exclusionary closure of the market place using credentials as the major mechanism (Saks 1983). In its general form credentialism creates signals, conventionalised bits of information about the capacity and skill of a worker offering labour in the market place (Freidson 1987). The most impressive form of credentialism works to produce an occupational cartel, which gains and preserves monopolistic control over the supply of a good or service. The most visible method of establishing an occupational monopoly lies in licensing, a process by which a government agency grants exclusive official permission, sustained by law, to eligible individuals.

## 3.2 Johnson's Typology: Institutionalised Strategies

This model focuses on the consumer-producer relationship and the way structural uncertainty is reduced (Johnson 1972). It suggests three, not necessarily mutually exclusive, strategies for occupational control. It links professionalisation and other occupational control strategies directly with a basic market variable, namely, the consumer - producer relationship. The three models of occupational control are Collegiate, Patronage, and Mediation.

According to the collegiate view, professionalism is a form of collegiate control where the professional body acts as a registering body, where the producer-consumer relationship are controlled by means of an institutional framework based on occupational authority. Power is exerted through sanction mechanisms to control occupational and non-occupational behaviour.

Where consumers define their own needs and the manner in which they are met, the patronage model may be established. Its significance is dependent on the degree to which practice is defined by the patron as opposed to the occupation. Where fully developed, the professional elite works for the more powerful corporations, either as consultants or as employees. Advancement in the occupational hierarchy will normally be by association with increasingly powerful patrons. Corporate patronage is characterised by less stress on the pursuit of basic knowledge than by emphasis on knowledge specifically related to the needs of the patron.

Under the mediation view, occupational control is exerted when State intervenes in the client practitioner relationship and defines the needs and the manner by which these needs will be metr. Thus the state attempts to remove from both the producer and consumer the authority to determine the content and subject of practice. This type of occupational control is prevalent in areas such as health care. In these areas, the government has a political responsibility to ensure that health services are accessible to the whole population.

## 3.3 The Cruciality- Mystique Model

According to Haga et al (1974), a combination of cruciality and mystique defines a true profession. The greater the degree of each possessed by an occupation the greater its status as a profession. An occupation possesses cruciality when the service provided is seen as vitally necessary to prosperity or survival. The more crucial the matter is perceived to be, the greater the tendency to seek out the particular profession that has a monopoly over it. The mystique of a profession creates authority relationships between the participants. The consumers of the service know the problem to be beyond their own comprehension, both in terms of ability and knowledge. Professions having high cruciality and mystique wield maximum professional power. Others, considered to have low mystique and low cruciality can not rely as heavily on professionalism as a source of power in the market.

| | | **Mystique** | |
|---|---|---|---|
| | | Low | High |
| **Cruciality** | Low | Maximum Constraint on aspirations to professional status<br>E.g., public relations, librarians | Possess some form of mystery and are not among the irrevocably damned<br>E.g., watch-making, astrology, science at technical level |
| | High | The most active strivers. Lacking in perception of the need for mystique. Workplace may not allow this to develop.<br>E.g., teaching, journalism, business management | The true profession.<br>E.g., law , medicine, dentistry, architecture and accounting |

**Figure 6** Cruciality - Mystique Matrix (after Haga et al 1974)

In a sense all of these models contribute towards the notion of professionalism as an occupational strategy. Occupations strive to improve their market position and power through actions to professionalise their occupation. This sometimes brings aemerging profession into direct competition with other groups which are concurrently striving to acquire recognition in a particular field. The competition between traditional professions such as accountancy and business management on the one hand and project management on the other exemplifies such a situation.. It is evident from the models that in addition to the knowledge base, superior positioning may be obtained by emphasising the political and economic actions that allow the profession to gain recognition.

At individual practice level, it concerns the manner in which association with a particular PMA enhances the professional status of an individual. In this sense professional status is a *sine qua non* for the individual and more recently the corporate member operating in the market. This aspect of professional status is more clearly understood by considering the implications of the above models.

Occupational control as discussed in the various models is based on the three primary attributes of influence, status and power that a profession can exert on key stakeholders. Exclusive knowledge, skills and competence form the core of the potential to exert occupational control. However, the individual with the necessary initial professional education and ongoing professional development operating within a grouping of a professional body with a clear occupational strategy will find it easier to thrive.

## 4. Discussion and Implications for Project Management

In sociological studies of professions and professionalism, there is no mention of project management and Zwerman and Thomas (2001) note in a preliminary report for the Project Management Institute (PMI) that under many definitions of profession, it does not qualify for inclusion. Furthermore, in many countries, it is not even recognised as an occupational grouping for statistical reporting purposes. However, in UK, the professions are expanding rapidly. Hodgson (2007) reports that almost 400 UK-based 'professional associations' were listed in a recent report (Perren, 2000), and that around 7 million people, or 27%, of the UK working population are now identified as professionals or associate professionals (ONS,

2004). This represents an increase of 2 million (7% of the working population) over the 1998 figures. Many of these 'professions' lie outside the traditional professions; as Hodgson notes, existing as either semi-profession in the same sector or as part of the emerging groups of organisational or entrepreneurial professionals (Larson, 1977; Reed, 1996). So there is clearly demand for recognition of emergent occupations as professions. The US based Project Management Institute (PMI) has as its mission 'to further the professionalization of project management'. Zwerman et al reported that PMI provided a research grant 'to explore the lessons that can be learned from the development of the traditional professions and the activities of other knowledge based occupations in pursuing professional status in society'.

Each of the notions of profession brings its own difficulties for the occupational body. Nevertheless, the concept of professions as occupational control systems is attractive since it is straightforward to see what actions are needed to establish occupational closure. The difficulty comes with building the barriers to entry and exerting market closure effectively without support from either major users of the service or from government.

Most accounts of profession recognise the role of knowledge in achieving professional status and most also note the importance of education. Traditional professions frequently refer to their 'body of knowledge' and tend to include in this, the range of text books, research publications, reference books and journals that make up the recorded knowledge of their field of interest. Discussions of the nature of knowledge (e.g. Noneka and Takeuchi 1995) extend the 'body of knowledge' to what is known but not recorded so it is reasonable to consider that there must also be a significant body of tacit knowledge linked to any profession. Further, mastery of this body of knowledge is generally accepted as one the major characteristics of individuals claiming to hold professional status. In the traditional professions, the body of knowledge is seen as extensive, segmented and not under the ownership of any particular organisation. However, in the case of project management, the PMAs have defined their own 'Bodies of Knowledge' (BoK) and claim ownership, hence PMBOK® (PMI 2008) and others (e.g. APM 2006). The nature of these BoKs and their implementation have been criticised (see for example, Cicmil and Hodgson 2006), mainly on grounds of narrowness and the lack of research supporting them. Others (e.g. Shepherd and Johns 2006) see a case for their use to support other activities in the professional field, while Morris (2006) notes the need of practitioners and users of projects for BoKs. Whichever view is taken, there can be no doubt that many university courses are based closely on BoKs and this too is a cause for concern (Winter et al 2006).

The functionalist view of professions developed by Parsons (1964) and others see professions as fulfilling distinct organisational forms separate from other middle class occupations which support social order. In this view, professions contribute to society because of shared cultural orientation and social psychological convictions rather than leaving social order to administrative mechanisms of social control and commercial incentives. In other words, the 'profession as value system' is stronger than the more commercial perspective. Sciuli (2005 p916) argues that claims under this view are unsubstantiated and further, the functionalist school fails to adequately delineate the link between professions and the benefit they bring to society.

Freidson (1987) believes the professions serve the important function of managing conflict and crisis in society. By undertaking this function they, and society, are part of an interdependent network. He argues that professions make claims, demand unique privileges; and in return, have to perform in accordance with public

expectation, a problem for PMAs where performance is frequently seen as suboptimal. Furthermore, professions do not exist as a single entity. Instead, they consist of a dozen or a few hundred or many thousands of individuals who differ as widely as all other human beings, yet who, as professionals are expected to act in a standard manner.

Haga et al (1974) claim that professionalization is a two way process. The occupation must take action to become a profession but the public at large must accept it as such. The action usually taken may involve a combination of establishing ethical standards, establishing full-time educational establishments and organising around occupational associations that will probably certify competent practitioners. These efforts are a set of intentional actions by a group of people aspiring to a favourable position in the surrounding social and economic environment. Zwerman et al (2004) extend the range of actions to include gaining control over the name of the 'profession' and the establishment of professional societies.

Adapting to new roles and increased competition for members requires most 'professional' societies to adopt a strategic approach to planning for their future. Diverse specialisation within a single profession is increasingly common but one that is barely evident in the main PMAs. Watkins (1999) argues that it is one of the key roles of professional bodies to pull all the diverging strands of the profession together. The issue of whether, and how, to create specialist divisions will be a key concern for professional bodies in future. Members who specialise will want recognition or they are likely to form their own competing membership association. As the knowledge base of the professions continues to grow and develop in established areas, new specialist areas will continue to emerge. The danger is that their acceptance may erode the unified face that is of crucial importance to influence, power and status. Generally, where fragmentation has taken place the advantage derived from it is not clear and it is often a regretted decision: this is the point made by Hodge (NCE 2006) in relation to the construction industry. In many professions the effect of this trend has been that professional bodies have failed to provide a unified voice and so have been powerless against the effects of consumerism, managerialism, market forces and government intervention over deregulation.

For example in UK construction and property sector, the influences of the various *Monopolies and Mergers Commission* reports that abolished mandatory fee scales and pushed for delivery of professional services on a competitive fee tendered basis had an adverse effect on the influence on Quantity Surveying and Architectural professions (MMC 1977, MMC 1978). These changes relegated these professions to a secondary role and emphasised the need for a project manager to cater for the client's interests. As a reaction to these changes, the occupational strategies of both the RICS and RIBA have staked a claim to provide project management services.

## 5. Conclusions

It is clear that PMAs see themselves as emergent professions and that there is an appetite to be recognised as formal professions. The world of project management is dominated by PMI which claims some 450,000 members and credential holders (Feb 2010) and with its intention 'to further the professionalization of project management' is clearly seeking formal recognition as a profession. This contrasts markedly with the International Project Management Association (IPMA) which has

as members the national project management associations of some 50 countries. While IPMA seeks professional recognition, it is less obvious in its approach since it is constrained by its deliberately federalist structure which slows its decision processes to that of its least developed member association. Continental countries have a very different view of 'profession' so there exists a range of perceptions on the value of pursuing such an end. However, within IPMA, its largest member association, the UK's Association for Project Management (APM), is currently awaiting a decision for the Privy Council on its application for a Royal Charter, the recognition of profession in UK.

PMI appears to be pursuing a strategy of professionalization through occupational closure. It has undergone rapid expansion of its membership based largely on its effective marketing of the PMP qualification. The likely effectiveness of this approach seems questionable since there is no indication that the general public see a need to employ credentialed project managers. PMI have also undertaken research on what is needed to advance their professional claims. The conclusions of this work enumerated the steps needed for any profession to gain recognition and it is clear that most PMAs, including PMI and IPMA, have completed many of the steps, particularly with the activities around credentials, education and definition of bodies of knowledge. There remain some areas for concern, notably control of the use of the name and the development of an effective code of ethics which can be enforced. It appears therefore that efforts to achieve occupational closure are unlikely to be effective, at least in the short to medium term.

There remain two aspects of profession on which agreement has yet to be reached; at least so far as project management is concerned. First, professional status is at least in part dependent on the general public accepting that there is some benefit to be gained from the activities of 'professional' practitioners. However, there is a substantial literature delineating the 'failure' of project management to deliver successful projects. Further, there is considerable discussion on what constitutes success in project management. Both aspects have implications for the status of project management since if the general public and other key stakeholders perceive project management as of limited effectiveness, they are unlikely to support the necessary occupational closure.

The second area of debate lies in just who wants to be considered a 'professional'. It is by no means certain that all project managers, or even a substantial proportion of them actually want to regarded as professionals. There remains the view that individual project managers may benefit from increased security of employment as licensed practitioners and might attain greater personal authority within the workplace, all of which might bring increased status and reward. Set against this, some will fear the loss of individual control for the most successful practitioners and the need to accept professional liability. As we have seen there is debate of what constitutes success so the issue of liability raises an unwelcome spectre for many practitioners.

The professionalization efforts of IPMA are probably best exemplified by work currently undertaken by its British member, APM. These efforts centre on their Charter project. While some see this activity as more a commercial reaction to demands of the rapidly expanding Corporate membership than necessarily a declaration of professional intent, it has clear endorsement by its members. Others, especially those not of an Anglo Saxon upbringing, may conclude that such steps are characteristically British and that the achievement of professional status has little equivalence elsewhere.

There can be little doubt that many aspects of PMA operation are of a commercial nature. Published accounts show that certification activities make up a significant proportion of PMI's annual income and there is no reason to suppose that IPMA is any different. Supporting certification is the concept of continuous professional development. While it is acknowledged that professionals need to maintain their level of knowledge and keep current with developments, some see the need to formally document such activities as more to do with commercial operation than true need to update professional skills. Such updating can also be seen as an attempt to exert occupational closure, particularly where the range of suppliers of such 'new knowledge' are prescribed by the professional body.

One of the major activities for any PMA is the building of influence with Governments, corporations and with the general public. Some observers note that there are serious issues with senior executives' perception of project management which they perceive to be unrelated to the organisational goals. This view may be related to the nature of the PMBOK which is seen by many analysts as addressing only the operational aspects of projects. Both the British and Japanese Bodies of Knowledge take a more discursive view of the nature of projects and so address a context that is more easily related to business objectives. Although they are now broadening their credentialing scheme, PMI have marketed their main credential most effectively, it is hard to see how this single level can support a view of professional development. Although these aspects do not of themselves prevent trust and influence from emerging, they do nothing to actively build the level of influence likely to be needed to persuade stakeholders that the discipline has indeed the depth and attributes of a profession.

We conclude that while project management has many attributes of a profession, it cannot yet be considered a candidate for recognition. While PMAs are striving to achieve occupational closure, there are many aspects that prevent such closure. Control over the title 'Project Manager' has not been achieved and the certification programme is still entirely voluntary so even the most basic control has not been established. Despite this, PMAs have achieved much over the past decade. Certification schemes exist and are extremely popular among practitioners, even if they are not yet regarded as indispensable. PMAs are beginning to accredit University courses and are forging relationships with academic and research communities which may lead to broadening of the body of knowledge. The main obstacle, however, lies with the members of the project management associations. So far, there is insufficient evidence that to show that they really appreciate the advantages and responsibilities that professional status bring.

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# Enterprise Resource Planning Systems for Project-Based Firms: Costs, Benefits & Implementation Challenges

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## Abstract
Enterprise Resource Planning (ERP) systems are configurable enterprise-wide information system services that integrate information and information-based processes within and across functional areas in an organization. They have been widely adopted in many organizations and accepted as a *de facto* industry standard for the replacement of legacy systems. This paper analyzes and presents the costs and benefits of ERP systems for project-based industries, which have lagged behind other major industries in adopting ERP systems due to their project-centric nature and the high stakes involved in ERP implementation. The challenges during the process of ERP implementations are also identified as part of the effort to understand the implied costs of an ERP system. The evidence of the costs and benefits is drawn from previous studies and the analysis of the prevailing working practices in project-based firms. The classification of the costs and benefits constitutes a cost and benefit taxonomy which can be used to enable executives in project-based firms to make informed decisions on their ERP system investments.

## Keywords
Enterprise Resource Planning (ERP) System, Cost-Benefit Analysis, Project-Based Organization, System Implementation

## 1. Introduction

Since the 1990s, Enterprise Resource Planning (ERP) systems have become a de facto industry standard for replacing legacy systems and been perceived as the prevailing form of business computing for many large organizations in the private and public sectors (Gable, 1998; Parr & Shanks, 2000). ERP systems are designed and configured to achieve seamless integration of all of the information flowing through an organization, by integrating information-based processes within and across different functional departments, such as accounting, finance, human resources, manufacturing and distribution. They also connect the organization to its customers and suppliers and thus enable the integration beyond organizational boundaries. They are multifunctional in scope, integrated in nature, and modular in structure (Mabert, Soni, & Venkataramanan, 2001). According to an AMR research, the total application revenue in the global ERP market was $28.8 billion in 2006; it was projected to increase to $47.7 billion in 2011 (Jacobson, Shepherd, D'Aquila, & Carter, 2007). Indeed, the ERP market is the largest segment of the applications budget (34%) in business organizations, with ERP penetration at 67% among large companies (Sirkisoon & Shepherd, 2002). ERP is also increasingly deployed in

small- and medium-sized companies, as ERP vendors turn their sights to smaller enterprises with tailored products for new business growth.

The adoption of ERP systems in project-centric industries appears to have been lagged behind other major industry sectors, such as manufacturing and financial services. Project-based organizing is found in a wide variety of industries, including architectural & engineering design, construction, aerospace & defense, professional services, entertainment, technology, etc. In project-based firms, the project, which is defined as "a temporary endeavor undertaken to create a unique product, service, or result" (PMI, 2008), is the primary unit for production organization, innovation, and competition. Hence project-based firms are distinguished from those organizations that are primarily based on and profitable from continual business operations, in which ERP system implementations have been more often documented. A study on ERP adoption by European midsize companies indicates that the project industry had the lowest ERP penetration rate at the time the survey was conducted (van Everdingen, van Hillegersberg, & Waarts, 2000). Another study states that few organizations in the construction industry, which is ubiquitously composed of project-based firms, have implemented ERP systems, despite wide awareness of such systems (Ahmed, Ahmad, Azhar, & Mallikarjuna, 2003). There is also room for growth in the ERP market in aerospace and defense companies, most of which are project-oriented (Botta-Genoulaz & Millet, 2006).

ERP systems, if successfully implemented, can bring substantial benefits to organizations. By providing real-time, organization-wide information access, ERP systems have the potential to improve organizational effectiveness and productivity, enable the management to make informed decisions, and enhance the competitiveness of the organization in the market. However, their implementations are often characterized with large capital outlay, long implementation period, high complexity, and proneness to failure. It has been reported that the average duration for ERP implementations was about 18 months and that the average cost was about US$ 6.2 million (Panorama Consulting Group, 2010). This might keep many project-based companies from adopting ERP systems due to their limited financial, technical and human resources, and aversion to risks. Without essential awareness of the benefits ERP systems can bring and the stakes involved, project-based firms either rush to implement an unsuitable ERP system that may result in cost and schedule overrun, abandonment of the project, or unrealized returns; or simply refuse to take advantage of ERP systems and risk losing business competitiveness and growth opportunity in the marketplace. Therefore, it is very important to fully understand and thoroughly evaluate the costs and the benefits of ERP systems before making the decision on whether to adopt an ERP system in the organization or which ERP packages and modules to be selected and implemented.

## 2. Research Design

The main objective of this study is to identify and analyze the full spectrum of costs and benefits of ERP systems in the context of project-based firms. Enumeration of costs and benefits is the prerequisite of sound cost-benefit analysis and many other kinds of economic or financial techniques in capital project decision making, such as Net Present Value (NPV) and Internal Rate of Return (IRR) methods. The indentified costs and benefits of ERP systems constitute a comprehensive taxonomy. In addition, the challenges to ERP implementation in project-based firms are discussed, considering the specific conditions of such firms.

The costs and benefits of ERP systems are identified and analyzed from the point of view of senior management and/or owners of project-based firms, who make the decisions on ERP investment. The evidence of ERP costs and benefits are primarily drawn from extant literature. There have been a large number of journal articles and conference papers related to ERP systems and their evaluation, selection, implementation, and use in recent years. However, most of them are placed in generic organizational environments and few addresses ERP systems in project-based firms specifically. In this study, the costs and benefits of generic ERP systems are considered to apply to project-based firms. Further, those costs, benefits, and issues more likely to be associated with project-based firms are elaborated in conjunction with the analysis on the prevailing working practices and characteristics of project-based firms. There are also numerous publications generated by ERP vendors and consulting firms, in the forms of white papers, case studies, presentations, and so on. These publications, although suffering from the lack of independence and objectivity, have been cited by researchers now and again and could provide useful references as well.

## 3. Benefits of ERP Systems

The benefits of ERP systems have been constantly advocated and reported by ERP vendors and consultants. These benefits are generally supported by the post-implementation performance of ERP systems and improvement of productivity and profitability of the hosting organizations. Davenport, Harris, & Cantrell (2002) propose a pyramid illustrating how the value from enterprise solutions, among which ERP system is the backbone, is achieved (see Fig. 1). The benefits of ERP systems are realized, in other words, the value is achieved, by the following three means: integration of information system, data, and processes among different organizational units and with existing organizational environment or external

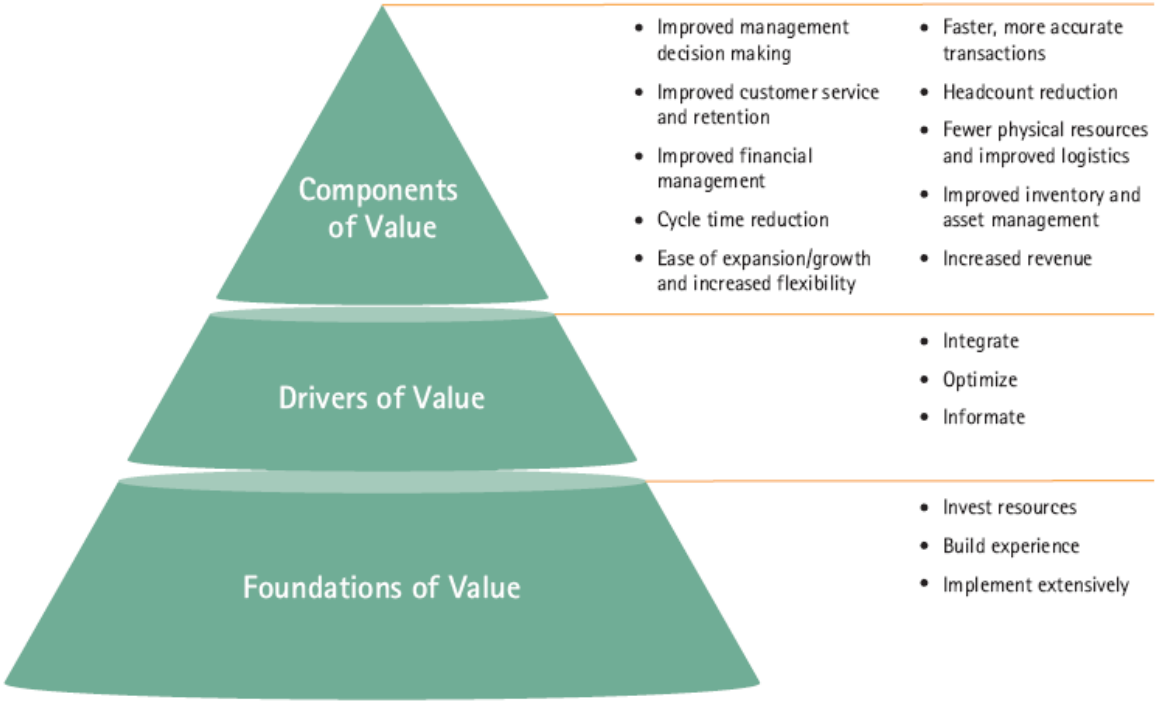


Fig. 1: Value of enterprise solutions (Davenport, et al., 2002)

stakeholders; optimization of business processes using best practices or fitting the business needs; and transforming data into context-rich information and knowledge that support business analysis and decision making (termed "informate") (Davenport, et al., 2002). There have also been attempts to systematically identify the benefits of ERP systems. Fig. 1 lists 10 types of benefits as components of value. Shang & Seddon (2000) presents a comprehensive framework for classifying ERP benefits; according to the framework, 5 dimensions of benefits are proposed, which could be further classified into 25 sub-dimensions. This framework provides a basis for analyzing ERP benefits in project-based organizations.

Cost and cycle time reduction are the basic operational benefits of ERP systems. There are numerous studies stating that investment in information systems to automate transactions can speed up processes, substitute labor, and increase operation volume (Brynjolfsson & Hitt, 1996; Shang & Seddon, 2000). Unlike retailing companies that sell a wide variety of identical products to a large base of customers, project-based firms operate by providing specific services, products or other results, which are highly customized and seldom duplicable; and their customer base is usually much smaller. Thus it is very important for them to ensure the quality of every product or service and retain customers or clients. The capabilities of ERP systems to reduce duplicates and errors and enhance responsiveness to customer needs can help project-based firms to improve productivity and quality and retain customers. Besides, risk reduction is regarded as an additional benefit of ERP (SAP, 2010). By providing real-time information as well as analysis and reporting tools, ERP systems can help management to better forecast or detect risky issues and take preventive or corrective measures in time.

Since project-based firms are composed of dispersedly located teams undertaking different projects that have loose coupling with each other, these project teams normally enjoy considerable autonomy (Bresnen, Goussevskaia, & Swan, 2004). This makes lots of firms essentially decentralized. Indeed, conflict and abrasion frequently occurs among different projects in a firm (Kodama, 2007). By storing and managing all the data in a centralized database and providing built-in data analysis capabilities, ERP systems can enable both project managers and senior executives to better manage the resources (asset, inventory, workforce, etc) within a project team and also among different teams, measure and control individual and team performance, and make better informed decisions. In addition, project cost management applications that are widely in use today may be confined to a single project or a number of them; they cannot provide a holistic view of corporate financial status or effectively manage all the financial assets and liabilities of the firm. In contrast, ERP systems have been proven able to effectively and efficiently manage the finance of a whole organization (Davenport, et al., 2002). Therefore improved financial management is considered as a separate benefit.

Rackoff, Wiseman, and Ullrich (1985) proposed five strategic thrust areas where a company could make a major offensive or defensive move: differentiation, cost leadership, innovation, growth, and alliance. As stated by Shang & Seddon (2000), ERP could assist in achieving these strategic benefits, although the benefit of product differentiation is questionable as the products of project-based firms are always differentiated. Powered by the up-to-date information of ERP systems and the increased processing capacity, it is possible for project-based firms to respond quickly and competitively to new opportunities leading to business growth, such as bidding on new projects. Such growth can lead to worldwide expansion, as ERP

systems are capable of supporting global operations. The need to achieve project objectives that fully address key stakeholder expectations throughout the project lifecycle has been stressed in previous studies (Bourne & Walker, 2005; Cleland & Ireland, 2006). Thus the benefit of ERP to build external linkage is of significance to project-based firms. Besides, ERP systems can help align business strategies with daily operations of an organization (SAP, 2010). Another benefit is that, as Internet becomes indispensable and ubiquitous today, web-enabled ERP systems can integrate or support e-Business.

ERP systems, with integrated and standardized application architecture, provide an infrastructure that could support 1) business flexibility for current or future changes, 2) reduced IT costs and marginal cost of business units' IT, with the high integration cost eliminated and the need to purchase third-party software diminished, and 3) increased capability for quick and economic implementation of new applications (Shang & Seddon, 2000). With organizational structure adjusted and business process reengineered according to the best practices embodied in the system, ERP implementation can support organizational changes and enhance corporate governance. Other organizational benefits include facilitating learning, empowering employees, building a culture with common visions, and improve employee morale and retention (SAP, 2010; Shang & Seddon, 2000).

Based on the above analysis and adapted from the framework developed by Shang & Seddon (2000), Table 1 lists 28 types of ERP benefits categorized into 5 dimensions. While the majority of these benefits are put forward from generic organizational environment, they could be evaluated in the context of project-based firms. Davenport, Harris, & Cantrell (2002) argue that increased revenue is a component of ERP value. Integrated business processes can enable an organization to provide new offerings of products or services or exploit new channels, thus generate extra revenue. Nonetheless, this is covered by other benefit sub-dimensions such as business growth and productivity improvement. There are also studies that support positive connections between ERP and improved liquidity (Matolcsy, Booth, & Wieder, 2005), and ERP and increased profitability (Hendricks, Singhal, & Stratman, 2007; Matolcsy, et al., 2005). Similarly, they are considered as the results of benefit realization rather than benefit themselves in this study.

| **Dimensions** | **Sub dimensions** |
|---|---|
| 1. Operational | 1.1 Cost reduction<br>• Labor cost (headcount) reduction<br>• Inventory cost reduction<br>• Administrative cost reduction (e.g. printing, office supplies, travel)<br>1.2 Cycle time reduction: faster project delivery<br>• Cycle time reduction in customer support activities<br>• Cycle time reduction in employee support activities<br>• Cycle time reduction in supplier support activities<br>• Cycle time reduction in support activities with other external partners or stakeholders<br>1.3 Productivity improvement<br>• Increase in products produced, or service provided, per employee or labor cost<br>1.4 Quality improvement<br>• Error reduction<br>• Duplicates reduction<br>• Accuracy or reliability rate improvement<br>1.5 Improve customer services and retention<br>• Ease of customer data access and inquiries |

| | |
|---|---|
| | • Improved ability to retain customers<br>1.6 Reduce business risks<br>• Better risk forecasting<br>• Improved response and responsiveness to risk occurrence |
| 2. Managerial | 2.1 Better resource management<br>• Better asset management<br>• Better inventory management<br>• Better production management for optimized supply chain and production schedules<br>• Better workforce management<br>• Few physical resources/better logistics<br>2.2 Improved planning and decision making<br>• Improved strategic planning and decisions<br>• Improved operational decisions<br>• Improved customer decisions<br>2.3 Better performance measurement and control<br>2.4 Improved financial management<br>• Improved financial budgeting and analysis<br>• Better management of financial assets and liabilities<br>• Centralized and real-time financial reporting and performance evaluation |
| 3. Strategic | 3.1 Improve alignment of strategies and operations<br>3.2 Support business growth<br>3.3 Support business alliance<br>• Consolidate newly acquired companies into standard business practice<br>• Collaborate with external parties for joint projects<br>3.4 Build business innovations<br>• Enable new market strategy<br>• Build new process chain<br>• Create new business<br>3.5 Build cost leadership<br>• Achieve economies of scale<br>3.6 Generate or enhance product differentiation<br>3.7 Build external linkage (with customers, suppliers, contractors, collaborators, etc.)<br>3.8 Enable worldwide expansion and operations<br>3.9 Enable e-Business |
| 4. IT Infrastru-cture | 4.1 Increased business flexibility<br>4.2 Reduce or optimize IT spending<br>4.3 Increase IT infrastructure capability and adaptability for implementation of new applications |
| 5. Organizational | 5.1 Support organizational changes and corporate governance<br>5.2 Facilitate business learning and broaden employees' skills<br>5.3 Empowerment<br>5.4 Changed culture with common visions<br>5.5 Changed employee behavior with shifted focus<br>5.6 Better employee morale and satisfaction with improved retention of top performers |

Table 1: Taxonomy of ERP Benefits, adapted from Shang & Seddon (2000)

## 4. Cost of ERP Systems

Compared with typical software licensing and installation, ERP systems are much more expensive to acquire and implement. The total cost of ERP project varies in a wide range, from hundreds of thousands of US dollars for a single ERP module implementation in small firms, to the magnitude of over one billion dollars for

complicated global ERP roll-outs in multinational corporations. ERP cost depends on many variables, such as the ambition of the project, the number of the organization units the system will serve, the number of modules installed, the amount of integration required with legacy systems, the readiness and extent of organizational changes in terms of structure and business processes, the scope of software modification and customization, etc. This makes it hard to precisely estimate or predict the expenses.

In general, the cost of ERP system implementation can be classified into two categories: direct costs and indirect costs. Direct costs, or tangible costs, are those costs explicitly related to ERP implementation that the hosting organization has to pay and thus can be reflected on the corporate income statements. Normally, direct costs include expenses incurred due to software purchase or licensing, hardware acquisition and installment, procurement of external professional services, addition of headcount, staff training, and so forth. According to a survey on ERP implementations in Swedish manufacturing companies, the average shares of the proposed six components of ERP direct costs are: software, 24.2%; hardware, 18.5%; consulting, 30.1%; training, 13.8%; implementation team, 12.0%; and others, 1.4%, respectively (Olhager & Selldin, 2003). Software and hardware costs basically depend on the selection of ERP packages and hardware upgrades, existing IT infrastructure, and IT planning. The use of ERP consultants, usually external consultants from professional service firms, is common in ERP projects and regarded as a success factor (Somers & Nelson, 2001). Because lots of project-based firms have fragmented processes and differentiated business needs, customization, system integration and data conversion are critical, thus using consultants' expertise could play a major role in diminishing ERP risks. As a result, choosing the right consultants with sufficient application knowledge and industry experience and making full use of consulting services have the potential to control or lower the direct cost of ERP implementation in project-based firms.

Indirect costs, or intangible costs, are elusive to define, identify and control. They are "off-the-books" expenses, damages, or losses generated mainly by human or organizational factors (Irani & Love, 2001). Organizations implementing an ERP system often have to be prepared to see the organization reengineered, its staff disrupted, and its productivity drop before the payoff is realized (Umble & Umble, 2002). Indeed, ERP system implementation may turn out to be a distraction or disruption, at least temporarily, to the firm's ongoing projects and operations. This include shifted management focus, using employees' time for extensive training, lowered employee morale and work efficiency because of possible job role redesign or headcount reduction, conflicts and frictions between organizational units, and so on. Indirect costs in generic IT investment (Irani, Ezingeard, & Grieve, 1998; Love & Irani, 2001; Marsh & Flanagan, 2000) are also likely to occur in the ERP projects.

Table 2 provides a taxonomy of ERP costs, categorized into the two dimensions. It is noteworthy that while ERP maintenance cost in the post-implementation stages must be taken into account, the cost of optional ERP system upgrades and introduction of additional functionalities are considered separate projects. Besides, although indirect costs are difficult to fully enumerate and quantify, total cost of ownership (TCO) has been advocated by some as an effective method to measure the cost of ERP systems and support ERP strategies and decisions (Aberdeen Group, 2006; West & Daigle, 2004), which may partially incorporate the estimation of indirect costs.

| Dimensions | Sub dimensions |
|---|---|
| 1. Direct costs | 1.1 Software purchase or licensing<br>• ERP solutions<br>• Database management system<br>• System software<br>• Security software<br>• Additional applications<br>1.2 Hardware acquisition or upgrade<br>• Servers & database machines<br>• PCs, workstations, printers, scanners, and other computer peripherals.<br>• Network equipment<br>• Installation and configuration of hardware<br>• Other facilities<br>1.3 Professional services by external consultants<br>• Customization<br>• Data conversion<br>• Installation and configuration<br>• System integration<br>• Testing and troubleshooting<br>• Other technical support<br>1.4 Internal staffing<br>• Additional permanent hiring<br>• Additional temporary hiring<br>• Staff turnover<br>1.5 Instruction and training<br>1.6 Maintenance and mandatory upgrades<br>1.7 Administrative and miscellaneous costs<br>• Overheads<br>• Travel<br>• Contingency |
| 2. Indirect Costs | 2.1 Disruption to ongoing projects (strains on resources, additional change orders, delays, etc.)<br>2.2 Temporary loss in productivity<br>2.3 Temporary decline in quality of work<br>2.4 Business process reengineering<br>2.5 Organizational restructuring<br>2.6 Shift of management focus and dedication<br>2.7 Use of management and employee time<br>2.8 Job role redesign & reassignment<br>2.9 Decline in employee engagement and morale<br>2.10 Culture changes<br>2.11 Conflicts and frictions among organizational units<br>2.12 Transition from legacy system to the ERP system<br>2.13 Impact on relationship with key stakeholders |

Table 2: Taxonomy of ERP Costs, adapted from Love & Irani (2001) and Iba (2006)

## 5. Implementation Challenges

ERP implementations are exposed to various risks. Previous studies have described a number of risk factors in generic ERP implementations, such as low top management support and involvement, inadequate business process reengineering, inadequate legacy system management, and ineffective project management (Aloini, Dulmin, & Mininno, 2007; Umble, Haft, & Umble, 2003). In project-based firms, the mission-oriented nature and resource- and time- constrained ways of working, combined with the loose coupling between different projects, usually

create highly distributed and fragmented working practices (Bresnen, et al., 2004; Lindkvist, 2004). As such, implementing ERP systems in such organizations must overcome certain additional challenges.

Project success is critically dependent on the collaboration and support of its stakeholders. Examples of such key stakeholders include major clients of the company, as well as suppliers, regulators, and collaborating partners. Regarding ERP projects, stakeholders not only include those participants in the implementation processes, but also need to involve the stakeholders in the projects carried out by the organization during and after the implementation. It is these projects that bring profits to the firm and make the ERP adoption worthwhile. Ineffective stakeholder relationship management leads to frictions, scope creep, inappropriate measurement, specification changes, delays, and other issues (Hartman & Ashrafi, 2002). Therefore, it is very important to maintain good relationships with stakeholders and involve key stakeholders, including but not limited to internal users, into the implementation process.

As a result of the physical dispersion of project teams, ERP systems in project-based firms have to be implemented in a multi-site manner, which brings special concerns (Umble, et al., 2003). The conflicts between centralized control and individual site autonomy, and between corporate standardization and localized optimization, increase the complexity of ERP implementation and entail difficult trade-offs. Local legal, regulatory, and environmental issues are also need to be seriously addressed and reflected in the reengineered business processes. Moreover, since project teams are of high mobility, moving from one site to another with reshuffled staff as a project is completed, the temporariness of project team composition and site location makes it difficult to carry out ERP implementation and manage the IT asset effectively. In addition, project-based firms often need third-party specialized applications with functionalities that current ERP systems are not able to provide. For example, engineering design and construction firms heavily rely upon Computer-Aided Design (CAD) or Building Information Modeling (BIM) solutions to undertake their projects. As a result, achieving integration and interoperability to some extent between ERP system and non-ERP applications is a big challenge during the implementation process.

## 6. Conclusion

The study reported herein aims to systematically identify and analyze the benefits and costs of ERP systems in the context of project-based firms. A number of challenges to ERP implementations are discussed that specifically pertain to such an organizational environment. The listed costs and benefits constitute a comprehensive taxonomy addressing the impacts of ERP systems on project-based firms, which can be used to conduct cost-benefit analysis and support decision making on ERP system evaluation and investment. While almost all direct costs can be quantified in financial terms, most of the benefits and indirect costs are difficult to measure with the use of quantitative methods, which makes a comparative evaluation of costs and benefits for implementation decision making inconclusive. Development of effective techniques to estimate quantitative values of intangible costs and benefits and a sound cost-benefit analysis methods for ERP systems in project-based firms is the subject of research being pursued by the e-Construction Group, a research unit at the University of Maryland.

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# Standardizing of Standards in IPM of Construction

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## Abstract
PM including construction nowadays crosses the borders of countries which points to the necessity to overcome borders of technical languages and culture. For it is necessary to unify the quantitive measurement properties of building materials.
In the presented model standardized standards of building materials are connected with known technology of matrix coding, scanning and decoding .
The model can be used in PM technology starting from the design of building in form of specification of project elements, their functions and resources bearing these functions and on the other side starting from the manufacture of producing specified resources and passing through the supply chain to the building site, including automated control by owner's supervisor. Implementing the BIM makes it possible to automatize over twenty datamation procedures in the project life-cycle.

## Keywords
construction, economics, building material, standard of standard

## 1. Trends on construction market

Construction is handicraft in its essence. The auxiliary works, such as transport and lifting and simple construction works not requiring high qualification of the employee such as soil works, concrete cast etc. are mechanised This means that out of the resources of power type (machines and people), the effectiveness of which management determines the intensiveness of construction work is labour. The conflict has been written into the construction management system in long-term plan. The pressure of the owner on the constructor to shorten the duration of the projects, incl duration of construction on the site, takes unavoidably to the uneven loading of resources of power type involving the non-productive expenses.

Economic-theoretically the problem cannot be described with the mainstream microeconomics methods where the production intensiveness is measured with the quantity of production in time unit which in other words is intensity of production. The latter is described by figure 1 where the entrepreneur chooses the production volume on the basis of equality of marginal cost $C_m$ and marginal revenue $R_m$. One construction project is often continues more than one year, the other only some months. How to make the production intensiveness comparable in construction (project management), if one company simultaneously constructs the buildings of very different size and complicacy?

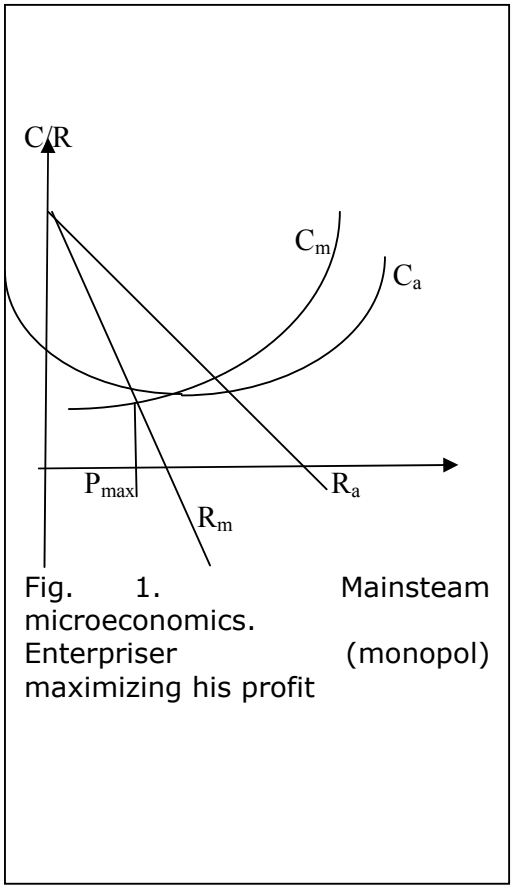


Fig. 1. Mainsteam microeconomics.
Enterpriser (monopol) maximizing his profit

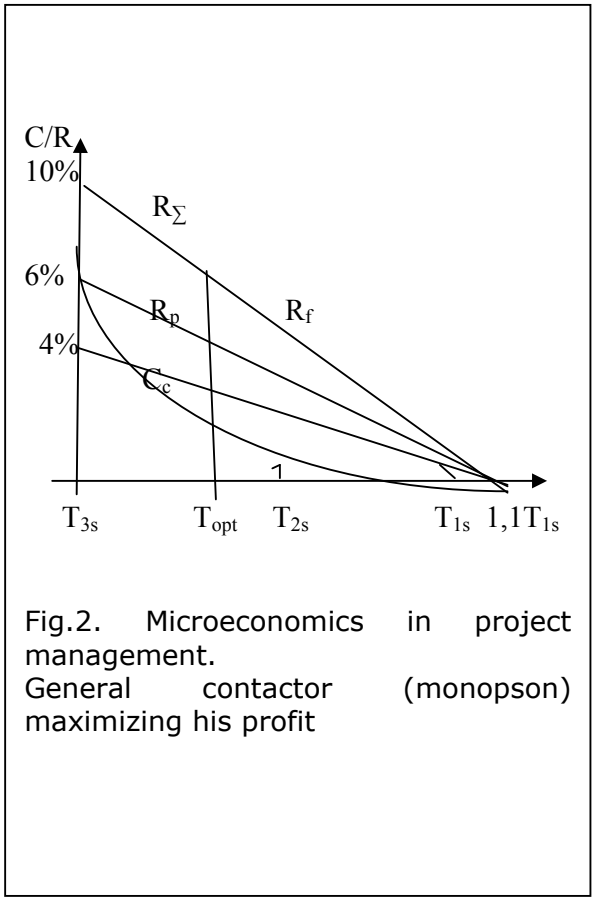


Fig.2. Microeconomics in project management.
General contactor (monopson) maximizing his profit

The solution lies in measuring the production intensiveness through relative construction duration, i.e. in other words with relation of actual construction durations to the standard duration of the same buildings.
The latter means the duration achieved in working in one shift with maximum close intensiveness (with the number of workers) which can be calculated in preparing the construction organisation project during the construction preparation period. Such a mean was used by Harris F. & McCaffer R.,1997 standardizing bids of tender prices. The interesting interval of change in duration of construction has been limited, on one side, by work in three shifts $T_{3s}$ (theoretically minimum duration) and on the other side, 1.5 times longer than in case of working in one shift ($1,5T_{1s}$). The contractor without the pressure of the client would prefer to work in one shift, i.e. during daytime and guaranteeing 50% time reserve for oneself The figure 2 indicates the change in cost price ($C_{c)}$ of construction in changing the average construction duration within the interval of$1,1T_{1s}$ up to $T_{3s.}$

## 2. Saving on cost without lose in quality

But it is necessary to keep in mind that costs on wages are only half of costs on building materials. As materials are storing resources there is no problem with uneven need of them on time scale. It seems that the problem to save on materials is very simple – only buy them cheaper. But as we can conclude on many dispute cases it can be achieved paying charge to quality.
The reason of loss in quality on international market of building materials is foremost in regional nature of construction market and the lack of internationally harmonised classifiers and standards for describing the properties of the materials.

And if these are, they themselves are non-standardised. The numerous classifications of the construction materials and their properties are in use.

Classifications base on generic properties of materials forgetting that main aspect in classification must be for what the materials are needed.

## 3. Classification of building materials

The structure of classifier of construction materials from the viewpoint of construction management should be determined based on the two different objectives. First, this should create the basis for grouping the construction materials for logical choice in multiple variant specification of *constructive element or functional part of the building* in the design phase. This means that materials should be grouped according to their purpose of use in the construction body and the subgroups according to the most important physical properties. The same structure should be also the basis for creating the catalogues of for estimators, the sales lists in web portals, in bookkeeping, websites of producers etc. The source of the special-purpose classification and coding of materials should be the structure of standard of constructional usage purposes of the material which would guarantee the compatibility of the databases both in the phases of designing the buildings, in construction and use of building.
The main function, i.e. usage purpose of the material proceeds from the logics of the system of the building as the system to be designed in the *constructive element or in the functional part of the building.* Considering that the database of construction materials (e.g. pricelist) includes thousands positions, it is reasonable to indicate the additional division of the usage purpose to the subclasses in the universal classifier by using the main property for that purpose in which constructive element of the building this material can be used. And the form of material if the use of material depends on it.
The number of groups of the database of construction materials based on the above is approximately 30, the properties of which could be described by at least half a smaller number of standards.
In classifying the database of materials the additional levels can be used for facilitating the search of materials from the database. In order to ensure the practical overview it seems that in most part three and/or four-level classifier is sufficient and adequate for structuring the material database.
Another two facets should be used for **identifying** the material:

- The first of them determines the combination of value (intervals of values) of physical properties described in the standard of material, thus the quality of material at its final level,
- The other one determines the trademark of producer or seller, thus also the price of material. The differentiation of these two steps could be necessary also due to the fact that the supplier is not known during the designing or due to that in case of public procurement the referring to the specific supplier is even forbidden.

## 4. Standartization of standards on properties of building materials

Traditionally the quantitative indicators of properties in the documents of the standard of construction material group have been submitted in different chapters of the standard intertwined with explanatory text, usually also in the tables of different shape which do not enable to realise one of the most important principle of automation of data processing: single insertion of the data to the information

carrier and its repeated (multiple) use in different tasks, by different users and at different moments of time. The standard of material group requires standardisation which in its turn opens up the possibility for **standardized description of the properties** specified in the project and in the certificates. As in case of classification of the materials, then also in case of classification of the standards of materials the same logics is appropriate, which in other words means that one standard is compliant to each material classification group.
In order to guarantee the requirements (strength, reliability, fire and noise resistance) the designers should consider the physical, i.e. inner (natural) properties of materials. These properties are measurable. These properties which should be considered in designing and constructing the building, are different for each material group bearing the above function. As to each material group with the same usage function the lists, descriptions and measuring scales of these properties should be prepared and agreed between all parties participating in the construction. Such description of properties can be formally provided as matrix. The properties of all materials belonging to the group can be fully described with the number combination of all lines and columns of the table (matrix).
When presuming that the material groups the different standards complying with which are ‹ 50 and each material has been described by ‹10 quality indicator, the characterization of each one ‹10 value, value interval or name of subclass is defined, it is concluded that the **full** classifier of the construction materials would involve approximately $10^5$ names. The operating with such classifier on paper would be probably troublesome, if not impossible.

As an example the standard of qualities of one material group *bricks* has been provided in Table 1.

| | Property | Measurement unit | Value | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 1 | Raw material | | clay | silicate | gas-concrete | granite | limestone | | | | |
| 2 | Working conditions | | Open outer surface | Covered external surface | Open internal surface | Covered internal surface | | | | | |
| 3 | Compressive strength | Mpa/$cm^2$ | 3,0 | 3,0-5,0 | 5,0-12,5 | 12,5-20 | 20-30 | | | | |
| 4 | Resistance to cold | Cycles | - | 15 | 25 | 30 | | | | | |
| 5 | Special thermal conductivity λ | w/mK | 0,10-0,12 | 0.12-0,20 | 0,20-0.25 | 0,25-0,50 | 0,50-0,70 | 0,70-0,80 | 0,80-0,90 | | |
| 6 | Fire resistance | min | 15 | 30 | 45 | 60 | 90 | 120 | 180 | 240 | |
| 8 | Density | kg/$m^3$ | 600-800 | 600-1000 | 1000-1200 | 1200-1400 | 1400-1600 | 1600-1800 | 1800-2000 | 2000-2200 | ≥2200 |
| 9 | Paint | | natural | According to order | | | | | | | |

Table 1 . Sample of the standardized standard of the properties of material group
The primary usage purpose of material:
1.1. Load bearing
2.3. Surrounding the room

The required qualities of the material to be specified can be described on the same scheme in the course of designing, but also in the certificate of the material issued in the producer's company or the values of the actual properties of the product provided in the conformity certificate in the same formal language. For that purpose the relevant nests should be indicated in the same table (toned columns in the table). The *silicate* used in the under-plaster wall*(covered surface)* as the periphery of the interior room with *even surface, regular shape and natural colour* with the *compressive strength 3 Mpa/cm*$^2$*, fire resistance 60 minutes, fire sensitivity class D* and for which *no thermal and density requirements are set.* The specification is achievable for the master file as a result of 8 clicks.
The usage purpose of the material (material group) which one material could have several in the construction has been written in the header of the standard for the clarity purposes. The material's (material group) own generic (Eckholm, 1995), i.e. construction physical properties, i.e. type of raw material is written to the nests of the table.
The digital coding form of such information should be chosen for the IT solutions. The high number of the properties describing one product gives the undisputable advantages for using matrix code IT tecnology. Such standardization enables to create full databases of materials in the companies and the systems of information offer, search and exchange in the company and between the companies with the help of universal and standard software systems (e.g. Microsoft Access and ORACLE). The standardised software for printing and scanning of such matrix codes is existent in the series PDF417.
The precondition of submitting and the reading of both the material group standard as well as the certificate of the specific material is already achieved required development phase of both matrix-codes software and hardware.
**The formal description of the quality of construction materials enables to overcome the language barriers but also the cultural barriers established as the good practice of the construction field of different countries which are unavoidable in verbal description of the qualities.**

The following list of tasks of data processing of construction materials in the life cycle of the building is surely not exhaustive, but describes adequately the total number of tasks and their diversity, where the material saving of human labour is achievable with the application of above described standardisation process:

- **Specification of required qualities of material by the designer (deciding),**
- Preparation of the summary specification of the construction materials by the designer (preparation of the lists of materials and works, the bill of quantities),
- Preparation of the cost budget by the designer,
- Raw material dosing tasks at the producer's,
- Production process monitoring at the producer's,
- **Marking of finished production at the producer's (labelling the product),**
- Automation and mechanisation of the warehouse search-removing operations of the producer or wholesaler,

- Registration of the certificate or quality conformation document at the producer's,
- Registration of the delivery note and invoice at the producer's,
- Preparation of the purchase order at the constructor's,
- Forwarding of the purchase order to the sellers in the web environment at the constructor's,
- Receipt of the goods at the constructor's and conformity control,
- Conformity control of the material by the owner's construction supervision,
- Preparation of the project of repair works for the user of the building with the new already described information processing iterations,
- Describing of the construction materials in the portals and websites of the retail and wholesalers of the sales agents,
- Publication of the pricelists of the construction materials on paper and in web,
- Construction technology projects and charts of standard technologies.

The operations where the qualities should be inserted by the persons onto the information carrier provided in *bold* (only by clicking on the columns of the matrix). The remaining operations can be performed with the help of the scanner and printer. Mobile phones can be used for generation and reading for matrix codes.

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# PhD Research Methodology

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Advancing Project Management for the 21st Century
Through Research: PhD Research Methodology

## Advancing Project Management for the 21st Century Through Research: PhD Research Methodology

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PhD Workshop
PM 05 International Conference in Project Management
Heraklion, Crete, 27-31 May 2010

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### Conducting Doctoral Research

- 'The PhD shall be awarded to a candidate who, having critically investigated and evaluated an approved topic resulting in an independent and original contribution to knowledge and demonstrated an understanding of research methods applicable to the chosen field, has presented and defended thesis to the satisfaction of the examiners'
- However, the PhD process has been perceived increasingly bureaucratised and understood as an apprenticeship in which transferable skills are learnt....emphasis is now placed on the (limited) time period of study, learning the essentials (research methods) and completing specific stages of research of research (literature review, methods chapters, and so on) (Grix, 2001)

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### Conducting Doctoral Research

- Undertaking a PhD should be seen as a learning process, an apprenticeship in the art of research in which you will learn to reflect on the origins of theories and concepts, how to theorise, how to 'mesh' theory with practice, and how to organise vast quantity of materials in a limited time period (Grix, 2001)

- For example, Albert Einstein and Karl Marx made relatively modest contributions to their fields of research in their doctoral theses, but they spent that time learning the tools of their trade whilst 'demonstrating their fully professional mastery of the established paradigms' in their field (Phillips and Pugh, 1994)



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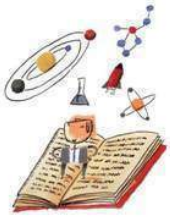
### Conducting Doctoral Research



- 'QAA (2008) in their degree descriptors specified (among several descriptors for doctoral degree): "…the creation and interpretation of new knowledge through original research or other advanced scholarship…", "..a detailed understanding of applicable techniques for research and advanced academic enquiry…", "…continue to undertake pure and/or applied research and development at an advanced level, contributing substantially to the development of new techniques, ideas, or approaches .."

- Conducting and designing original research', 'understanding techniques for research and advanced academic enquiry and undertake pure and/or applied research and development at an advanced level', 'contributing substantially to the development of new techniques, ideas, or approaches' can be closely linked to the **research methodology**

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## Advancing Project Management for the 21st Century Through Research: PhD Research Methodology

### Methods and Methodology

- Methodology is different from methods
- Research methods can be seen as the techniques or procedures used to collate and analyse data. The research method(s) chosen for a research project are linked to the research questions posed and to the source of data collection
- Methodology is driven by certain ontological and epistemological assumptions and consists of research questions or hypothesis, a conceptual approach to a topic, the methods to be used in the study (and their justification), and consequently the data source. All of these components are linked to one another in a logical manner
- Methodology takes the most time in research as the researcher attempts to "place" his/her works among the existing works on the topic, drawing on insights from wide-range literature reviews, and developing an "innovative" angle on the topic.

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## Advancing Project Management for the 21st Century Through Research: PhD Research Methodology

### Research Methodology

- Philosophical Level
- Reasoning Level
- Data Level

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## Advancing Project Management for the 21st Century Through Research: PhD Research Methodology

### Philosophical Level: Ontology and Epistemology

- Ontological and Epistemological stand point will lead to different methodology applied to tackle the research
- Ontology logically precedes epistemology whilst epistemology precedes methodology
- Ontology concerns about the nature and conception of reality. It studies being or existence and their basic of categories and relationship to determine what entities and what types of entities exist.
- Epistemology concerns about the nature, origin, and scope of knowledge. Much of the debate in epistemology focused on analysing the nature and variety of knowledge and how it relates to similar notions such as truth and beliefs.



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### Ontology

- Ontology discusses the 'claims' and assumptions that are made about the nature of (social) reality, claims about what exist, what it looks like, what units make it up, and how these units interact with each other
- A researcher's ontological position is their answer to the question: what is the nature of the (social) reality to be investigated?
- An example of ontological positions: objectivism vs. constructivism
- Objectivism is an ontological position that asserts that (social) phenomena and their meanings have an existence that is independent from the (social) actors
- Constructivism is an alternative ontological position that asserts that (social) phenomena and their meanings are continually being accomplished by the (social) actors (not only produced through interaction but they are in a constant state of revision)

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### Epistemology

- Epistemology is concerned with the claims of what is assumed to exist can be known. Knowledge and the ways of discovering it are not static but forever changing. When reflecting on theories and concepts in general, a researcher need to think about the assumptions on which they are based and where they originate from (the context and circumstances)
- Epistemology looks at the theory of knowledge, especially with regard to its methods, validation and the possible ways of gaining knowledge of (social) reality
- An example of epistemological positions: positivism vs. interpretivism
- Positivism is an epistemological position that advocates the application of methods of natural science to the study of (social) reality and beyond, the "truth" is out there to be discovered (by the researcher)
- Interpretivism is an epistemological position that separate the objects of natural science from the (social) actors, the researchers/observers somehow construct their own "truth" in viewing the world



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### The 'Continuum'

OBJECTIVISM — — — — — — — — CONSTRUCTIVISM

POSITIVISM — — — — — — — — INTERPRETIVISM

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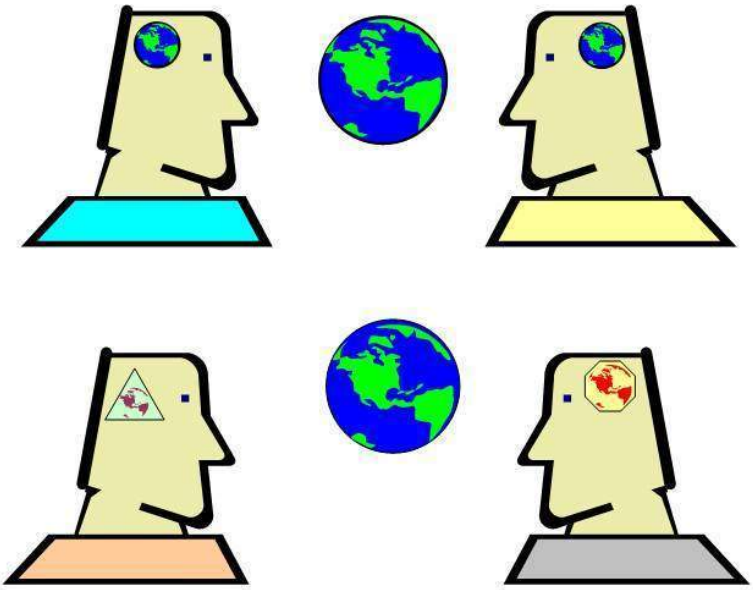



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## Reasoning Level

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### 'Continuum'

OBJECTIVISM — — — — — — — — CONSTRUCTIVISM

POSITIVISM — — — — — — — — INTERPRETIVISM

DEDUCTIVE — — — — — — — — INDUCTIVE



## Advancing Project Management for the 21st Century Through Research: PhD Research Methodology

### Deductive Research

- Conventionally commences by analysing the literature, i.e. studying existing works in the field providing the context for the research
- Continues by identifying and stating a single selected problem leading to the isolation of the major research question(s) for which the existing knowledge is inadequate (could be identified gaps between existing theories or evidence, contradictions to be explored, or new contexts for applying previous findings)
- This is continued by formulating a hypothesis (can be accompanied by a series of sub-hypothesis), The hypothesis may be in the form of a conceptual model and was proposed to tackle the identified problem(s) with proposed set of further steps to test the hypothesis
- Then data collection using an the proposed data collection methodology followed by the analysis resulting in the findings in terms of the existing knowledge found earlier

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### Beyond Deductive Research

- Alternative methodological paradigms refuse to accept that deductive approach is always the most appropriate way of selecting realistic research topics and research questions
- The main arguments against the scientific method (deductive) focused on the constraints which is methodological paradigms place upon realism
- There was a claim that deductive paradigm tends to "preserve" the methodology and assumptions underlying existing work and therefore constrain novelty
- Novel methodologies approaches originated disciplines other than scientific/engineering ones (i.e. social sciences)
- These new methodologies have offered new insights into existing issues however, their rigour and reliability have becoming the subject of counter-criticism of the deductive researchers



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### Inductive Research

- Inductive research intends to learn about the phenomena in question by applying a "less-structured" methodology to gain richer and deeper information
- Instead of formulating a hypothesis, inductive research try to keep their mind open for any possible results (no pre-supposition) whilst proposing a set of further step for data collection in attempt to answer the phenomena in question (research question)
- In certain methodologies, such as the grounded theory methodology, the literature review is not even recommended in the early phases as it may influence the stance of the researcher (some background reading is alright, but not a full literature review)
- Explanations and theories are then developed from this observations of the empirical world (i.e. through the data collected)
- According inductive researchers, a research question has to relate to all complexities of the real situation if the findings are to be applicable to the real world

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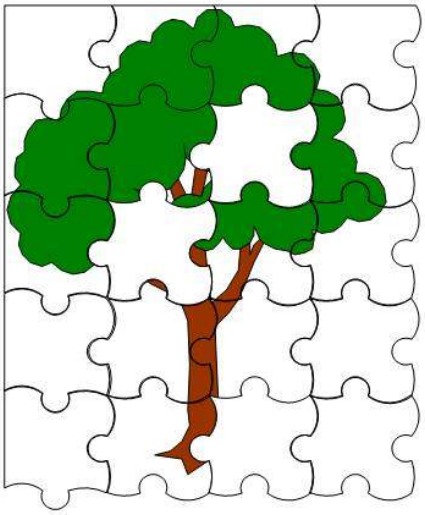



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# Data Level

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## Advancing Project Management for the 21st Century Through Research: PhD Research Methodology

### 'Continuum'

OBJECTIVISM — — — — — — — — CONSTRUCTIVISM

POSITIVISM — — — — — — — — INTERPRETIVISM

DEDUCTIVE — — — — — — — — INDUCTIVE

QUANTITATIVE — — — — — — — — QUALITATIVE



## Advancing Project Management for the 21st Century Through Research: PhD Research Methodology

### Quantitative Methods

- Also known as the scientific method, positioning the researchers as neutral observers of the phenomena (necessary to maintain distance or objectivity from the subject of the research)
- Quantitative methods are based on *positivistic* ideal coined by the 17th century philospohers (Descartes and Compte).
- For Descartes, mathematics reflected the divine perfection of God's worldly creation
- Compte was the first to adopt the term positivism to describe his methodological procedures for attaining 'positive' knowledge of theory-neutral empirical facts. For Compte, mathematics constitute a supra-human language of description and by using mathematics as the only method for attaining facts; the realm of scientific knowledge would be purged of culturally bound assumption to belief
- Quantitative approaches assumed to be repeatable, and capable of isolation from reality without compromising the cause and effect being researched

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### Qualitative Methods

- Qualitative methods are based on the assumption that there is no singular objective reality and hence the observed reality will be related to the researchers' interaction with the phenomenon
- According to qualitative researchers, real-world phenomena need to be assessed from within the context of that reality (taking into account the subjective realities)
- As the consequences, qualitative research tend to yield rich but complex data (which does not render itself to isolation of singular realities or generalisable and quantified causes and effects)
- The findings of qualitative research are focused to illuminating the qualities of phenomena rather than their numeric measurement
- Qualitative research are inductive by nature and will normally resulted in unanticipated findings based on the evidence gathered along with the causal explanations of its dynamic

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## Credibility of Research Findings

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### Validity and Reliability issues

• Different research approaches have different inherent strengths and weaknesses, which need to be taken into account in relation to the goals of the research. In evaluating the credibility of the research methodology, validity and reliability are commonly used as the evaluation criteria

• Internal validity refers to whether the identified inputs within their attributes actually produced the expected output

• External validity refers to the extent to which any research findings can be generalised or extrapolated beyond the immediate research sample or setting in which the research took place

• Reliability refers to the consistency of results obtained in the research, i.e. the reliability of the method of collecting evidence

• Ethical issues of research concern the appropriateness of the researchers' behaviours in relation to the rights of those subjects of the research or who are affected by the research



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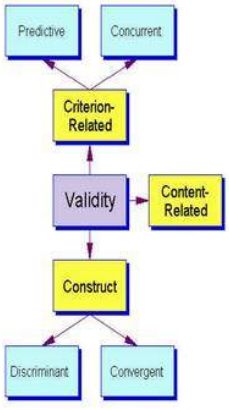
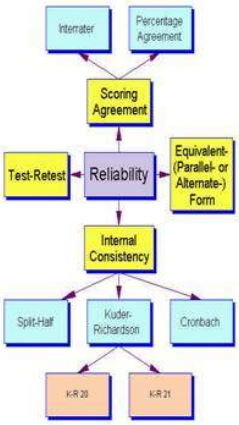
### Validity & Reliability of Quantitative methods

In many cases are measured from the instrument used to collect the data




Diagrams taken from http://www.gifted.uconn.edu/siegle/research/Instrument%20Reliability%20and%20Validity/Reliability.htm

School of the Built Environment
University of Salford
Prepared by:
Dr. Monty Sutrisna

## Advancing Project Management for the 21st Century Through Research: PhD Research Methodology

### Validity & Reliability of Qualitative methods

- Validity and Reliability address issues about the quality of the data and the appropriateness of the methods used in carrying the research project
- These are important particularly in the social sciences due to different philosophical and methodological approaches in studying human activity
- Validity deals with the appropriateness of the method adapted to tackle the research question: justifying the appropriateness of the methodology, demonstrating that the research subject are in position to corroborate or disapprove the researcher's interpretation on the matters being discussed
- Reliability deals with the quality of the data: demonstrating triangulation of various data source (such as documentary analysis, non-participation observation, and interviews) thus providing similar results from different angles, demonstrating the same research instrument (set of questions) can be used by other researcher without compromising the answers



## Advancing Project Management for the 21st Century Through Research: PhD Research Methodology

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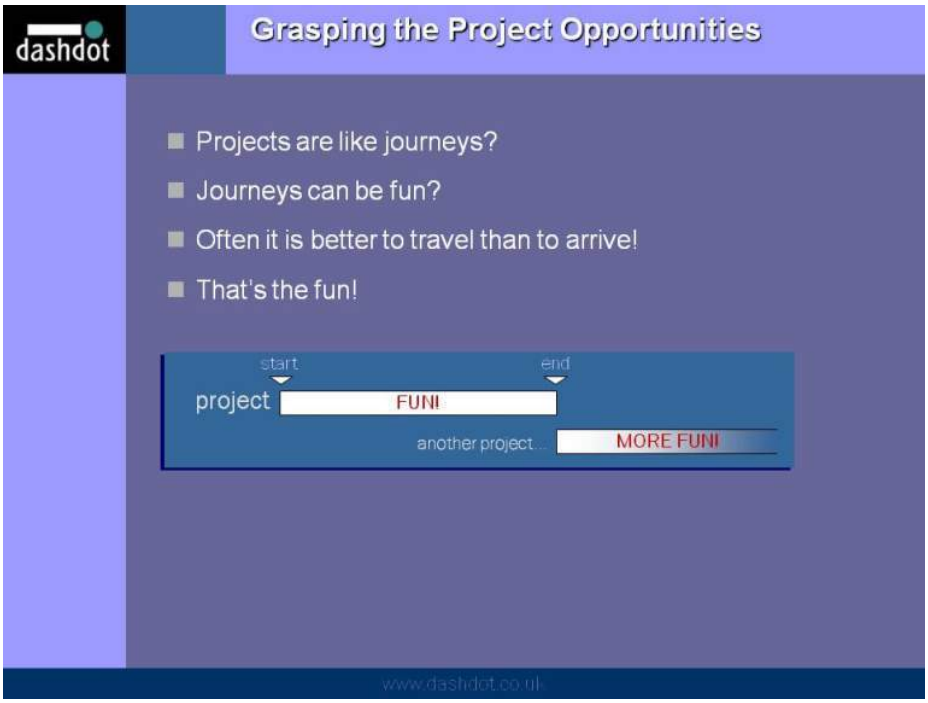
*TAY-1*

# Grasping the opportunities of the PM decade

Tom Taylor
*(Buro Four,dashdot & APM ,UK)*



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## The PM Decade/Journey

- Also the communities in Project and Programme Management (PPM) themselves appear to be on journeys of their own
- How is PPM getting on?
- How will we know if and when we have arrived?
- Will it be fun?
- Looking forward and looking back

- 2000 (+/-) → 2010 (+/-) → 2020 (+/-)

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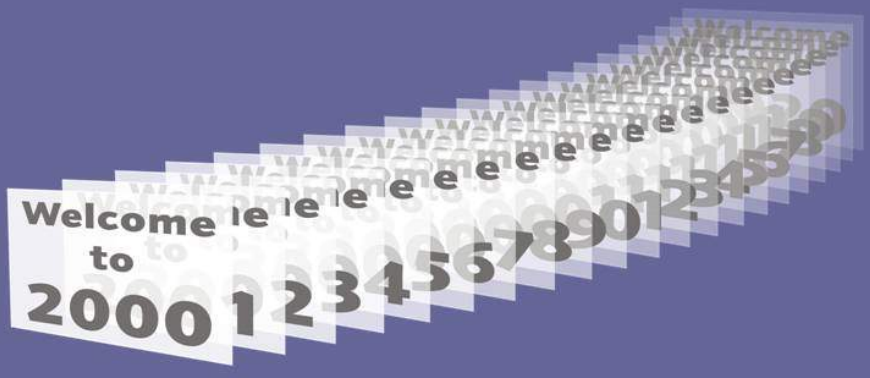
## Progress

| | | |
|---|---|---|
| 2000 (+/-) → | 2010 (+/-) → | 2020 (+/-) |
| Unusual → | Universal → | Nationalised? |
| Unknown → | Ubiquitous → | Global? |
| Unproven → | In Demand → | Expected? |
| Specialist Sectors → | All Sectors → | All life? |

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## Noah and the Ark

- – a programme manager? with three careers?

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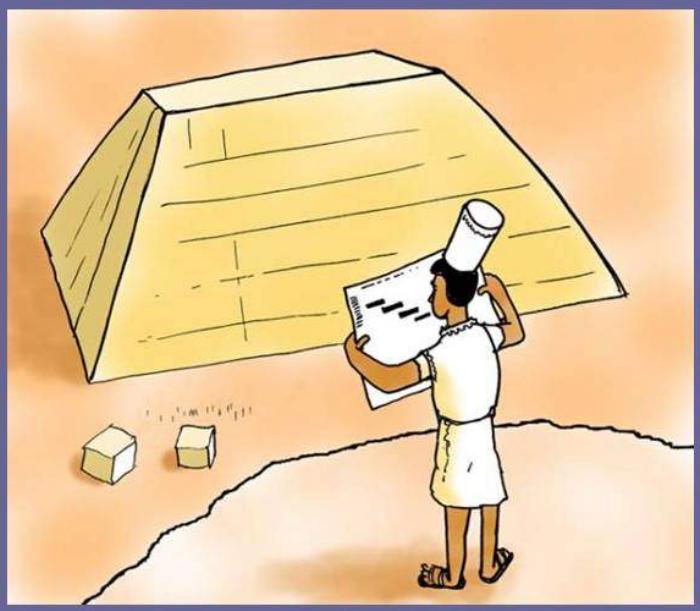
## The Egyptians

- – with supply chain management? critical sequencing?



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## The Romans

Adopting:

- Quality Assurance,
- Consistency,
- Innovation,
- Ingenuity
- Plagiarism

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## The Victorians (19th Century)

- mass production and safety
- research and development
- engineering and infrastructure
- management and contract

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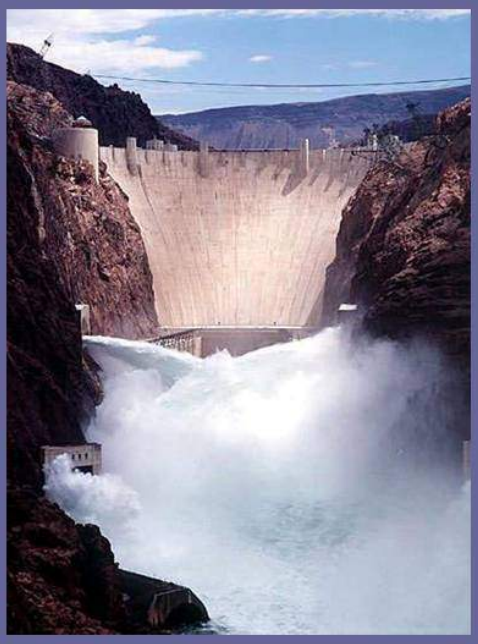
## The 20th Century

- work study
- work breakdown
- Gantt charts
- major projects
- managed conflicts (war)



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## The post-war push

- defence sophistication
- oil and gas complexity
- space explorations
- 'hard' systems
- technology
- 'soft' skills
- knowledge
- and beyond…

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## Arrival of PM as a profession:

- creates and owns a distinctive relevant body of knowledge
- members of the profession need to continue to practice and apply themselves to ongoing learning in order to maintain appropriate skills
- individual members should follow standards of professional ethics and behave in a manner appropriate to the profession
- a profession should award certificates-to-practice based on examination of individuals' competence

**ref. APM Body of Knowledge 7.9 Professionalism and Ethics**

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## What types of Effective Project Manager are needed?

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## Arrival of PM as an Independent Vocation?

- its own conferences, forums, exhibitions, events
- its own magazines, websites, media
- its own institutions, associations, clubs/SIGs
- its own awards, personalities, gurus
- its own qualifications, education, academics
- its own support of trainers, software, advocates
- its own employment streams, career paths

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## Some KPI's for PM's Arrival? 1 of 2

- recognition, adoption, application - private sector - all parts
- recognition, adoption, application - Central Government, Local Government and Public Sector
- management of all change - through Project Management - all sectors
- education ladder through school to Further Education and Higher Education through to Continuing Professional Development
- and established recognised qualifications to suit
- gradings of PPM from fullmost to "regular" to light

cont'd /-

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## More KPI's for PM's Arrival? 2 of 2

- in the board room - PPM with finance, engineering, human resources, public relations, marketing etc.
- multi-national/cross-border utilisation - large corporations, international bodies
- narrowing of products, elimination of weaker elements
- survival and prospering through hard times/recession
- part of popular culture/society
- plus "other"

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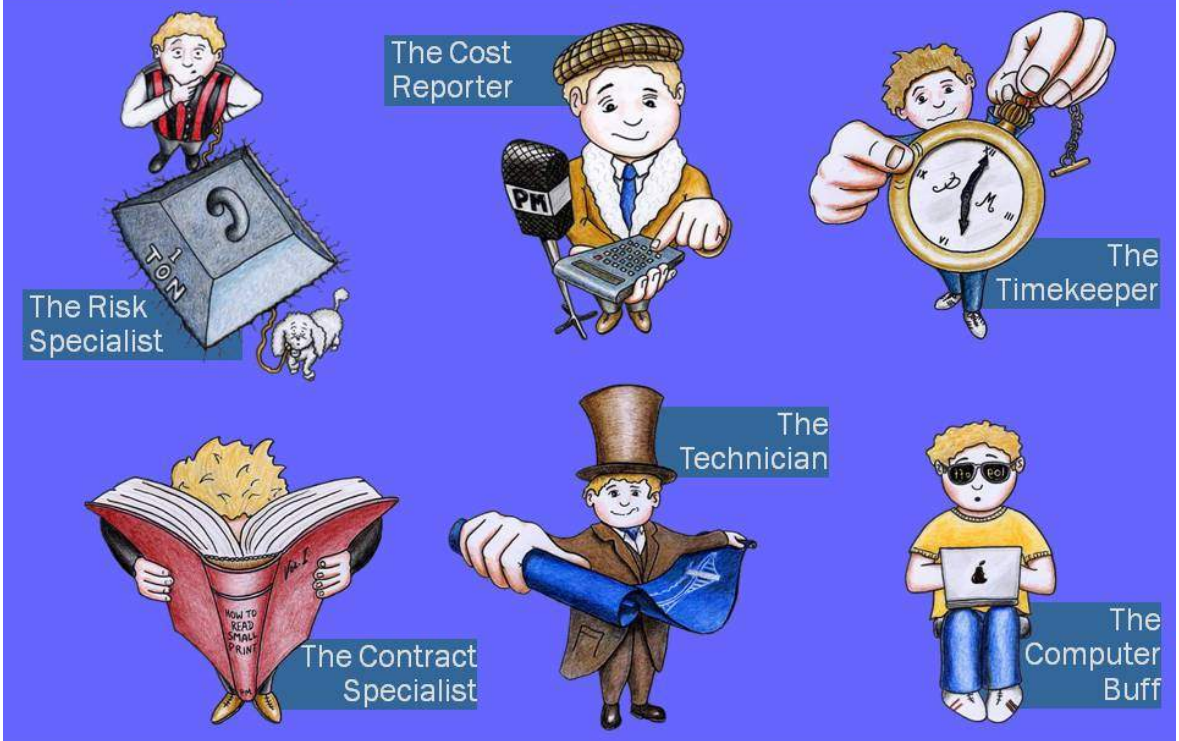
## What Specialities are required?

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## Your Views on the PM Journey

| | |
|---|---|
| 1. Are we making progress? | Y / N / Don't know |
| 2. Unusual to Universal to Nationalised | 0 25 50 75 100 |
| 3. Unknown to Ubiquitous to Global | 0 25 50 75 100 |
| 4. Unproven to In Demand to Accepted | 0 25 50 75 100 |
| 5. Specialist Sectors to all sectors to All Life | 0 25 50 75 100 |
| 6. How are we getting on? | Poorly - Satisfactorily - Well |
| 7. When will we get there? | 1y - 3y - 5y - 10y - More - Never? |

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## And in the Next Decade?

### What do we need? = Your Top 4?

- ☐ more focussed project managers – full time, first choice
- ☐ more expert project managers – elite
- ☐ more technology to serve project management
- ☐ better-informed customers and clients
- ☐ more qualifications in PM
- ☐ better understanding and use of current technology
- ☐ better salaries and remuneration of project managers
- ☐ greater focus on sustainability, the environment and green issues
- ☐ increased management capabilities in all team members
- ☐ increasing focus on value of management service

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## Project Management Associations

**What should they be doing in the next Decade? = Your Top 4?**

- ☐ increasing their membership numbers
- ☐ putting on more events
- ☐ supporting research
- ☐ supplying knowledge, information
- ☐ promoting project management to all
- ☐ influencing government
- ☐ developing next generations
- ☐ providing networking opportunities
- ☐ cooperating internationally
- ☐ going on a journey/having fun

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## Contributions to the PM Journey

- First – Who are the internal contributors to PM development?
- Second – Who are the external ambassadors for PM?
- Third – What are you doing to help on this journey?
  - Driving? – in forward gear
  - Navigating a route?
  - Packing a picnic?
  - Looking out of the window?
  - Standing at the kerbside?
  - Waiting to be asked?

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*AA073*

# Resource-Constrained Scheduling of Construction Projects and Simulation of the Entropy Impact on the Duration and the Cost of a Project

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## Abstract
The paper reports on research about the relationship between project resources and the entropy generated during construction, as well as on the development of a related mathematical model. The aim is to optimize the allocation of resources in a resource-constrained project by use of an entropy metric, to study the delays which occur during the project and to relate them with the resources and the entropy in the project. Entropy is hereby defined as the disorder brought about by the fluctuation of resources in the project, and a higher entropy value relates to a higher risk in terms of schedule completion. The case study shows that a significant reduction of time (up to 25.7%) can be achieved by utilizing the entropy method for allocating resources. Furthermore, should a resource-constraint be imposed then the entropy approach results in a schedule that shows a 6.25% improvement in duration (and 8% in profit) over the solution obtained by classical scheduling methods. The reported work builds on previous and ongoing research at the University of Cyprus and the Democritus University of Thrace.

## Keywords
Resource-Constrained Scheduling, Entropy, Time-Cost Trade-off

## 1. Introduction

A common problem occurring in construction scheduling is that required resources are often not available when needed or in the number/amount needed. So the planner has to reschedule activities considering such resource constraints. The aim is to avoid delays that arise from this kind of problems and to reduce the duration and cost of the projects while not compromising the quality of works. Nevertheless, a study based on statistics of several projects, shows that a compression of the project duration for up to 50% can cause a decrease of productivity up to 17% (Hanna et al. (2008)). In the past, there have been some studies for resource constrained scheduling, mostly by use of serial and parallel scheduling (Colak et al. (2006); Hegazy, T. (1999); Senouci and Eldin (2004); Sakellaropoulos and Chassiakos (2004)).

A new approach has recently been developed based on minimizing the total entropy of the project schedule (Christodoulou et al. (2008a,b); Christodoulou et al. (2009a,b,c)). Entropy (Hx) is a metric generally defined as the product of the

probability distribution (px) of a variable times the natural logarithm of the inverse of that probability distribution (Eq.1).

$$Hi, j = pj \ln (1/pj) \quad (1)$$

The progress of an activity and the project's subsequently is being defined by the productivity of the resources and the number of assigned resources (nr) (Griffis and Farr (2006); Christodoulou and Ellinas (2008a)). Therefore, the entropy (H) of an activity (i) produced by a resource (j) is being defined by means of the ratio of required (R) over assigned resources (R') per activity (Christodoulou and Ellinas (2008a)) (Eq.2). Entropy is defined as the disorder brought about by the fluctuation of resources in the project, and a higher entropy value relates to a higher risk in terms of schedule completion.

$$HACT = R/R'\ln(1/ (R/R')) \quad (2)$$

In order to minimize the total project entropy

$$\min HT = \min\{ \Sigma \Sigma (Ri/ R'i) [\ln (1/(Ri/ R'i))]\} \quad (3a)$$

subject to

$$\Sigma(R'i)<=nr \quad (3b)$$

$$Ri \text{ and } R'i, \text{ integer} \quad (3c)$$

$$R'i>= 0 \quad (3d)$$

## 2. Solution method

As the number of assigned resources increases, so does the activity duration decrease (usually and up to a certain limit such relationship is linear). However there is a limit. After this, any increase of the number of assigned resources causes a decrease in productivity and problems in managing the activity (work space limitations and time-space conflicts), which means an increase in the cost and the duration of the project with resulting proportional delays.
The aim is to optimize the utilization of resources in order to balance between low entropy (thus disorder), low cost and low duration of the project without compromising quality standards.

A closer look at Eq.2, reveals that the entropy can have negative values when the assigned resources (R') are fewer than the required resources (R). Similarly, as the assigned resources increase, the entropy gets positive values (assigned resources are more). A maximum is reached when the assigned resources are equal to 2.718 of required resources. Then the entropy tends to reach a zero value. With that in mind, and assuming the linear relationship between resource usage and productivity, the limit of "2.718" can be defined as the limit of disorder that the system can handle and only solutions within this limit are deemed to be acceptable (Eq.4).

$$R' \leq 2.718R \quad (4)$$

In order to find the best solutions that combine low entropy and low cost and duration of the project, a simulation-based approach can be utilized so as to help us

arrive at all possible combinations of resource allocations under the imposed resource-availability constraints.

## 3. Case Study

A real-life 3-floor building was scheduled by use of commercially-available software (Primavera Project Planner). The project contains 83 activities (excavations, concrete works, iron works and everything else needed to complete the project) and finishes 218 days after it starts. A Pert diagram is produced (Fig. 1), where critical activities are being identified. The total cost of the project (unconstrained) is 722,490 euros. After taxes and profit considerations the cost is calculated at 1,166,698 euros. The profit of the constructor is 18% of the total cost before taxes. In this case study resources refer only to labor resources, and the original resource demands are as shown in Table 1.

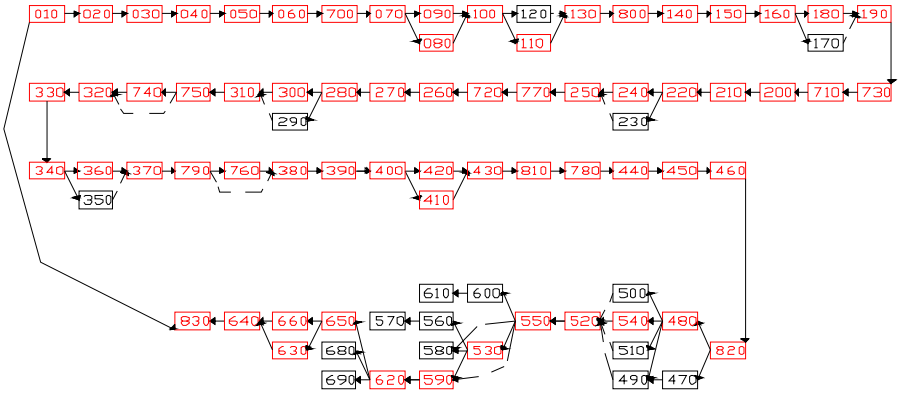


**Fig 1**: Pert Diagram of the project

Solution of the entropy optimization equations was obtained by means of simulation. This was achieved by use of commercially available software (Decissioneering's Crystal Ball) which enables the automatic generation of random events from defined probability distribution functions and the simulatineous evaluation of their effects based on mathematical formulations. In this way, all possible combinations for resource allocation were investigated in order to find solutions that combine low entropy, low cost and low duration of the project, under the resource constraint. Results for the best solutions of project entropy, project duration and project cost are shown in Tables 2-3. The best solution obtained in the simulation is one that completes the project in 167 days (51 days earlier) with a related project entropy of negative value (thus easily managed).

| Activity | Required Laborers | Act. | Req. Lab. | Act. | Req. Lab. | Act. | Req. Lab. |
|---|---|---|---|---|---|---|---|
| 10 | 3 | 220 | 2 | 430 | 2 | 640 | 2 |
| 20 | 0 | 230 | 4 | 440 | 4 | 650 | 1 |
| 30 | 2 | 240 | 4 | 450 | 4 | 660 | 4 |
| 40 | 4 | 250 | 2 | 460 | 2 | 680 | 1 |
| 50 | 1 | 260 | 4 | 470 | 4 | 690 | 1 |
| 60 | 2 | 270 | 4 | 480 | 4 | 700 | 1 |
| 70 | 1 | 280 | 2 | 490 | 2 | 710 | 4 |
| 80 | 2 | 290 | 4 | 500 | 2 | 720 | 4 |
| 90 | 2 | 300 | 4 | 510 | 1 | 730 | 4 |
| 100 | 2 | 310 | 2 | 520 | 2 | 740 | 4 |
| 110 | 4 | 320 | 4 | 530 | 4 | 750 | 4 |
| 120 | 4 | 330 | 4 | 540 | 2 | 760 | 4 |
| 130 | 2 | 340 | 2 | 550 | 2 | 770 | 4 |
| 140 | 4 | 350 | 4 | 560 | 2 | 780 | 4 |
| 150 | 4 | 360 | 4 | 570 | 2 | 790 | 4 |
| 160 | 2 | 370 | 4 | 580 | 2 | 800 | 4 |
| 170 | 4 | 380 | 4 | 590 | 2 | 810 | 4 |
| 180 | 4 | 390 | 4 | 600 | 2 | 820 | 2 |
| 190 | 2 | 400 | 2 | 610 | 1 | 830 | 0 |
| 200 | 4 | 410 | 2 | 620 | 2 | | |
| 210 | 4 | 420 | 4 | 630 | 4 | | |

**Table 1**: Resources required per activity (quantity of labor, initial plan)

| Aver. Daily Entropy | Max Res. per day | Total Delay | Total Entropy | Total rev. Cost | Total Rev. Duration |
|---|---|---|---|---|---|
| -0,11 | 19 | -14 | -23,25 | 721090 | 204 |
| -0,09 | 21 | -16 | -17,15 | 720890 | 202 |
| -0,08 | 17 | -14 | -16,25 | 721090 | 204 |
| -0,07 | 18 | -15 | -13,88 | 720990 | 203 |
| -0,07 | 21 | -16 | -13,04 | 720890 | 202 |

**Table 2**: Best solutions for lowest project duration

| Aver. Daily Entropy | Max Res. per day | Total Delay | Total Entropy | Total rev. Cost | Total Rev. Duration |
|---|---|---|---|---|---|
| -0,01 | 21 | -51 | -2,12 | 717390 | 167 |
| 0,03 | 19 | -48 | 5,41 | 717690 | 170 |
| -0,03 | 19 | -42 | -5,16 | 718290 | 176 |
| 0,02 | 19 | -41 | 2,62 | 718390 | 177 |
| 0,01 | 19 | -40 | 1,89 | 718490 | 178 |
| 0,03 | 18 | -40 | 6,03 | 718490 | 178 |
| 0,05 | 14 | -40 | 9,06 | 718490 | 178 |

**Table 3**: Best solutions for lowest project entropy

All above solutions are obtained within the "2.718" criterion. If the laborers for each activity are assigned exactly at 2.718 times of required laborers then we would have the solution shown in Table 4, which gives the lowest duration of the project, from all the solutions found, but with big enough entropy. Of course, it is up to the project manager to take the risk and decide which solution is the best and most manageable.

| Aver. Daily Entropy | Max Res. per day | Total Delay | Total Entropy | Total rev. Cost | Total Rev. Duration |
|---|---|---|---|---|---|
| 0,21 | 20 | -80 | 29,16 | 714489,93 | 138 |

**Table 4**: Best solution for the lowest project duration.

In this project the laborers work only 8 hours every day, without shifting work. The factor that changes from solution to solution is the number of laborers that are being assigned to every activity. So the time compression doesn't affect the laborers productivity. Nevertheless, if a decrease of productivity is set up to 17% (Hanna et al. (2008)), as the worse situation that could be found because of the compression of time, then the duration of the solution found in Table 4, is 162 days (very close to 167 days previously obtained with negative project entropy) which means a 25.7% reduction in the project duration. The extra profit of the constructor is calculated at 39,000 euros (extra 5% of the initial cost). The project can be completed faster and the resources can be used in other projects.

A resource constraint can also be set. In this case study, the maximum total resource number required by the initial planning is 8 laborers for several days. A constraint was set for a maximum of 6 laborers that can be assigned per day (Fig 2).

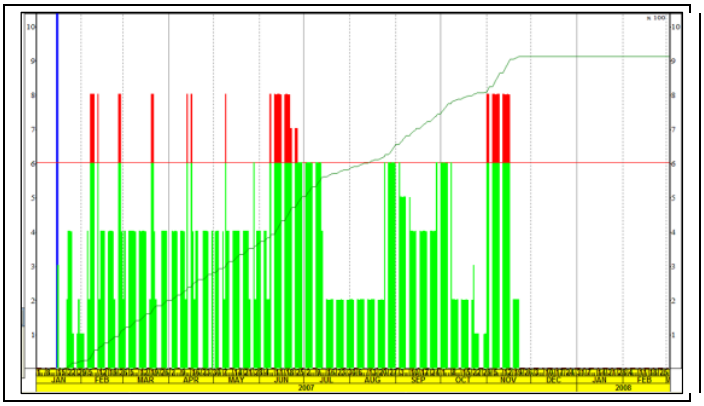

**Fig 2**: Total use of laborers per day of work in the project and constraint of six laborers per day availability

The project was then rescheduled by leveling the network with the use of Primavera v.3 (Primavera Systems, 2001), without splitting activities. The new duration of the project is 240 days with a delay of 22 days from the initial planning.

By the same method as before, all possible combinations are examined (by use of simulation) in order to find solutions that combine low entropy, low cost and low duration of the project, but this time under the resource constraint.

Because of the enormous number of possible combinations needed, the simulation is limited by assigning a varying number of resources only to the activities which are in progress during the days when required resources are more than six laborers per day. The number of assigned laborers is from 1 up to the number of required laborers for these activities (Table 1 shows these activities shaded). The other activities are assigned with the required number of laborers as used in the initial planning. The results of the simulation for the entropy, cost, duration and delay of the project under the resource constraints are shown in Figures 3-6. The 5 best solutions that could be found, combining lowest duration, lowest entropy and lowest cost appear in Table 5. The best utilization of the available resources is the one that completes the project in 225 days, 15 days earlier than the new schedule from Primavera and only 7 days delay from the initial unconstrained plan, which means a 6.25% improvement in duration and 8% in profit over the solution obtained by classical scheduling methods. So the comparison of the results of the two methods (classical and entropy based) show that better resource allocation can be found in order to get lower duration and cost of the project, while taking into account the risk factor (represented by the entropy level).

Finally, Figure 7 shows the relationship between total delay and total entropy of the project. As the delay increases, so much does the entropy decrease, which means that it is more difficult to manage the project while trying to reduce the delay and the duration of the project.

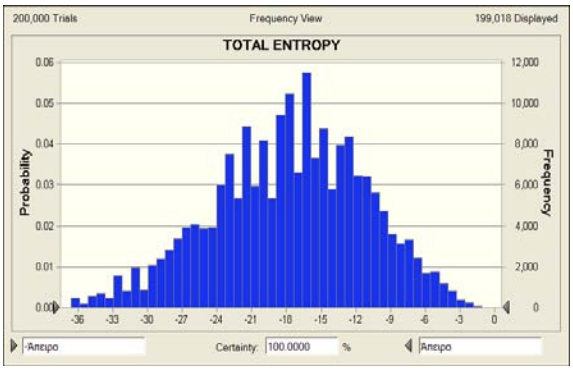


**Fig 3**: Resource-constrained total project entropy

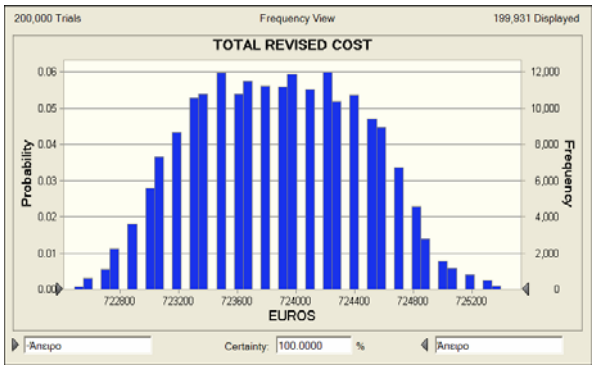


**Fig 4**: Resource-constrained total cost

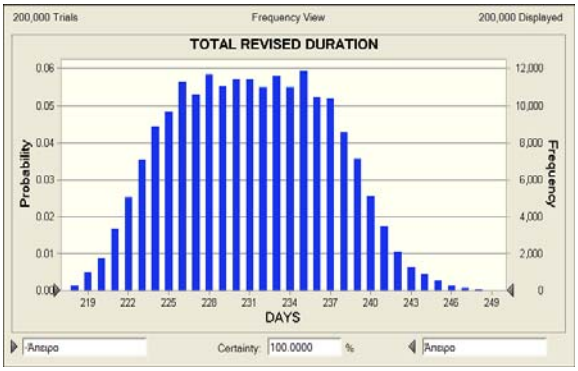


**Fig 5**: Resource-constrained total project duration

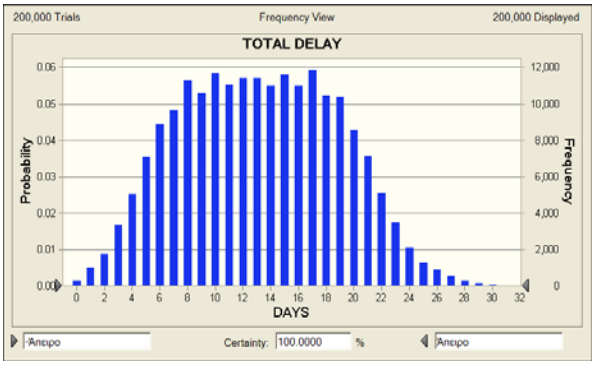


**Fig 6**: Resource-constrained total delay

| Aver. Daily Entropy | Avg Daily Resource Utilization | Max Res. per day | Total Delay | Total Entropy | Total rev. Cost | Total Rev. Duration | 110 | 120 | 170 | 230 | 290 | 350 | 470 | 490 | 500 | 630 | 660 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -0,05 | 65,33% | 6 | 7 | -11 | 723189,93 | 225 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 3 | 3 |
| -0,07 | 63,94% | 6 | 8 | -17 | 723289,93 | 226 | 4 | 2 | 2 | 1 | 2 | 2 | 2 | 1 | 1 | 2 | 4 |
| -0,07 | 64,38% | 6 | 8 | -16 | 723289,93 | 226 | 4 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 3 |
| -0,08 | 64,97% | 6 | 8 | -17 | 723289,93 | 226 | 4 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 3 |
| -0,09 | 63,72% | 6 | 8 | -19 | 723289,93 | 226 | 3 | 3 | 1 | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 3 |

**Table 5**: Best solutions for the lowest project duration.

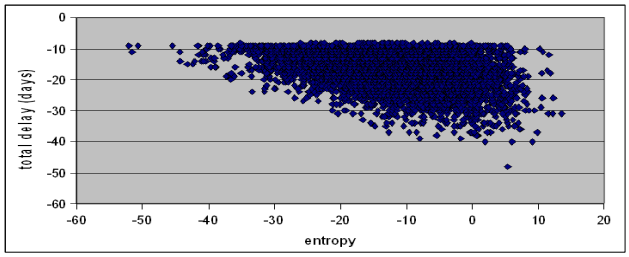


**Fig 7**: Relationship between delay and entropy of the project

## 4. Conclusions

Entropy is a new factor in decision making that can show the level of risk of a project to manage. The higher the entropy is (disorder), so more difficult is to manage the project.
The paper shows that there is a strong relationship between entropy and project duration and cost. With the shown entropy-based methodology, solutions that combine low entropy, low cost and low duration of construction can be found. In this specific case study a significant reduction of time has been achieved (up to 25.7%) and after imposing the resource constrain then the entropy approach results in a schedule that shows a 6.25% improvement in duration (and up to 8% in profit) over the solution obtained by classical scheduling methods, with entropy in low level, which means low level of risk to complete the project as planned.

Furthermore, a project manager is given the decision-making tools to use in deciding which solution is best attained and the risk associated with each solution, based on his/her knowledge of the level of difficulty in managing the project, the resulting entropy and its impact on the duration and the cost of a project.

## 5. References

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*AA056*

# Skills and Competences of Project Managers

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## Abstract
This study aims to diagnose the skills and competences profile of Project Managers in a holistic approach by utilizing a comprehensive framework (ICB–IPMA Competence Baseline Version 3.0, 2006). The Competing Values Model is adopted to operationalize Project Managers' effectiveness, as it shares wider acceptance among researchers. It is constituted from two dimensions (flexibility versus control and internal focus versus external focus), defining four quadrants that address distinct demands in the organizational arena. The Competing Values Model has also been utilised as a device for mapping organizations' leadership profiles and conducting comparative analysis. Furthermore, it may serve as a diagnostic tool, providing guidance to Project Managers in the identification of the key skills and competences that they will need to improve in order to foster individual effectiveness. This preliminary field research (the research is still on-going) is based on a structured questionnaire pilot-tested and adapted to fit to Greek reality.

## Keywords
Project Manager, Soft Skills, Managerial Competences, Performance, Field Research

## 1. Introduction

Nowadays, the implementation of principles and techniques of Project Management has expanded rapidly in many enterprises worldwide. Project Management can be defined as the implementation of knowledge, skills, methods and modern techniques or tools to activities in projects in order to satisfy the needs or to overcome the expectations of all stakeholders. The modern Project Manager understands that effective teams have interdependent members. The productivity and efficiency of an entire team is determined by the coordinated, interactive efforts of all its members. As a matter of fact, Project Managers must deal with team members or external negotiators with different perceptions and values, especially critical to the management of conflicts and crisis. On this account, apart from technical competences, behavioural competences are also a vital prerequisite in order the project to be completed successfully. A Project Manager needs strong communicative and interpersonal skills. To some extent, the deficiency of some behavioural competences is considered to be a significant obstacle for project success.

## 2. Review of the Literature

### 2.1. Behavioural Competences

There can be classified 15 behavioural competence elements, which are relevant to the profession of Project Management and in the context of the project (ICB–IPMA Competence Baseline Version 3.0, 2006). Their importance can and will differ depending on the situation. These behavioural competence elements are listed and analysed below in Table 1:

| No. | Behavioural Competence Elements | *12.1.1 Brief Definition* |
|---|---|---|
| 1 | **Leadership** | **Leadership** refers to patterns of behaviour as well as attitudes about communication, conflict resolution, criticism, teamwork, decision making and delegation. |
| 2 | **Engagement & motivation** | **Engagement** with and motivation of the project manager and the team members reflect the personal buy-in from all individuals associated with the project. |
| 3 | **Self-control** | **Self-control** or self-management mirrors a systematic and disciplined approach to deal with daily routine as well as stressful situations. |
| 4 | **Assertiveness** | **Assertiveness** involves the ability to state views persuasively and authoritatively taking into consideration their impact on decision making and consequently on project success. |
| 5 | **Relaxation** | **Relaxation** is focused on the relief of tension in difficult situations in order to re-energise individuals. |
| 6 | **Openness** | **Openness** refers to the cultivation of an open climate among individual so as to benefit from their input, suggestions, worries and concerns, avoiding discrimination on the grounds of age, gender, sexual orientation, religion, cultural differences or disability. |
| 7 | **Creativity** | **Creativity** describes the ability to think and act in original and imaginative ways in order to achieve project success. |
| 8 | **Results orientation** | **Results orientation** outlines project team's attention on key objectives to obtain the optimum outcome for all the parties involved. |
| 9 | **Efficiency** | **Efficiency** refers to the efficient allocation and exploitation of all resources available to the project. |
| 10 | **Consultation** | **Consultation** is focused on rational decision making and solid arguments presentation in order to find solutions. |
| 11 | **Negotiation** | **Negotiations** establish the means by which the involved parties can resolve disagreements towards a mutually satisfactory solution. |
| 12 | **Conflict and crisis** | **Conflict and crisis** in a project can be described as a time of acute difficulty, demanding risk analysis and scenario planning in order to handle these obstacles. |
| 13 | **Reliability** | **Reliability** reflects the ability to meet time and quality project's specifications. |
| 14 | **Values appreciation** | **Values appreciation** is based on mutual respect and on the receptiveness of others' opinions, value judgements and ethical standards. |
| 15 | **Ethics** | **Ethics** embraces the morally accepted conduct or behaviour representing personal and professional freedoms as well as boundaries. |

**Table 1:** The behavioural competence elements based on ICB – IPMA Competence Baseline Version 3.0

## 2.2. Competing Values Framework (CVF)

The Competing Values Framework (CVF) evolved from the work of Quinn and Rohrbaugh (1983) as they attempted to circumscribe a generally agreed upon theoretical framework of the concept of organizational effectiveness. This framework was chosen for this study, because it was experimentally derived and found to have a high degree of face and empirical validity in comparison with other instruments commonly used in organizational sciences (Cameron and Ettington, 1988; Cameron and Quinn, 1999). The CVF has also been utilised as a device for mapping organizations' leadership profiles and conducting comparative analysis (Trivellas and Dargenidou, 2009). It is constituted from two dimensions (flexibility versus control, and internal focus versus external focus), defining four quadrants, those are Open Systems, Rational Goal, Internal Processes and Human Relations. The diagonal dimensions also produce conflicting or competing values. For example, the values in the Open Systems Model (upper right quadrant) emphasize an external focus concerned with flexibility and growth, while the values in the Internal Processes Model (lower left quadrant) accentuate an internal focus with control and stability.

Cameron and Quinn (1999) developed an instrument to assess individual effectiveness based on the four CVF models and consolidated a list of successful leadership skills into a set of 12 competency categories. In particular, **Open Systems** Model involves managing the future, promoting continuous improvement, and fostering innovation, **Rational Goal** Model is comprised of managing competitiveness, energizing employees and focusing on customer service, **Internal Processes** Model is consisted of managing acculturation, controlling the system and coordination, and **Human Relations** Model considers the management of interpersonal relationships, teamwork and personal development.

# 3. Methodology

## 3.1. Research design

The field research was conducted using a structured questionnaire, which was developed based on the work of ICB–IPMA Competence Baseline Version 3.0, describing behavioural competences, and Quinn and Cameron's instrument of individual effectiveness. The research instrument was tested twice before it was released. Firstly, it was examined by ten project managers from consulting, construction and engineering companies. Secondly, it was provided to academics for in depth discussions. This process was fruitful, since they commented, rejected and finally confirmed the cognitive relevance of the items comprised the final competency questionnaire. It must be stressed that this paper provides the results of an ongoing field survey, thus the findings of this research must be treated with caution because of the small sample size and its limited representativeness of the respective population. The data analysis was based on an aggregation of individuals' scores for each of the high and low performers subgroups (N=30) according to each one of the four individual effectiveness dimensions, which were compared using t-tests. Almost 23% of the respondents are female. The majority of the respondents (47%) has a working experience of more than 15 years. Finally, 30% of the respondents have been Certified Project Managers.

## 3.2. Internal reliability of subscales

Inter-item analysis was used to verify the behavioural competences sub-scales for internal consistency or reliability. Specifically, Cronbach's coefficient alpha was calculated for each sub-scale, as recommended by Flynn et al. (1990), ranging approximately between 0.65 and 0.85, apart from Rational Goal Model dimension of effectiveness (0.65). Thus, most sub-scales exhibited over 0.70 reliability levels, which as suggested by Nunnally (1967) is the minimum level for acceptance. Given that the Rational Goal Model effectiveness sub-scale comprises only three items and considering its cognitive complexity and ambiguity, we favoured to sustain the theoretical designed component structure, notwithstanding this comparatively low alpha coefficient.

| | **Items** | **Cronbach's alpha** |
|---|---|---|
| **Behavioural Competences** | | |
| Leadership | 13 | .81 |
| Engagement & Motivation | 7 | .79 |
| Self-control | 8 | .78 |
| Assertiveness | 8 | .81 |
| Relaxation | 7 | .75 |
| Openness | 10 | .89 |
| Creativity | 5 | .85 |
| Results Orientation | 4 | .70 |
| Efficiency | 8 | .83 |
| Consultation | 8 | .71 |
| Negotiation | 6 | .70 |
| Conflict & Crisis | 6 | .79 |
| Reliability | 4 | .70 |
| Values appreciation | 10 | .87 |
| Ethics | 5 | .70 |
| **Individual Effectiveness** | | |
| Human Relations Model | 3 | .80 |
| Open Systems Model | 3 | .75 |
| Rational Goal Model | 3 | .65 |
| Internal Processes Model | 3 | .70 |

**Table 2:** Results of internal reliability analysis for all subscales

## 4. Findings and Analysis

### 4.1 T-test analysis

The objective of our study was to identify the profiles of high and low levels of Project Managers' effectiveness. T-test analysis was used to assess the statistical significance of the differences between groups of Project Managers according their level of individual effectiveness across the four dimensions prescribed by the CVF. Results of paired t-test analysis comparing the means of each competence across the four effectiveness dimensions are exhibited in **Tables 3, 4, 5 & 6**, indicating each group's high and low value, difference and level of significance of each paired

comparison. Graphical visualisations of the findings across the emerging dimensions are presented in the **Appendix (Figures 1, 2, 3 & 4)**.

## 4.2 PMs' behavioural competences profiles according to individual effectiveness

Regarding individual effectiveness focused on Human Relations Model, the three types of competences which were proven to be the most dominant ones distinguishing high and low PMs' performers are Efficiency, Values appreciation, and Engagement & Motivation. However, six out of the fifteen behavioural competences have no significant difference between high and low levels of Human Relations Model effectiveness (Table 3).

| *12.1.2 Behavioural Competences* | | Low | High | Dif. | Sig.(t-test) |
|---|---|---|---|---|---|
| 1 | Leadership | 5,30 | 6,07 | 0,77 | p<0,01 |
| 2 | Engagement & Motivation | 5,17 | 6,13 | 0,96 | p<0,01 |
| 3 | Self-control | 5,25 | 5,65 | 0,40 | n.s. |
| 4 | Assertiveness | 5,31 | 5,88 | 0,57 | n.s. |
| 5 | Relaxation | 5,10 | 5,54 | 0,44 | n.s. |
| 6 | Openness | 5,41 | 6,23 | 0,82 | p<0,01 |
| 7 | Creativity | 5,07 | 5,78 | 0,71 | n.s. |
| 8 | Results Orientation | 5,09 | 5,74 | 0,65 | n.s. |
| 9 | Efficiency | 4,96 | 5,97 | 1,01 | p<0,01 |
| 10 | Consultation | 5,14 | 5,83 | 0,69 | p<0,05 |
| 11 | Negotiation | 4,97 | 5,88 | 0,91 | p<0,01 |
| 12 | Conflict & Crisis | 5,36 | 5,92 | 0,56 | n.s. |
| 13 | Reliability | 5,61 | 6,18 | 0,57 | p<0,05 |
| 14 | Values appreciation | 5,10 | 6,11 | 1,01 | p<0,01 |
| 15 | Ethics | 5,52 | 6,45 | 0,93 | p<0,01 |

**Table 3:** Results of paired t-test analysis among competences of high and low level of Human Relations Model effectiveness

Considering individual effectiveness focused on Open Systems Model criteria, the top three types of competences differentiating high and low PMs' performers are Creativity, Efficiency, and Engagement & Motivation. However, two behavioural competences (Self-control and Reliability) found to have no significant difference between high and low levels of this effectiveness dimension (Table 4).

| 12.1.2.1 Behavioural Competences | | Low | High | Dif. | Sig.(t-test) |
|---|---|---|---|---|---|
| 1 | Leadership | 5,32 | 6,08 | 0,76 | p<0,01 |
| 2 | Engagement & Motivation | 5,14 | 6,16 | 1,02 | p<0,01 |
| 3 | Self-control | 5,16 | 5,73 | 0,58 | n.s. |
| 4 | Assertiveness | 5,22 | 5,96 | 0,74 | p<0,05 |
| 5 | Relaxation | 4,99 | 5,70 | 0,71 | p<0,05 |
| 6 | Openness | 5,39 | 6,26 | 0,87 | p<0,01 |
| 7 | Creativity | 4,82 | 6,00 | 1,18 | p<0,01 |
| 8 | Results Orientation | 5,02 | 5,71 | 0,69 | p<0,05 |
| 9 | Efficiency | 4,91 | 6,00 | 1,09 | p<0,05 |
| 10 | Consultation | 5,22 | 5,80 | 0,58 | p<0,05 |
| 11 | Negotiation | 4,92 | 5,89 | 0,96 | p<0,01 |
| 12 | Conflict & Crisis | 5,30 | 6,00 | 0,70 | p<0,05 |
| 13 | Reliability | 5,68 | 6,11 | 0,43 | n.s. |
| 14 | Values appreciation | 5,13 | 6,12 | 1,00 | p<0,01 |
| 15 | Ethics | 5,57 | 6,42 | 0,85 | p<0,05 |

**Table 4:** Results of paired t-test analysis among competences of high and low level of Open Systems Model effectiveness

Referring to individual effectiveness focused on Rational Goal Model, the three types of competences which were proven to be the most dominant ones distinguishing high and low PMs' performers are Creativity, Efficiency, and Engagement & Motivation, sharing the same pattern with the Open Systems Model. Reliability was the only behavioural competency with no significant difference (Table 5).

| *12.1.3 Behavioural Competences* | | Low | High | Dif. | Sig.(t-test) |
|---|---|---|---|---|---|
| 1 | Leadership | 5,23 | 6,09 | 0,85 | p<0,01 |
| 2 | Engagement & Motivation | 5,01 | 6,19 | 1,17 | p<0,01 |
| 3 | Self-control | 5,08 | 5,76 | 0,69 | p<0,05 |
| 4 | Assertiveness | 5,13 | 5,98 | 0,85 | p<0,05 |
| 5 | Relaxation | 4,87 | 5,74 | 0,87 | p<0,01 |
| 6 | Openness | 5,31 | 6,25 | 0,94 | p<0,01 |
| 7 | Creativity | 4,72 | 5,98 | 1,26 | p<0,01 |
| 8 | Results Orientation | 4,94 | 5,72 | 0,78 | p<0,05 |
| 9 | Efficiency | 4,80 | 6,00 | 1,20 | p<0,01 |
| 10 | Consultation | 5,13 | 5,83 | 0,70 | p<0,05 |
| 11 | Negotiation | 4,82 | 5,90 | 1,08 | p<0,01 |
| 12 | Conflict & Crisis | 5,23 | 6,00 | 0,77 | p<0,05 |
| 13 | Reliability | 5,68 | 6,08 | 0,40 | n.s. |
| 14 | Values appreciation | 5,03 | 6,12 | 1,09 | p<0,01 |
| 15 | Ethics | 5,53 | 6,38 | 0,85 | p<0,01 |

**Table 5:** Results of paired t-test analysis among competences of high and low level of Rational Goal Model effectiveness

Examining individual effectiveness focused on Internal Processes Model criteria, the top three types of competences differentiating high and low PMs' performers are Creativity, Efficiency, and Engagement & Motivation, sharing the same pattern with the previous two models. However, two behavioural competences (Self-control and Reliability) found to have no significant difference between high and low effectiveness, results identical to those of the Open Systems Model (Table 6).

| *12.1.4* | *Behavioural Competences* | Low | High | Dif. | Sig.(t-test) |
|---|---|---|---|---|---|
| 1 | Leadership | 5,32 | 6,10 | 0,78 | p<0,01 |
| 2 | Engagement & Motivation | 5,15 | 6,18 | 1,03 | p<0,01 |
| 3 | Self-control | 5,17 | 5,76 | 0,59 | n.s. |
| 4 | Assertiveness | 5,23 | 5,98 | 0,76 | p<0,05 |
| 5 | Relaxation | 4,99 | 5,72 | 0,73 | p<0,05 |
| 6 | Openness | 5,40 | 6,28 | 0,88 | p<0,01 |
| 7 | Creativity | 4,83 | 6,02 | 1,20 | p<0,01 |
| 8 | Results Orientation | 5,03 | 5,73 | 0,71 | p<0,05 |
| 9 | Efficiency | 4,92 | 6,02 | 1,11 | p<0,01 |
| 10 | Consultation | 5,22 | 5,82 | 0,60 | p<0,05 |
| 11 | Negotiation | 4,93 | 5,91 | 0,98 | p<0,01 |
| 12 | Conflict & Crisis | 5,31 | 6,02 | 0,72 | p<0,05 |
| 13 | Reliability | 5,69 | 6,13 | 0,45 | n.s. |
| 14 | Values appreciation | 5,13 | 6,14 | 1,01 | p<0,01 |
| 15 | Ethics | 5,58 | 6,44 | 0,87 | p<0,05 |

**Table 6:** Results of paired t-test analysis among competences of high and low level of Internal Processes Model effectiveness

## 5. Conclusions

This study aims to invistigate the skills and competences profile of Project Managers based on the ICB–IPMA Competence framework. The CVF is adopted to operationalize Project Managers' effectiveness, as it shares wider acceptance among researchers. This preliminary field research (the research is still on-going) is based on a structured questionnaire pilot-tested and adapted to fit to Greek reality. The first findings reveal that **project managers characterized by high levels of competencies exhibit also enhanced individual effectiveness across all four dimensions** (Open Systems, Rational Goal, Internal Processes and Human Relations). In particular, **Creativity, Efficiency, Engagement & Motivation** as well as **Values appreciation** are the four competency categories that **best highlight the gap differentiating high and low PMs' performers**. Furthermore, CVF may serve as a diagnostic tool, providing guidance to Project Managers in the identification and cultivation of the key skills and competences that they will need to improve in order to foster individual effectiveness.

# 6. Appendix

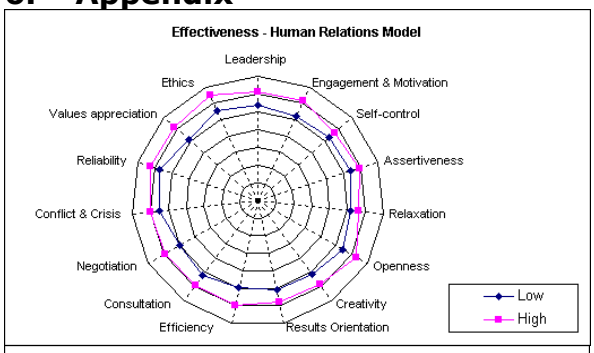


**Figure 1:** Competences' profiles of high and low performing PMs regarding Human Relations Model effectiveness

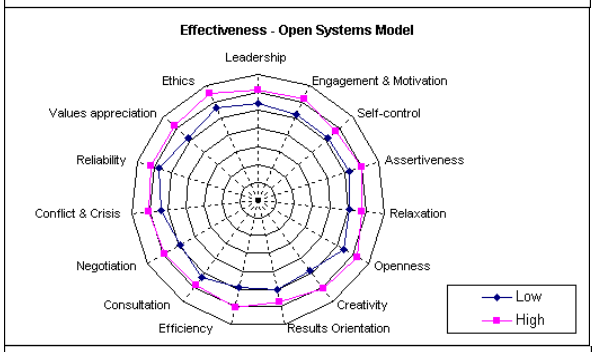


**Figure 2:** Competences' profiles of high and low performing PMs regarding Open Systems Model effectiveness

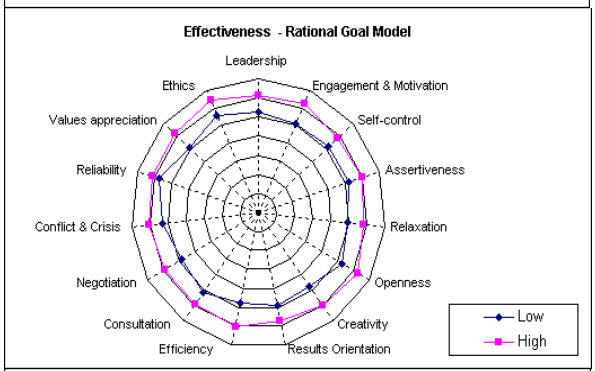


**Figure 3:** Competences' profiles of high and low performing PMs regarding Rational Goal Model effectiveness

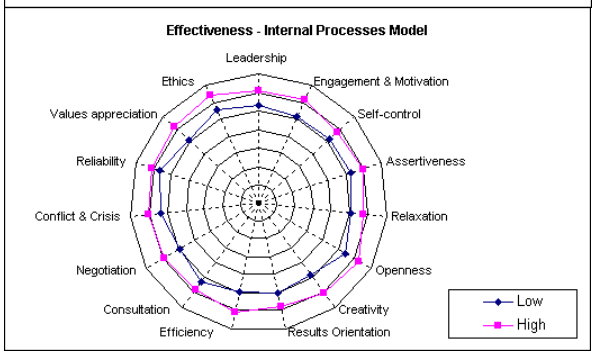


**Figure 4:** Competences' profiles of high and low performing PMs regarding Internal Processes Model effectiveness

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*AA018*

# Development and Prototype Application of an Oil Spill Risk Analysis in a Coastal Zone

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## Abstract
This paper introduces the development of a methodology for performance of oil spill risk analysis in coastal zones through a prototype application. The main objective of the research effort is to develop the basis for a tool that can assess risks due to the occurrence of an oil spill event aiming at assisting to the risk response process. The methodology concerns the processes of probability and consequence assessment. The two processes are accomplished qualitatively with a risk prioritization based on Analytic Hierarchy Process. Being a decision-making technique, Analytic Hierarchy Process can only be used after some appropriate modifications, which transform it into a tool for prioritizing risks with respect to their probability and consequence in different oil spill scenarios. This is an approach that attempts to rationalise the risk analysis stages and to indicate the uncertainties imposed to the problem, hence creating a basis for optimization of the risk analysis results.

## Keywords
Risk Analysis, Oil Spill, Analytic Hierarchy Process.

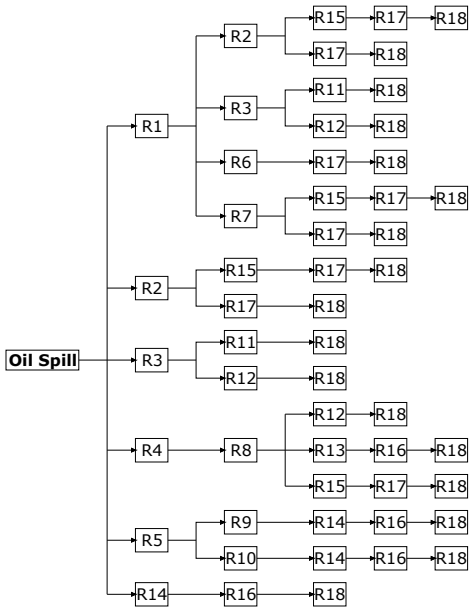
## 1. Introduction

The aim of oil spill risk management is to minimize the probability of occurrence of an oil spill event, and to optimize the risk response process once the event occurs. The present research effort is orientated to the risk response process, and particularly to the assessment of risks that occur after an oil spill event. The main objective is the elaboration of the basic processes of a risk analysis, which are the identification of risks, the assessment of their probability and consequence, and finally the actual risk assessment.

The analysis is performed in an imaginary coastal area that is assumed to concentrate some particular features which allow demonstration of a broad number of oil spill cases. Those features are the existence of wetlands, fisheries, a port with both commercial and passengers' services, an oil refinery and coastal tourism.

## 2. Risk identification

The risk identification has been based on literature (Kassomenos, 2004) and the author's experiential review, and facilitated by the event-tree technique. Accounting for the assumed characteristics of the application area, a number of mainly short-term risks were initially recorded, which were then presented with an event-tree. The event-tree as well as the identified risks are presented in figure 1.




R1 : Degradation of coastal ecosystem
R2 : Ban on swimming
R3 : Ban on fishing activities
R4 : Port entrance blockage
R5 : Accident (fire/explosion)
R6 : Degradation of coastal aesthetics
R7 : Loss of balance in coastal ecosystem
R8 : Delays in port operations
R9 : Life losses/injuries
R10: Material damages on ships
R11: Financial losses in fishing and aquaculture industry
R12: Limitations in the supply of goods to the market
R13: Decrease of Port Organization's reliability
R14: Decrease of involved shipping companies' reliability
R15: Decrease of tourists' inflow
R16: Financial losses in shipping companies
R17: Financial losses in tourism industry
R18: Political costs

**Fig 1**: Event-tree and identified risks

The identified risks can be classified in three categories based on their position in the event-tree. They can be direct, indirect or dual. Direct are the risks that constitute direct consequence of the oil spill event. Indirect are the risks that constitute direct consequence of another risk that has occurred, and not of the oil spill event. Dual are the risks that can be consequence of both the initial event and some other risk. In the above event-tree, direct are the risks R1, R4 and R5, dual are the risks R2, R3 and R14, while all the remaining risks are indirect. In the upcoming analysis it is assumed that dual risks belong in either set of direct and indirect risks.

## 3. Probability assessment

The probability of occurrence of the identified risks is assessed qualitatively. The choice for a qualitative analysis is based on the fact that records referring to follow-up risks of an oil spill are usually not available, and therefore a quantitative analysis is not possible. The product of this process is qualitative probability values for every identified risk. For this reason a probability scale is required. The scale proposed contains five probability classes, characterized with the integer numbers from 1 to 5. Each class corresponds to a probability range. The description of the five classes together with an indicative correspondence to real probabilities is presented below (table 1).

| Class | Probability range | Description |
|---|---|---|
| 1 | 0-20% | very low |
| 2 | 20-40% | low |
| 3 | 40-60% | medium |
| 4 | 60-80% | high |
| 5 | 80-100% | very high |

**Table 1**: Probability scale

The probability of each risk varies under different conditions. For direct risks it depends on the characteristics and the nature of the oil spill event. For indirect risks, it depends on the probability of all preceding direct and indirect risks. The main parameters that affect the probability of direct risks are the following: P1) Oil spill size, P2) Weather conditions, P3) Oil spill location. These parameters can take various values. The combination of certain values of the three parameters determines certain oil spill scenarios for which the risk probability can be assessed. The parameter values that are used in this research are presented in table 2. The oil spill size is determined in accordance to the oil spill categories of the International Tanker Owners Pollution Federation. The weather conditions are determined by a combination of wind speed and direction. The wind direction is characterized favorable or unfavorable, depending on if it results in decrease or increase of a certain risk probability respectively.

| **P1** | **P2** | **P3** |
|---|---|---|
| S1: < 7t | W1: 0-15km/h, favorable | L1: close to wetlands |
| S2: 7-700t | W2: 15-35km/h, favorable | L2: close to tourism installations |
| S3: > 700t | W3: 35-55km/h, favorable | L3: close to fisheries |
| | W4: > 55km/h, favorable | L4: port entrance |
| | W5: 0-15km/h, unfavorable | L5: commercial quay in the port |
| | W6: 15-35km/h, unfavorable | L6: passengers' quay in the port |
| | W7: 35-55km/h, unfavorable | |
| | W8: > 55km/h, unfavorable | |

**Table 2**: Parameter values

Based on the above parameter values, 168 different oil spill scenarios can be derived. The probability assessment of the direct risks in each of these scenarios can be facilitated if an intermediate process of risk prioritization with respect to probability is accomplished. In order to minimize the uncertainties imposed by a qualitative prioritization, it is necessary that the process is rationalized in a way that all steps requiring subjective decisions by the analysts are distinguishable. This can be achieved with application of a modified form of Analytic Hierarchy Process. The modifications made concern mainly its transformation from a decision-making technique to a tool for risk prioritization.

Analytic Hierarchy Process offers a rational framework for structuring and solving multi-criteria decision-making problems. The outcome of its application is a prioritization of the alternative choices by means of numerical factors. Its framework can be easily adapted for use in a risk prioritization process when different hazard scenarios are examined. In this case the process has to be repeated as many times as the number of direct risks. The outcome is a prioritization of the scenarios with respect to the magnitude of probability that they impose to the examined risk. Two additional simple steps can lead to the final objective, which is the prioritization of all direct risks with respect to their probability in every single scenario. A presentation of the risk prioritization steps as applied to the example area is given below. Only steps that are not identical to the corresponding steps of Analytic Hierarchy Process are described. These are steps 1, 2, 3 and 7. Steps 4, 5 and 6 are in absolute correspondence with Analytic Hierarchy Process, and therefore their presentation is neglected. The application refers to risk R3.

1. Definition of the problem parameters and their possible values. They have been already introduced. There are three parameters namely P1, P2 and P3 with values S1-S3, W1-W8 and L1-L7 respectively.
2. Comparisons of the problem parameters in pairs with respect to the rate that they affect the probability of the examined risk. The comparisons made are based on a series of assumptions related to the importance of parameters and their values, whose reliability is directly dependent to the analysts' experience on the subject. This step is therefore a source of uncertainty. The comparisons are facilitated by a comparison grading scale that determines the rate of importance of a parameter i when compared with a parameter j. This scale is absolutely correspondent to the fundamental scale of Analytic Hierarchy Process (Saaty, 1990), and is presented in table 2.

| Class | Description |
|---|---|
| 1 | i and j are of equal importance |
| 2 | intermediate class |
| 3 | i is slightly more important than j |
| 4 | intermediate class |
| 5 | i is fairly more important than j |
| 6 | intermediate class |
| 7 | i is much more important than j |
| 8 | intermediate class |
| 9 | i is absolutely more important than j |

**Table 2**: Comparison grading scale

The comparisons made are presented in a matrix as shown in table 3. When the importance of parameter j is higher then the inverse values of the comparison scale are used.

| i \ j | P1 | P2 | P3 |
|---|---|---|---|
| **P1** | 1 | 1/3 | 1/3 |
| **P2** | 3 | 1 | 1 |
| **P3** | 3 | 1 | 1 |

**Table 3**: Comparison matrix of parameters

3. Comparison of the parameter values in pairs with respect to the rate that they affect the probability of the examined risk. This step follows in practice the same procedure as step 2. The comparison matrix of parameter P1 is demonstrated in table 4. The matrices of parameters P2 and P3 are similar, hence their demonstration is neglected.

| i \ j | S1 | S2 | S3 |
|---|---|---|---|
| **S1** | 1 | 1/7 | 1/9 |
| **S2** | 7 | 1 | 1/7 |
| **S3** | 9 | 7 | 1 |

**Table 4**: Comparison matrix of values of parameter P1

4. Consistency control of the created matrices.

5. Computation of normalized Eigen vectors of the matrices of steps 2 and 3.
6. Computation of weight ratios of the problem parameters and parameter values.
7. Computation of the final prioritization factors of each scenario. This is the final prioritization step. The scenario with the highest factor imposes the highest probability to risk R3, while the one with the lowest factor imposes the lowest probability.

A step further stands the estimation of the probability class in which every direct risk belongs. This can be achieved through a correlation code between prioritization factors and probability classes, so that every factor corresponds to a certain probability class. Since there is already a correlation available among the different scenarios expressed by the prioritization factors, it is sufficient to estimate the probability class in only one scenario. The probability class of the remaining 167 scenarios can be then derived with a straight forward calculation.

A quick examination of the established scenarios reveals that the probability class of some of them can be reasonably estimated. Such a case is scenario C164 (S3-W8-L3). It refers to a large oil spill, occurring under the highest possible wind speed with unfavorable direction, and is located close to fisheries. In this case the probability that risk R3 occurs is very high, and thus a probability class 5 can be considered. C164 can be therefore used as a base-scenario for the calculation of probability in the remaining scenarios as follows:

$$P_{Ci} = \frac{V_{Ci}}{V_{C164}} P_{C164} \quad (1)$$

In this equation $V_{Ci}$ is the prioritization factor of scenario Ci, $V_{C164}$ the prioritization factor of scenario C164 and $P_{C164}$ the probability of risk R3 in scenario C164. Since the performed analysis is quantitative, the probability $P_{C164}$ is not a certain numerical value. The only information about it is that it belongs to the range 80-100% which is indicative of probability class 5. In the present analysis the maximum probability of the corresponding range is considered for the base scenarios. This way a conservative risk assessment is accomplished, since the most unfavorable risk values will be extracted. Choosing the median or lowest value of the range would result in more favorable risk estimation. This choice constitutes another source of uncertainty in the analysis.

Another point that needs to be stressed is that the probability calculated with equation 1 is not a real probability, but it indicates the probability class that scenario Ci imposes to the examined risk. If for instance $P_{Ci}$ is equal to 29%, then in case of scenario Ci, the probability class of risk R3 is 2.

The risk prioritization process and probability class estimation is repeated six times, since there are in total six direct risks. The results of this procedure are used in the probability class estimation of the indirect risks. This estimation can be realized with the use of the event-tree that has been previously presented and of the principles of Probability Theory. In particular a methodology with two basic steps is proposed. These steps are presented below:

1. Empirical assessment of the probability class in which every indirect risk belongs, when the preceding direct or indirect risk according to the event flow lines has occurred. This is in fact an empirical determination of conditional probabilities. The imposed probability classes to the indirect risks that may occur

after the occurrence of risk R3 are presented in figure 2. This step is highly subjective and therefore imposes a high degree of uncertainty to the analysis.

2. Assuming that the numerical probability value that corresponds to a certain probability class is the highest value of its probability range, and according to the Probability Theory principles, a probability is calculated for every indirect risk. Similarly to the estimations made for direct risks, the calculated probabilities are not real, but their value is indicative of the probability class in which every indirect risk belongs.

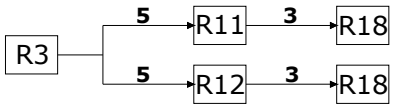



**Fig 2**: Probability classes of event-flow lines following the occurrence of R3

It should be noted that there are risks occurring in more that one event sequences, such as risk R12. According to the event tree of figure 1, risk R12 can be a cause of the occurrence of risk R3 or of risk R8. The final probability class of this kind of risks is the most unfavorable of the two resulting classes.

## 4. Consequence assessment

The consequence assessment of the identified risks follows a methodology similar to the one of the probability assessment process. The two problems are not identical, hence some adaptations are necessary. In accordance to the probability assessment, the consequence assessment process is qualitative and makes use of a consequence class scale with the integer numbers from 1 to 5. The description of the consequence classes is absolutely correspondent to this of the probability classes.

The risk consequence is affected by five parameters. The three of them are the same with the probability parameters, P1, P2 and P3. The remaining two parameters are the following: P4) Oil type, P5) Season. The possible values of oil type are: O1) Crude oil and O2) refined oil. The possible season values are: T1) Spring, T2) Summer, T3) Autumn, T4) Winter.

In total 1344 new oil spill scenarios are produced with combination of the parameter values. The risk prioritization with respect to consequence is accomplished through application of the modified form of Analytic Hierarchy Process. The followed steps are identical to the ones presented in chapter 3. The determination of the consequence class in which every identified risk belongs follows too the base-scenario technique that has been used for determining the risk probability classes. Unlike the probability assessment, the determination of consequence classes does not differ between direct and indirect risks. The severity of consequences of any risk is considered correlated to the oil spill scenarios, and there is no correlation between the consequences of direct and indirect risks. Hence all risk consequences are calculated with the same method.
A minor divergence between the base-scenario technique for probability and consequence assessment is that there are no ranges of consequence indicative of the consequence classes to be used as boundary values. The consequence classes could be described with damage ranges expressed in real damage costs. Such quantification is out of the scope of a quantitative analysis. A practical solution to

this problem is the use of numerical ranges correspondingly to the probability ranges for indication of each consequence class. Thus class 1 can be described with the range 0-20, class 2 with the range 21-40 and so on.

## 5. Risk assessment

Following a qualitative probability and consequence analysis, the risk assessment has to be qualitative as well. A risk scale similar to the scales of probability and consequence is necessary in this process too. The proposed scale contains three classes, 1, 2 and 3 correspondent to low, medium and high risk respectively. The nature of results extracted by the two previous processes enables the use of a probability-consequence table, which seems to be the most appropriate technique for the assessment of risks. The table used is presented in figure 3.

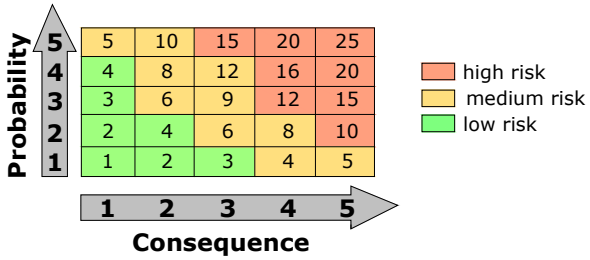



**Fig 3**: Probability-consequence table

The probability-consequence table technique is applied for every risk in all oil spill scenarios. The scenarios used in this process are the ones that have been used for the consequence assessment. The 168 scenarios of the probability assessment are integrated in the consequence scenarios.

Some indicative results of the analysis performed for risk R3 in five random scenarios are presented below (table 5).

| Scenario | Descriction | Probability class | Consequence class | Risk class |
|---|---|---|---|---|
| C1 | S1-W1-L1-O1-T1 | 2 | 2 | 1 |
| C255 | S1-W5-L4-O2-T3 | 2 | 1 | 1 |
| C589 | S2-W3-L4-O1-T4 | 1 | 2 | 2 |
| C1050 | S3-W3-L6-O1-T2 | 3 | 5 | 3 |
| C1341 | S3-W8-L7-O2-T1 | 5 | 3 | 3 |

**Table 5**: Risk assessment results for risk R3

## 6. Conclusions

- A methodology for probability and consequence assessment is developed which is based on Analytic Hierarchy Process. After some appropriate modifications, Analytic Hierarchy Process is transformed from a decision-making technique into a tool for risk prioritization and qualitative risk analysis.

- The risk prioritization is achieved through the comparative evaluation of the problem parameters and their values, and not through a direct risk assessment. A rationalization of the risk assessment stages is attempted with this approach, which facilitates the discrimination of uncertainties imposed to the analysis.

## 7. Recommendations

- The developed methodology refers to an oil spill risk analysis. Appropriate alterations of the problem parameters enable its application in other kinds of hazards as well, such as flooding, failure of structures and nuclear accidents.
- An objective evaluation of the methodology through a validation is necessary. This can be achieved with application in a real area by experienced analysts. Such a procedure can indicate elements that need to be reconsidered.
- The methodology indicates the sources of uncertainty in the risk analysis. Further research on the deviation of the final results caused by the imposed uncertainties would highly contribute to the reliability of the analysis.
- The possibility of transforming the method to a quantitative analysis tool is interesting to be examined. This can be possibly realized by correlating the qualitative probability and consequence classes with real probabilities and damage costs respectively.

## 8. Acknowledgements

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# Analysis of Project Performance of a Real Case Study and Assessment of Earned Value and Earned Schedule Techniques for the Prediction of Project Completion Date

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## Abstract
The management of a project, especially in the construction industry, is without doubt a subject of high interest, demanding and complex and in the same time challenging and exciting. In the line process of planning-supervision-control, the last element enables the manager to determine the deviation range of actual practice from the original planning. Developing a construction schedule for a complex viaduct using the software MS Project 2007, and tracking the progress with real dates and durations, the results of Earned Value (EV) and Earned Schedule (ES) techniques are assessed regarding the duration forecasting accuracy schedule performance of a late finish project. The schedule includes complex interrelations, logistics in relation to the effective management of construction equipment and unforeseen events during the construction process. Three different scenarios are examined, from the construction of the whole bridge to a single structural element in order to assess the effectiveness of the methods, their sensitivity to re-baselining, and the contribution of critical tasks to the end result.

## Keywords
*Construction Management, Earned Value, Earned Schedule, Microsoft Project, Egnatia Odos AE*

## 1. Introduction

In project management, it is vital to have adequate means of obtaining information about the progress of a project against a baseline and the anticipated outcome of the project. The information are required to (1) assure managers that the project is progressing within acceptable budget, schedule and quality expectations; (2) support decisions to approve the movement of the project through its stages, and (3) confirm subjective assessments that benefits will be realised. A project has traditionally been viewed as successful if it was completed on time, within budget and with the specified quality. More recent views of project management consider a project successful if it came in within its original schedule and its expected cost, but also if it still works after the implementation as suggested by Mahaney and Lederer (2008) with a particular relevance to construction projects. EV systems, being a standard method of measuring project performance, have been setup to deal with the complex task of controlling and adjusting the baseline project schedule during execution, taking into account project scope, timed delivery, and total project budget. Vanhoucke and Vanvoorde (2006) state that although EV systems have

been proven to provide reliable estimates for the follow-up of cost performance within certain project assumptions, it often fails to predict the total duration of the project. Although there are barriers to having an estimating formula for predicting final project duration from EVM data, it remains a desired capability. Project managers (PM) need the ability to generate reasonable estimates of the duration. Furthermore, they need to be able to estimate a revised completion date at every reporting period without having to exhaustingly evaluate the tasks remaining each time. That is, to manage cost and schedule equally well, PMs need comparable analysis capability for both (Lipke and Henderson, 2006). Earned Value Method (EVM) has not been as successful in assessing schedule performance. After a project is about two-thirds complete, EVM schedule performance metrics become unreliable, as EV invariably converges on PV. Another question frequently asked is how the project managers handle the effects of re-baselining in making their forecasts. Lipke (2008) states that in the research it was discovered that there is a little discussion of the topic, in even the best EVM reference books.

Lipke in 2003 proposed the concept of 'Earned Schedule" (ES) to address these issues. Rather than just looking at schedule performance using the value of work, earned schedule also looks at when the work was to be completed. ES aims to measure schedule performance using a time-based measure from which time based measures of Schedule Variance (SV(t)) and Schedule Performance Index (SPI (t)) metrics are derived. The ES concept is claimed to be analogous to EV and can be used to calculate measures intended to be analogous to EVMs cost based counterparts. Small scale research mainly focused on IT or high technology projects has occurred throughout the evolution of ES. Although lack of testing is a drawback, the risk associated with ES usage is minimal. Henderson (2003) suggests that one compelling point supporting ES is that, regardless of the circumstances of the application (who, project type, company, country), the findings from all sources are consistent. The ES method, in every application, outperforms other EVM-based methods for representing schedule performance.

The purpose of the paper is to examine the capability of the methods to represent the schedule performance effectively in a late construction project with inherent complexities and unforeseen events. It is also to test the capabilities of the methods to adequately forecast the final duration. The analysis includes three parts. First, we compare the classic earned value performance indicators SV and SPI with the newly developed ES performance indicators SV(t) and SPI(t) and their forecasting accuracy, during the assessment of the overall viaduct construction schedule. Next, we present the comparable findings when a re-baselining takes place at an early stage of the project. Finally, we illustrate the use of each method on lower-WBS level where the majority of activities are part of the critical path of the project. The methodological approach is outlined in detail and results are presented in tables and graphs. The conclusion is that the ES concept has validity. The ES based schedule metrics more accurately portray a project's schedule performance compared to the EVM equivalents.

## 2. Project monitoring tools, EVM vs. ES

Earned Value Management (EVM) uniquely connects cost, schedule, and requirements thereby allowing for the creation of numerical project performance indicators and enable to managers to express the cost and technical performance of their project in an integrated and understandable way to employees, superiors and customers. EVM has three measures: Planned Value (PV), Actual Cost (AC), and

Earned Value (EV). The planned values of the tasks comprising the project are summed for the periodic times (e.g., weekly or monthly) chosen to status project performance. The time-phased representation of the planned value is the Performance Management Baseline (PMB). AC and EV are accrued and are likewise associated with the reporting periods. For each measure, the time-phased graphs are characteristically seen to be "S-curves". From the three measures, project performance indicators are formed. The schedule indicators are: SV = EV - PV, and SPI = EV / PV, where SV is the schedule variance and SPI is the schedule performance index. The fact that PV equals BAC at the planned completion point and does not change when a project runs late causes the schedule indicators to falsely portray actual performance. In fact, it is commonly observed that the schedule indicators begin this behavior when the project is approximately 65% complete (Lipke, 2008). The irregular behavior of the schedule indicators causes problems for project managers. At some point it becomes obvious when the SV and SPI indicators have lost their management value. From this time of uncertainty until project completion, the manager cannot rely on the schedule indicators portion of EVM. For all of the accomplishments of EVM in expressing and analyzing cost performance, it has not been as successful for schedule performance. The EVM schedule indicators are, contrary to expectation, reported in units of cost rather than time. Beyond this problem, there is the much more serious issue: the EVM schedule indicators fail for projects executing beyond the planned completion date.

The technique to resolve the problem of the EVM schedule indicators is Earned Schedule (ES). The ES idea is simple: identify the time at which the amount of earned value (EV) accrued should have been earned (Lipke, 2003). By determining this time, time-based indicators can be formed to provide schedule variance and performance efficiency management information. Projecting the cumulative EV onto the PV curve (i.e., the PMB), determines where PV equals the EV accrued. This intersection point identifies the time that amount of EV should have been earned in accordance with the schedule. The vertical line from the point on the PMB to the time axis determines the "earned" portion of the schedule. The duration from the beginning of the project to the intersection of the time axis is the amount of Earned Schedule (ES). With ES determined, time based indicators can be formed. It is now possible to compare where the project is time-wise with where it should be in accordance with the PMB. Actual time (AT) is the duration at which the EV accrued is recorded. The time-based indicators are easily formulated from the two measures, ES and AT. Schedule Variance becomes SV(t) = ES - AT, and Schedule Performance Index is SPI(t) = ES / AT. The computed value of ES describes where the project should be in its schedule performance.

## 3. The project

Egnatia Odos, part of the Trans-European Road Network and one of the 14 priority projects of the EU, is a modern 680km highway, stretching from one side of Greece to the other. Being one of the few Greek highways to be designed and built to full up-to-date national and modern international specifications has been described as Europe's most difficult and modern motorway. The case study used in this paper is related to the construction of complex viaduct is part of the significant structural content of a 37km section 720m€ from Panagia to Grevena in the western part of the motorway, crossing a mountainous area with complex geology and severe environmental constraints.

# 4. The case study of a bridge construction and the monitoring of the construction schedule

This bridge carries the road over the deep valley of a river (Figure 1). At the southern end of the valley the carriageway splits into two separate viaducts, the lengths of which are different due to the prevailing topography. The structure consists of twin segmental box girder viaducts, with integral piers varying in height from 29m to 70m. The ground conditions are variable with visible fractures in the rock slope formations. The overall length is 636.20m and 531.10m for the eastbound and westbound structures respectively. The isolated site, with its steep 70m-deep valley, required a bridge solution driven more by construction method than anything else, which is why a balanced cantilever bridge was chosen. Similarly, the position of the river Venetikos in relation to the steep valley slope resulted in spans up to 120m.

**Fig 1**: View of the viaduct

## 4.1 Time Schedule Details

In a bridge of such size and complexity, overall time is mainly determined from the construction equipment (machinery, cranes, and formworks) which is available on the construction site and obviously not all activities start simultaneously. Thus in addition to the scheduling of works for the construction of foundations and pier walls, critical activities for the completion of the bridge are the available number of formwork for the construction of pierhead and cantilevers, and effective use and transfer from pier to pier. A WBS established to make such a complex project more manageable and is formed in such a way to help breakedown the project into manageable chunks that can be effectively estimated and supervised. The analysis followed the determination of deliverables with a four level breakdown structure. Resources include the detailed quantites of all the items of the bridge construction (concrete, reinforcing steel, prestresssing steel, earthworks, accessories) in accordance with the design provisions and tender documents. The overall cost of the bridge is estimated at 19.6 m€. The start date of the construction was the 27$^{th}$ of May 2005, with a planned duration of 129wks. The schedule is characterized by slow early progress, followed by a significant acceleration following completion of about 10% of works. The actual duration was 145.2 wks.

## 4.2 Particular aspects of construction

There are several factors affected the schedule performance. Some of them were unforeseen events others required re-work of several activities. However most or all of them are common in the construction projects. Variations in the initially assumed geotechnical conditions, under-skilled personnel in demanding activities,

late supply and management of equipment, bad concreting and a fire incident are the main aspects influenced the schedule performance.

## 4.3 Analysis and results

For the analysis of the overall bridge construction schedule, nine control periods were determined taking into account the percentage completion of works and main events along the timeline of the project. In Table 1, the control dates are presented along with the corresponding items.

| Control period | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| Wk. No. | 10 | 19 | 37 | 45 | 76 | 89 | 106 | 123 | 141 |
| Compl.% | 1 | 3 | 7 | 11 | 34 | 44 | 66 | 84 | 96 |

**Table 1:** Data related to the control periods of the schedule

Based on the activities progress and completion dates, the curves of Earned Value (EV) and Planned Value (PV) against cost are prepared at each control period, followed by the accumulation of all the results representing the overall schedule performance as illustrated in Fig 2.

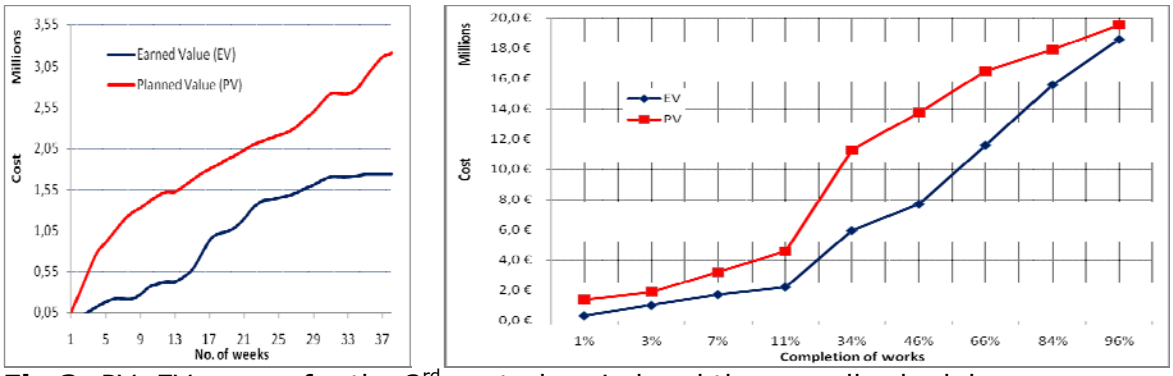


**Fig 2**: PV, EV curves for the 3rd control period and the overall schedule

Following the principles and techniques of the methodologies presented in the precedence paragraphs, the main duration metrics and indices are calculated with both methods. EV metrics are obtained directly from MS-Project where ES values are processed manually. Fig 3(a), portrays the forecasting performance of the two methods, along with the actual duration (in black) and the Critical Path(CP) analysis (in red) for comparison. It is apparent that Earned Schedule converges faster towards the actual duration but without any remarkable results. It is also clear that CP forecast, continuously underestimates the actual duration. The schedule performance is illustrated in Fig 3(b), where SPI for both methods is plotted against the percentage of work performed. It is clear, from a value of as low as 0.2, that there is a late start and slow progress at the beginning up to approximately 1/3 of the work completed, which clearly indicates a problematic project. The tendency of the SPI(c) to reach a value of 1.0 is clearly noted even though the project is late and exceeded the original contractual deadline, and that occurs at about 66% completion, that is when 2/3 of the project is effectively complete.

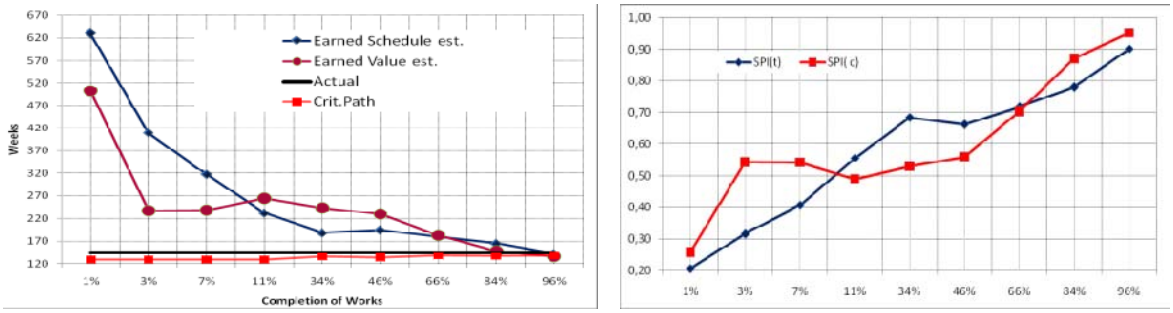


**Fig 3 :** (a)Comparison of forecasting accuracy and (b)Schedule Performance Index

A second analysis includes the assessment of the two methods during re-baselining. During this process a revised baseline is set, which purposely involves the BCWS of the 3rd control period since it corresponds to approximately 10% of work completion. A recalculation of EV and ES metrics is carried out in order to assess the forecasting result, having recovered the project form a late start. In Fig 4, the revised baseline (in red) is plotted against the original PV (in brown) and the EV curve (in green).

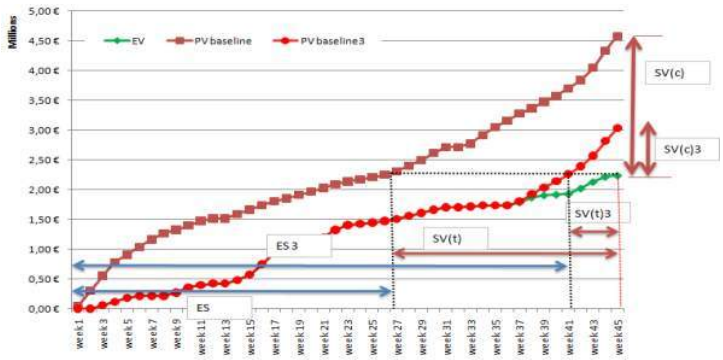


**Fig 4** : Re-Baselining and ES,EV metrics

The values from the analysis and the revised indices are shown in Table 2. It is remarkable how the schedule performance index is improved, with values of 0.7 and 0.9 for EV and ES analyses respectively comparing with original corresponding values of 0.49 and 0.56. What is to be noted is that the forecasting made with ES is 144.7wks is remarkably close to the actual duration of 145.2wks, whereas EV suggests a value of 189wks.

| EV & ES Metrics | Original Baseline | New Baseline |
|---|---|---|
| BCWP, EV(€) | 2.239.983,37 | 2.239.983,37 |
| BCWS, PV(€) | 4.582.255,75 | 3.034.095,15 |
| SV(c) (€) | - 2.342.272,38 | - 794.111,78 |
| SPI(c) | 0,489 | 0,7 |
| ES | 25,01 | 40,11 |
| SV(t), (wks) | -19,99 | -4,89 |
| SPI(t) | 0,56 | 0,89 |
| Forecasting with ES | 232,08 | **144,72** |
| Forecasting with EV | 263,80 | 184,29 |
| Actual | **145,2** | **145,2** |

**Table 2** : Data of ES and EV extracted from re-baselining

A third analysis included the schedule performance of a single structural element which includes the foundation and column of the pier, the pier table and the cantilevers. The pier selected, has all its activities along the critical path of the project. The control periods are now coinciding with the full completion of a structural section or activity. The schedule consists of 64 activities with a small and controllable duration. The planned duration was 48.2 weeks. Thirteen control periods were set from the start date to 100% completion of the cantilevers. Fig 5, illustrates the schedule performance and the project duration forecasting. It is stated that the planned work should have been completed at 62% completion. It is very clear from the first diagram that SPI(c) tends to increase at 2/3 completion in order to receive eventually the value of 1.0, thus not accurately representing the schedule performance. On the contrary SPI(t) follows a smoother trend, with a better representation of the performance reaching a value of 0.8. Very good convergence is shown by ES after the 43rd week which corresponds to the 50% completion at a SPI(t) value of around 0.6. On the contrary convergence using EV is reached after the 80% completion of works. Almost accurate is the CP but that is explained from the fact that all activities are in critical path therefore the software provides almost the exact duration throughout the schedule.

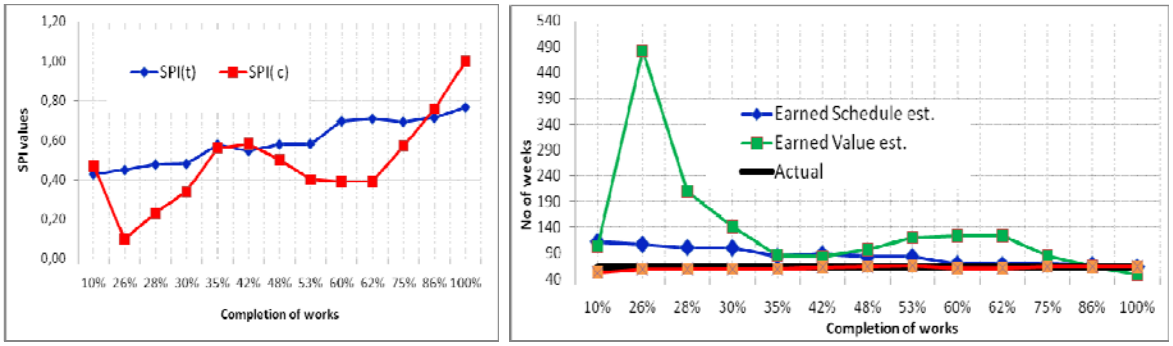


**Fig. 5** : Schedule performance and forecasting accuracy

## 5. Summary and conclusions

Highway construction projects are quite uncertain in nature and often are late, exceeding original budget. Although responsibilities of parties and causes of such events are interesting to explore further in a contractual framework, for a client who needs to prioritize work and effectively manage European funding within strict deadlines, the ability to forecast the end date of a project and have progress indicators early in the course of construction and at least before the 2/3 of the duration, is of vital importance. Testing the performance of the techniques on an actual construction project was a challenge as it allows easy comparisons of the forecasting ability and performance indicators analytically obtained, with real values. In this paper, we presented an application of the EV and ES methodologies, as specific-duration methods, using EV metrics and evaluate them on real-life construction project data extracted from a complex viaduct in Egnatia Odos highway, using MS-Project. The three analyses carried out reveal the superiority of the ES method showing reliable results during the whole project duration, confirming conclusions previously published in literature related to the weakness of the EV method to produce reliable duration forecasting even at 50% project completion. The ES method seems to provide valid and reliable results along the project's lifespan. The value of the paper to practicing professionals can be summarized in the following items:

1. It demonstrates the application of the two methods on a late construction project with variations and unforeseen events, having the actual data of the schedule as planned, the actual progress and the actual finish date.
2. The methods are tested with three scenarios including a re-baselining of the schedule and a group of activities along the critical path, giving a very good insight of how the methods are performing in each case in terms of forecasting the duration and progress indicators and compared with the real case.
3. It helps the reader and potential user of a tracking method, to get an appreciation of the use of the techniques for particular cases and how the indices resulting from the methods should be read, their reliability during the 2/3 duration of the project and how these can be assessed and combined to obtain a good idea of how the schedule is performing leading to an optimum decision to recover from a possible disaster.

As a conclusion, the use of EVM or the ES method depending on the need and knowledge of the project manager might lead to similar results for project monitoring in the early and occasionally in middle stages. However this statement can be misleading if a re-baselining is applied at early project stages, and that needs to be handled very carefully. In general, the EV metrics shall be set-up as early warning signals to detect potential problems in an easy and efficient way. Our forecasting results and the assessment of schedule performance on the three cases demonstrate that reliable early warning signals are obvious. We refer to Cooper (2003) stating that the use of EVM can be questioned when they are applied in highly complex projects. Due to the cycles of rework, the accuracy of the EVM metrics can be biased, leading to incorrect management decisions. Therefore further investigation is necessary to this research topic and more data is necessary for assessment and comparison when a complex project also subject to a vast amount of rework cycles.

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*NGO3*

# Social economy and certification in the context of the EQF

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## Abstract
One of the economy sectors, which in the past years has been concentrating the interest of researchers is that of the social economy, contributing to the development of regions and support of groups of the population that are struggling with significant problems of unemployment. The lack of a specialized executive dynamic workforce, and especially the weakness of the typical educational system to adapt to new data and conditions, has led many individuals with insufficient typical qualifications to be active as advisors and/or educators of social economy. The present paper deals with the development of a professional profile of the advisor of social economy and an innovative method of certification of non-formal learning that responds to the directional guidelines of the EU in relation to the recognition of learning outcomes. The research that was conducted, utilizing the Delphi Method on 45 participants in 3 different EU countries revealed a necessity for the certification of informal learning in the specific field. With regards to the methodology of certification, a new, innovative method of correlation of the learning outcomes with the European Qualifications Framework is being proposed. In parallel, the need for further research in the field of social economy, and especially with regards to the methods of exploitation and integration of the suggested methodology to non-governmental organizations, is highlighted.

## Keywords
Social economy, Certification of informal learning, European qualifications framework, Social consultant, Non Governmental Organisation

## 1. Introduction

The sector of social economy, one of the most developing sectors, employed more than 11 million individuals in Europe in 2007 (CERIEC, 2007), while it also presented with remarkable progress in the last years in all member states of the EU, has created new prospects of employment, which are based on the combat of discrimination and exclusion from the labor market, and has created favorable conditions of development of entrepreneurial initiatives, while meeting the needs for the provision of social services.
However, despite the development of the sector, significant weaknesses are observed as to its development with the most significant one constituting the lack of an integrated framework for the dimensions, characteristics, organization and functioning of the specific sector, especially in Greece. The aforementioned deficiency has led to the entrance of non specialized individuals that undertake the counseling and education of individuals and institutions that are active in the social

economy, which most often are unable to cope with modern day requirements. As a result, the validation of non-formal and informal qualifications constitutes a challenge that will improve the qualifications of executives and will contribute to the development of the sector. The present work discusses and presents the development of a professional profile of the advisor of social economy and an innovative method of certification of non-formal learning that responds to the directional guidelines of the European Union in relation to the recognition of learning outcomes. The sector of Social Economy is presented in continuation, as well as the certification of qualifications, the methodology with which the research was conducted, and the results and conclusions of the research.

## 2. Social economy: A third sector in economies

The Social Economy is defined as the sector of the economy that is found between the private and public sector of the economy, in which economic activities with social aims and objectives are being concluded in. The European definition of social economy supports that *social enterprises are particularly active in certain fields such as social protection, social services, health, banking, insurance, agricultural production, consumer affairs, associative work, craft trades, housing, supply, neighbourhood services, education and training, and the area of culture, sport and leisure activities*" (CEPCMAF, 2002). The definition of social economy may also be supplemented by Roelants (2002) definition where social economy is the part of economy where enterprises are created by and for those who have common needs and are responsible for those to whom they are to serve. Social economy is also defined as the specific kind of entrepreneurship with unique features, which is assessed by its contribution into solidarity field, social cohesion and territorial development.
Between the member states of the European Union, Italy is the only member state throughout the 90s that allocated specific legislation for social enterprises. Later, in 1995 and afterwards, Belgium, France, Portugal, Finland and Lithuania drew up relative legislation (National Institute of Employment, 2002). In Greece the participation of the third sector to the employment represents the 1% to 2% of the total employment in Greece. More specifically, in the third sector approximately 68,700 people are employed which represent the 1.8 % of the total employment and the 3.3 % of the paid employment (*Chrysakis et al.* 2002). The main interest and focus of social enterprises is either socially or geographically excluded people and the enterprises in social sector are usually Very Small Enterprises VSEs.

## 3. Advisors of social economy

Independent of the realized benefit of social economy to sustainable development and employment/entrepreneurship, in our country the meaning and activities of the sector of social economy are not yet developed. The lack of an integrated framework in secondary and tertiary education for the dimensions of the sector of social economy and the lack of the "deliverance" of the third sector contribute to the involvement of individuals in the area of social economy employed as advisors/educators that are either characterized by a lack of qualifications or the allocation of non-certificated informally acquired knowledge.

## 4. The professional outline

In order to set the limits to the object of the advisor of social economy, the determination and definition of all tasks that he executes is necessary, leading to

the development of the professional profile of the profession. The *"Professional Profile (P.P)"* includes the overall basic and individual professional tasks and functions that make up the object of work of the profession, as well as the respective knowledge, skills and competences that are required for the correspondence to these functions and tasks (Greek Ministrial order, 2006).
The analysis of the profession is concluded in four levels (a) Main Professional Functions (MPF), (b) Individuals Professional Functions, (c) Professional Activities, (d) Knowledge, Skills, Competences, (Halas, 2002).

## 5. The certification of advisors and the European Qualifications Framework (EQF)

The certification of informal learning constitutes a significant parameter for the personal and professional development of a significant number of professions, as well as for mobility in the labor market. It is especially significant that practices for the recognition of past experience of individuals are adopted for professions that have recently appeared in the labor market, such as the social advisor/educator, where the delimitation of the profession and the recognition of learning are deemed necessary, especially in the context of the fulfillment of the strategy of lifelong learning for the recognition and evaluation of learning outcomes. As a matter of fact, the process of recognition of informal learning causes significant issues with regards to its acceptance and inclusion in the different systems of education and training throughout Europe. The certification of learning outcomes is able to satisfy the objectives only if these are recognizable and transferable throughout Europe.
The EQF is a common European reference framework which links the qualification systems of the countries, acting as a translation device for easier reading and understanding of qualifications across different countries and systems in Europe.
The common reference level of the EQF contains eight levels, each level is determined by a set of descriptions that indicate the learning outcomes associated with the main functions of each profession.
So far only partial analysis efforts of the profession of the advisor of social economy with a European dimension have been observed, while internationally, the only attempt to certify learning outcomes of advisors/educators was implemented by the Scottish Qualifications Authority but which does not propose a specific methodology of certification.
Since the previous review, the need for the development of the Professional Profile of the advisor/educator of social economy and the development of a proposed methodology of certification of the learning outcomes that is in line with the EQF becomes apparent.
As a result, it is important to answer research questions such as: a) what are the basic tasks that an advisor of social economy executes? B) At what level is it assigned to the EQF; (c) what is the recommended method for the certification of learning outcomes? d) What is the importance/weighting of learning outcomes and assessment categories in the certification?

## 6. Methodology

For the development of professional profile, the tools utilized for the concentration of information were: *literature desk research* for the collection of necessary information concerning the profession and its dynamic and the *adapted to the needs of the Professional Profile Delphi method* (Halas, 2002). The Delphi method included a coordinator for each participating country and 15 individuals who are

active in the field of social economy (academics and professionals). The research took a sample of 45 participants in 3 different EU countries.
Regarding the process of assigning the learning outcomes of the advisor/educator of social economy to the EQF, 3 workshops (1 for each country) with 10 experts, each followed by qualitative interviews were concluded. They included the correlation of each MPF to the level of the EQF, depending on the learning outcomes that are required (Leveling), the statement of the weight of each MPF relating to the learning outcomes required (Weighting Procedure) and the evaluation of the results by experts of other European countries. Finally, *literature desk research* for the collection of necessary information relating to the methods of valuation of informal learning and 3 workshops (1 in each country) with qualitative interviews by 3 experts in each workshop were carried out for the process of assessment and evaluation of the learning outcomes and the certification of informal learning.
The research instrument for the development of the Professional Profile was a structured questionnaire *description of the profession, adapted to the basic features of* the Delphi method, based on a review of international literature. The questionnaire was designed to extract individual expert responses to the problem at hand and to allow for the processing of views.
The research instruments for the process of correlation of the learning outcomes with the EQF included a set of template forms evaluating the level of the EQF in correspondence to each learning outcome and the weighting of each outcome, which were adapted to those of the Advisor of Social Economy. The templates were designed in the context of a Leonardo da Vinci project for the assigning of EQF levels to existing qualifications in the financial sectors across EU member states, under the Lifelong Learning Programme (€QUALIFISE, 2008).

## 7. Results

*a) The basic tasks that an advisor of social economy must execute*
From the summary of the results obtained, the following Main Professional Functions (MPF) resulted regarding the Professional profile of the advisor of Social Economy.

| MPF | GR | IT | PL | Total |
|---|---|---|---|---|
| Welcome, Supports and Serves the individuals referring to the institution | - | 10% | 5% | 15% |
| Advises/Trains interested individuals in general entrepreneurial and business issues | 20% | 25% | 15% | 60% |
| Advises/Trains interested individuals in organizational and management issues | 20% | 10% | 20% | 50% |
| Advises/Trains interested individuals in issues relating to marketing and business communication | 20% | 15% | 15% | 50% |
| Materializes educational and training adult programs in the sector of social economy | 20% | 20% | 20% | 60% |
| Supports the processes of dissemination of services of the institution and entrepreneurship | 10% | - | 15% | 25% |
| Supporting social capital mobilization – managing human resources | - | 5% | - | 5% |
| Activities supporting self-employment | - | 5% | - | 5% |

| | | | | |
|---|---|---|---|---|
| Activities supporting financial capital mobilization for the social economy objectives usage. | - | 10% | - | 10% |
| Activities supporting social problems elimination which generate pathologies | 10% | - | - | 10% |

**Table 1:** Weighting of the MPF of the Professional profile of the advisor of Social Economy

The MPFs that prevailed and are proposed, as they emerged from the development process, include the following:

- Welcome, Supports and Serves the individuals referring to the institution (MPF 1)
- Advises/Trains interested individuals in general entrepreneurial and business issues (MPF 2)
- Advises/Trains interested individuals in organizational and management issues (MPF 3)
- Advises/Trains interested individuals in issues relating to marketing and business communication (MPF 4)
- Materializes educational and training adult programs in the sector of social economy (MPF 5)
- Supports the processes of dissemination of services of the institution and entrepreneurship (MPF 6)

*b) Level of assigning the professional profile to the EQF?*
Composing the results of the workshop of evaluation materialised in Greece and the results of the workshops of evaluation that were materialised by the partners in their countries, the final results with regards to the level of the EQF that the Certificate of Advisor/Educator of Social Economy receives is apparent.

| | GR | | PL(1) | | PL(2) | | IT | | **TOTAL** | |
|---|---|---|---|---|---|---|---|---|---|---|
| | EQF Level | % weighting | EQF Level | % weighting | EQF Level | % weighting | EQF Level | % weighting | **EQF Level** | **% weighting** |
| Knowledge | 5 | 39% | 5 | 38% | 5 | 30% | 5 | 39% | 5 | **36%** |
| Skills | 5 | 22% | 5 | 31% | 5 | 30% | 5 | 22% | 5 | **26%** |
| Competences | 5 | 39% | 5 | 32% | 6 | 40% | 5 | 39% | 5 | **38%** |
| | 5 | 100% | 5 | 100% | 5 | 100% | 5 | 100% | **5** | 100% |

**Table 2:** Final level of EQF and weighting that the Certification of Advisor/Educator of Social Economy receives.

*c) proposed methodology (categories) for the certification of learning outcomes*
From the summary of the results of literature desk research and the workshops of the experts, the proposed methodology of assessment and certification of learning outcomes consists of three stages, (a) Evaluation and assessment of the curriculum vitae, (b) on-line test with multiple choice questions and (c) development of a case study.
The valuation of the CV was based on a standard electronic tool that includes four major areas: (a) Education, (b) Training, (c) Work Experience, (d) Additional Skills/Abilities. The axes of Education, Training and Work Experience are separated depending on their relevance or not to the Social Economy, while the score of each variable is also defined respectively. The maximum score for each basic axis so that education is not a substitute for professional experience and vice versa, has been

set as follows: 25% Education, 25% Training, 30% work experience and 20% Skills/Abilities. The maximum score that can be collected by each participant from the CV is 100.
The conclusion of the online test was based on an appropriate educational platform (moodle) which hosts a database with approximately one thousand questions from which participants were asked to answer 100. All questions are scored equally (considering that the process of weighing questions of primary and secondary business functions/thematic took place prior to the exam). The maximum score that can be gathered from the online test is 100.
The third category of evaluation relates to a database of approximately 60 Case Studies that concern the social economy and cover at least three MPFs of the profile of the advisor of social economy. The evaluation of the case study is based on three pillars (a) Content, (b) Written Presentation and (c) Support CASE STUDY.

*d) Weighting of learning outcomes and categories of assessment and evaluation in the certification?*
The table that follows shows the category and percentage with which each learning outcome is evaluated and assesses, in accordance to the results of the expert groups.

| | **CV** | **TEST** | **CASE STUDY** | **Total** |
|---|---|---|---|---|
| **Knowledge** | - | 70% | 30% | ***100*** |
| **Skills** | 20% | 60% | 20% | ***100*** |
| **Competences** | 30% | - | 70% | ***100*** |

**Table 3:** Percentage of evaluation of each learning outcome per category

The percentage weight of each category of evaluation (curriculum vitae, online test, case study) results from the percentage of evaluation of each learning outcome per category (table 3) depending on the weight given to each learning outcome from the process of correlation/assigning to the EQF (table 2).

| | **CV** | **TEST** | **CASE STUDY** | **Total** |
|---|---|---|---|---|
| **Knowledge** | - | 25,2[14] | 10,8 | ***36*** |
| **Skills** | 5,2[15] | 15,6 | 5,2 | ***26*** |
| **Competences** | 11,4 | - | 26,6[16] | ***38*** |
| | ***16,6*** | ***40,8*** | ***42,6*** | ***100*** |

**Table 4:** Weighting of each category of evaluation in the overall score

## 8. Conclusions

The social economy sector has not become an important pillar of economic growth, which enhances both the employability and quality of life of local communities and can be shown to cover economic and social purposes not covered by the public and private sector. However, the lack of an integrated framework for the dimensions of the sector contributes to the depreciation of the competitiveness of human resources, which in the absence of a single framework for the recognition of l

[14] *70 (percentage of knowledge that the online test evaluates, table 3)*36% (percentage of weighting of knowledge, table 2)*
[15] *20 (percentage of skills that the CV evaluates, table 3)*26% (percentage of weighting of skills, table 2)*
[3] *70 (percentage of competences that the case study evaluates, table 3) *38% (percentage of weighting of competences, table 2)*

earning fails to respond to current trends. Therefore, the definition of the profession of the social economy advisor and the development of a methodology for the validation of informal learning harmonized with the EQF would assist in addressing these challenged.

The present paper, compiled after literature desk research and the use of the Delphi method in three European countries, proposes the Professional Profile (P.P) of the advisor of social economy, which consists of six MPFs, which the advisor must be able to perform. The process of assigning the P.P with the levels of the EQF, which was based on qualitative interviews with 30 experts of three EU countries, shows level 5 of the EQF as appropriate. The proposed method of certification of learning outcomes, which results from literature desk research and 9 qualitative expert interviews in three EU countries, includes three categories, the valuation of the CV, the conduct of an on-line test of multiple choice questions and the preparation of a case study. According to the survey results, knowledge represents 36% of the learning outcomes that an advisor of social economy should have, skills represent 26% and competences 38%. The contribution of each category to the final certification of learning outcomes results as follows: CV 16.6%, on-line test 40.8% and case study 42.6%.
The impact of the present paper is to overcome the lack of qualifications of advisors, to upgrade their knowledge and skills, to the transparency of qualifications in the labor market and to facilitate mobility in the workplace.
However, it is important to further explore the application of the methodology by the target group to determine the degree of response to the needs of advisors of social economy. Furthermore, it would be useful to explore whether the proposed methodology can be applied to other professional profiles that require the recognition of non-formal learning.
Finally, it would important to develop the Professional Profile of executives of NGOs and the development of methodology for the certification of learning outcomes harmonized with the EQF.

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# Predicting cost of prefabricated housing using neural networks

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## Abstract
Political and economic pressures have become an aggravating circumstance for construction companies in achieving basic project management criteria, i.e. cost, time and scope. The construction's low performance only stresses out the need for improving current practices - especially in regard to cost. Therefore, we sought to find a critical set of variables for predicting total cost of prefabricated housing. We applied neural networks on data from more than 30 projects and thus have identify 17 critical variables for the cost prediction. The model was verified on 28 buildings with following performances: 85.7% of predicted values had the deviation lower 5%, while 10.7% had the deviation lower than 10%, in relation to the actual cost. After validating the model on data from 3 buildings, that had been new to the network, the performances were as follows: 83.8% of predicted values had the deviation lower 5%, while 12.9% had the deviation lower than 10%. Therefore this model showed to be very robust. Furthermore, this study has also demonstrated a more efficient and effective way of predicting total cost of building. Thus construction companies can influence project performance during project early phases, and acquire more competitive position on the market. Conclusion brings guidelines for use of the model and gives recommendation for its further development.

## Keywords
prefabricated housing, prediction, cost, neural networks, model, construction

## 1. Introduction

Construction industry has a poor project management performance, especially in relation to achieving cost objectives (Al-Jibouri, 2003, Atkinson, 1999, Costa et al., 2004, Roztocki and Weistroffer, 2005). Therefore, construction companies have to be more accurate in predicting total cost of building, still during the tendering phase. Nowadays only 34% of projects make it on the time, within the budget and in accordance with the agreed scope (Vukomanović et al., 2008, Standish-group, 2009). Because of this bad performance the construction has been proclaimed the worst, inefficient, plundering etc (Beatham et al., 2005, Beatham et al., 2004).
Neural networks (NN) are a form of artificial intelligence which tries to simulate behavior of human's brain. The first model was published in 1943 by McCulloch and Pitts (McCulloch and Pitts, 1943), where the authors analyzed fundamental logic functions. Besides the founders; Hebb (1949), Lashley (1951), Minsky (1988) and many others served as the catalyst of change and as promoters of NNs. After initial

fame, up to 1980s and the IT dawn, NN were developing in a slower pace, considering only smaller improvement (Rumelhart and McClelland, 1982, Werbos, 1994, Kohonen, 1988). Rapid development of IT stimulated further development of NN, as well.

Nowadays, NN can be also found in researches in area of construction management. E.g., Chua et al. (Chua et al., 1997) studied the influence of critical success factors on planned construction cost. Ling et al. (2004) defined a set of indicators that can predict project performance in Design & Build projects. They found strong correlation among 65 success factors and 11 criteria of project success. Odeh et al. (2002) studied a set of indicators in correlation with project time, in traditional, construction management procurement routes. Kog et al. (Kog et al., 1999) designed a model using NN in predicting the deviation [%] of project time. Iyer et al. (2005) and Iyer and Jha (2006) analyzed more than 1500 projects in India and found reliable set of factors for prediction of cost in traditional building projects. NN can be also found in many areas besides construction, e.g.: finance, ICT, medicine, transport etc, as well.

While competitive pressures are forcing construction contractors companies to produce numerous bids every day, investors (sponsors) do not have any obligation to even consider them. This huge gap between realized and unrealized bids has unfortunately become a common practice, especially in prefabricated housing. This only indicates low ability of the companies in calculating the final cost. Therefore we sought to find a solution to this problem using NN approach.

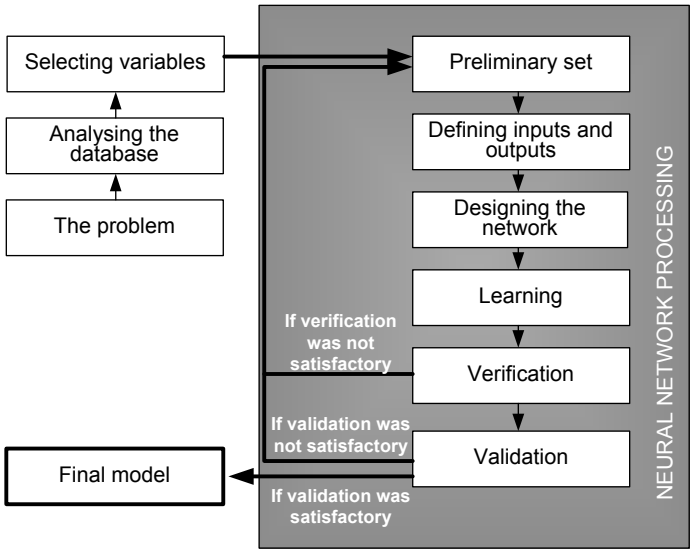


**Fig 1:** The NN methodology

This paper elaborates the potential of NN on prefabricated housing. It examines and identifies variables for predicting final cost of building. It proposes a NN model for cost prediction, which companies can, during early project phases; use to calculate relatively accurate estimate of total cost of building and thus save scarce resources. The research starts with hypothesis that: The final cost of prefabricated housing can be, within reasonable limits, predicted using Neural Networks on a critical set of factors.

## 2. Methodology

The methodology of this research is presented on Figure 1. After we had identified the problem, we started to analyze database of already finished prefabricated housing projects (DB). The original DB included 35 indicators from 28 projects. The initial selection of the indicators for NN was based on heuristics and experience of the authors. We employed mean cost/m2 ratio as a filter for identifying outliers from the set. From initial set, altogether three outliers were discarded.

During verification of the model, we compared actual cost vs. predicted cost. The performance of verification was evaluated using statistical indicators, i.e. R square and standard deviation. If we had found that a variable had no influence on the output, we removed it from the set. Moreover, if we had found a significant deviation between actuals and predictions, the variable was also removed from the set. After 12 iterations, the initial set of 32 variables was reduced to 17 successfully verified variables. We validated the set on new data (three new projects), that model had not seen before. The validation performance was used to test the hypothesis. We set validation treshold at 5% of deviation between predicted and actual values.

## 3. Application of NN on the problem

### 3.1. The identification of variables

Variables were filtered in NN in regard to two crucial criteria: a) influence of a variable on the final outcome and b) interrelation among variables. Variables had to be at the same time specific and easily calculated, so that companies could swiftly come up with accurate predictions. Otherwise, the concept becomes only a redundancy to procurement process. Table 1 shows the final, verified and validated set of 17 variables.

| Variable | Definition | Values |
|---|---|---|
| **Out.wall** | Outer wall – quality of outer wall is defined by different quality levels, in regard to different building materials, thermodynamic properties etc. In accordance with Croatian market we defined three levels of quality. | **1 - 3** |
| **Ceil** | Ceiling. Two levels of quality: with visible beams and without visible beams. | **1 - 2** |
| **Floor** | Floor. Two levels of quality dependant of floor covering. | **1 - 2** |
| **Stair** | Staircase. Two types of staircases, dependent of building material. | **1 - 2** |
| **Carp** | Carpentry. Three levels of quality, dependant of different material, i.e. wood, aluminum/wood or PVC. | **1 - 3** |
| **Elec** | Electrical installation - Two levels of quality in regard to price levels. | **1 - 2** |
| **Cen.heat** | Central heating - Two levels of quality in regard to price levels. | **1 - 2** |
| **P&S** | Plumbing and sanitation - Two levels of quality in regard to price levels. | **1 - 2** |
| **Fnetto** | Net area. The area was calculated without any correction factors in regard to attic. | **numeric** |
| **NB** | Ratio between the net and gross area. The gross area was calculated as area in between outer walls. | **numeric** |
| **Win** | Ratio between area of windows and total length of outer walls | **numeric** |
| **Attic** | Ratio of area of area of gallery against gross area of the attic. The gallery is defined as a part of the ceiling where no ceiling was built. Gallery area did not involve the area of the stairs. | **numeric** |
| **Roof** | Ratio of roof area against orthogonal area of the roof. | **numeric** |

| | | |
|---|---|---|
| **Wall** | Ratio between the height of ceiling wall and the height of one floor (2.65 m). | **numeric** |
| **Gable** | The ration between total lengths of the roof on longitudinal side against total length of the roof on the gable. | **numeric** |
| **Ceil.fl** | The ratio of ground floor ceiling area against 1st floor ceiling area. | **numeric** |
| **Terrace** | The ratio of gross area of covered terrace against ratio of the total gross area. | **numeric** |

**Table 1:** The final set of variables for the cost prediction

Table 1 also shows two types of variables; ones with preset quality levels and ones with numerical values that have to be calculated in regard to the building's architecture. Thus, the ones with predefined intervals [1-3] or [1-2] (e.g. V.ZID) were predetermined and dependant of market conditions, and the ones with numeric variables had to be calculated in regard to building dimensions (e.g. house net area, ratio of roof area against orthogonal area of the roof, etc).

## 3.2. The network design and the learning procedure

After the initial outlier filtering, the set of 32 indicators was subjected to NN training in Neuro Shell 2 application (Release 4.0., Ward System Group, Inc). Table 2 shows input and output data for Nero Shell 2. Values of 0.000 were replaced with 0.001 (see table 2, e.g. OBJ 16), since otherwise NN would not recognized the input and would considered it as missing data. The data was trained on different NN architectures, different training modes and different termination criteria. The design phase also considered different numbers of neurons in order to find an optimal solution. In total, we ran over 20 different architectures and came with the final set consisting of 17 indicators (see table 1). We have found that the most effective network was 3 Layer Backprop with Jump Connections, from the group of recommended classification net.

## 3.3. Verification of the model

The network's effectiveness depends on duration of training. Too much training would give the best results for current data, but would not perform as good on new data. Therefore, a good verification performance does not indicate a good validation performance, as well. Table 3 shows unfavorable (Output Layer Dampened Feedback Link NN architecture) and favorable (3 Layer Backprop with Jump Connections NN architecture) performances from verification phase.

| | Out.wall | Ceil | Floor | Stair | Carp | Elec | Cen.heat | P&S | Fnetto | NB | Win | Attic | Roof | Wall | Gable | Ceil.fl | Terrace | Total cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OBJ 1 | 3 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 135.8 | 0.847 | 0.4 | 0.007 | 1.27 | 0.275 | 0.51 | 0.58 | 0.001 | 701.499. |
| OBJ 2 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 149.8 | 0.849 | 0.4 | 0.048 | 1.33 | 0.132 | 0.56 | 0.49 | 0.04 | 558.809. |
| OBJ 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 162.9 | 0.825 | 0.3 | 0.029 | 1.28 | 0.377 | 0.89 | 0.52 | 0.03 | 607.838. |
| OBJ 4 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 154.9 | 0.853 | 0.2 | 0.001 | 1.32 | 0.128 | 0.56 | 0.52 | 0.001 | 741.073. |
| OBJ 5 | 2 | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 198.3 | 0.862 | 0.2 | 0.048 | 1.08 | 0.490 | 0.85 | 0.36 | 0.04 | 689.093. |
| OBJ 6 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 108.4 | 0.822 | 0.3 | 0.001 | 1.39 | 0.369 | 0.76 | 0.55 | 0.001 | 463.718. |
| OBJ 7 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 189.8 | 0.856 | 0.3 | 0.001 | 1.37 | 0.286 | 0.99 | 0.52 | 0.001 | 828.784. |
| OBJ 8 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 140.7 | 0.844 | 0.2 | 0.053 | 1.27 | 0.098 | 0.83 | 0.37 | 0.08 | 512.498. |
| OBJ 9 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 154.6 | 0.852 | 0.4 | 0.001 | 1.22 | 0.569 | 0.87 | 0.52 | 0.001 | 556.143. |
| OBJ 10 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 181.3 | 0.853 | 0.5 | 0.044 | 1.32 | 0.301 | 0.64 | 0.56 | 0.03 | 766.131. |
| OBJ 11 | 3 | 1 | 2 | 2 | 3 | 2 | 2 | 2 | 132.6 | 0.842 | 0.2 | 0.001 | 1.41 | 0.169 | 0.75 | 0.49 | 0.13 | 686.075. |
| OBJ 12 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 141.8 | 0.823 | 0.3 | 0.057 | 1.26 | 0.113 | 0.84 | 0.35 | 0.06 | 528.189. |
| OBJ 13 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 245.9 | 0.878 | 0.4 | 0.047 | 1.13 | 0.754 | 0.86 | 0.76 | 0.03 | 815.195. |
| OBJ 14 | 3 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 209.7 | 0.854 | 0.3 | 0.001 | 1.22 | 0.452 | 1.29 | 0.64 | 0.05 | 933.829. |
| OBJ 15 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 131.3 | 0.837 | 0.2 | 0.001 | 1.31 | 0.128 | 0.52 | 0.52 | 0.02 | 513.529. |
| OBJ 16 | 1 | 0.00 | 1 | 0.00 | 1 | 1 | 1 | 1 | 103.8 | 0.867 | 0.2 | 0.001 | 1.15 | 0.001 | 0.001 | 0.001 | 0.12 | 405.594. |
| OBJ 17 | 2 | 0.00 | 1 | 0.00 | 2 | 1 | 1 | 1 | 123.8 | 0.872 | 0.6 | 0.001 | 1.15 | 0.001 | 0.001 | 0.001 | 0.08 | 478.294. |
| OBJ 18 | 1 | 0.00 | 1 | 0.00 | 1 | 1 | 1 | 1 | 56.55 | 0.826 | 0.2 | 0.001 | 1.1 | 0.001 | 0.001 | 0.001 | 0.001 | 271.332. |
| OBJ 19 | 2 | 0.00 | 2 | 0.00 | 2 | 1 | 2 | 1 | 93.82 | 0.856 | 0.3 | 0.001 | 1.18 | 0.001 | 0.001 | 0.001 | 0.07 | 456.011. |
| OBJ 20 | 3 | 0.00 | 2 | 0.00 | 3 | 2 | 2 | 2 | 140.0 | 0.865 | 0.3 | 0.001 | 1.15 | 0.001 | 0.001 | 0.001 | 0.17 | 687.015. |
| OBJ 21 | 1 | 0.00 | 1 | 0.00 | 1 | 1 | 1 | 1 | 93.13 | 0.861 | 0.2 | 0.001 | 1.23 | 0.001 | 0.001 | 0.001 | 0.04 | 361.531. |
| OBJ 22 | 3 | 0.00 | 2 | 0.00 | 3 | 2 | 2 | 2 | 139.1 | 0.865 | 0.4 | 0.001 | 1.15 | 0.001 | 0.001 | 0.001 | 0.06 | 666.780. |
| OBJ 23 | 2 | 0.00 | 2 | 0.00 | 2 | 2 | 1 | 2 | 123.7 | 0.867 | 0.1 | 0.001 | 1.16 | 0.001 | 0.001 | 0.001 | 0.13 | 549.856. |
| OBJ 24 | 1 | 0.00 | 1 | 0.00 | 1 | 1 | 1 | 1 | 134.9 | 0.880 | 0.6 | 0.001 | 1.18 | 0.001 | 0.001 | 0.001 | 0.03 | 491.374. |
| OBJ 25 | 3 | 0.00 | 2 | 0.00 | 2 | 2 | 2 | 2 | 104.6 | 0.860 | 0.3 | 0.001 | 1.15 | 0.001 | 0.001 | 0.001 | 0.001 | 544.925. |
| OBJ 26 | 2 | 0.00 | 2 | 0.00 | 3 | 2 | 2 | 2 | 135.5 | 0.861 | 0.4 | 0.001 | 1.18 | 0.001 | 0.001 | 0.001 | 0.06 | 671.687. |
| OBJ 27 | 3 | 0.00 | 2 | 0.00 | 2 | 2 | 2 | 2 | 121.6 | 0.865 | 0.5 | 0.001 | 1.15 | 0.001 | 0.001 | 0.001 | 0.04 | 619.887. |
| OBJ 28 | 1 | 0.00 | 1 | 0.00 | 1 | 1 | 1 | 1 | 115.4 | 0.862 | 0.3 | 0.001 | 1.08 | 0.001 | 0.001 | 0.001 | 0.07 | 443.711. |

**Table 2:** Overview of the input data for the NN model

| statistics | unfavorable values | favorable values |
|---|---|---|
| $R^2$ | 0.9373 | 0.9809 |
| $r^2$ | 0.9375 | 0.9824 |
| Square mean arror | 1391.588 | 422.622 |
| Absolute mean error | 28.381 | 12.827 |
| Min. mean error | 0.348 | 0.432 |
| Max mean error | 80.446 | 61.837 |
| Correlation (r) | 0.9682 | 0.9912 |
| percentage under 5% | 60.714 | 85.714 |
| percentage between 5% and 10% | 25.000 | 10.714 |
| percentage between 10% and 20% | 10.714 | 3.571 |
| percentage between 29% and 30% | 3.571 | 0 |
| percentage over 30% | 0 | 0 |

**Table 3:** The comparison of favorable and unfavorable values in the verification phase

## 3.4. Validation of the model

Validation of the network was conducted on three new objects, where each one had different characteristics.

| Actual cost | Predicted cost (NN) | deviation | % |
|---|---|---|---|
| 556.7750244 | 560.5253296 | -3.750305176 | -0.67 |
| 450. 618988 | 429.5108948 | 21.10809326 | 4.68 |
| 731.3359985 | 778.3654175 | -47.02941895 | -6. 43 |

**Table 4:** Comparison of actual vs. predicted values during the validation

Table 4 shows deviation between predicted and actual total cost. The validation showed that the NN model performed within preset boundaries (5%). Therefore, the mean deviation of 4.13% was accepted as final.

| Output | verification | validation |
|---|---|---|
| $R^2$ | 0.9809 | 0.9781 |
| $r^2$ | 0.9824 | 0.9783 |
| Square mean arror | 422.622 | 467.896 |
| Absolute mean error | 12.827 | 13.905 |
| Min. mean error | 0.432 | 0.432 |
| Max mean error | 61.837 | 61.837 |
| Correlation (r) | 0.9912 | 0.9891 |
| percentage under 5% | 85.714 | 83.871 |
| percentage between 5% and 10% | 10.714 | 12.903 |
| percentage between 10% and 20% | 3.571 | 3.226 |
| percentage between 29% and 30% | 0 | 0 |
| percentage over 30% | 0 | 0 |

**Table 5:** Comparison of the verification and the validation performances

Another interesting fact was that the verification and the validation performances differed only in smaller amounts (0.9809 and 0.9781, respectively) which show model's robustness. Therefore, we concluded that the network stable and trained enough.

## 4. The discussion: analysis of results and the use of the model

This paper has demonstrated that by using a set of critical set of variables construction companies can, in very short time, predict the total cost of prefabricated buildings and thus save huge amount of energy. The final set of factors is consistent of 17 variables, which are: Out.wall, Ceil, Floor, Stair, Carp, Elec, Cen.heat, P&S, Fnetto, NB, Win, Attic, Roof, Wall, Gable, Ceil.fl, Terrace. Definition of the variables is given in table 2.

The model was validated with satisfactory validation performance: the minimum deviation of predicted from actual values was on 0.67%, the mean deviation on 4.13% and the maximum deviation on 6.43%. Therefore, the hypothesis: The final cost of prefabricated housing can be, within reasonable limits, predicted using Neural Networks on a critical set of factors was tested and accepted. Since the model becomes more and more robust as the database grows (Chua et al., 1997, Ling and Liu, 2004, Iyer and Jha, 2006) construction companies should use the set of variables and try to fill it with new data whenever a new project is realized.

Besides NN, we had considered other methods, as well (E.g. linear regression, nonlinear regression and stepwise regression). In all our attempts we could not find as efficient models as NN are, which was especially evident when introducing or replacing new variables to the model. Practical value of this research can be found in possibility to effectively respond to client requests, while consuming as little resources as possible.

## 5. Limitations regarding different types of houses

In order to compare this study with simmilar ones, first, some limitations have to be acknowledged. Prefabricated housing, in this research, was considered as facilities with prefabricated wooden bearing structure - panel type. The total cost of building was considered as for the turn key projects, i.e. the cost of fully completed and totally functional buildings. The cost also considered all of the craft work, e.g. pluming, HVAC etc. The final cost did not comprehend: the cost of design, consulting fee, cost of land and infrastructure etc. The profit margin of 10 % was also included in the final cost. Furthermore, the model was designed only for family-type houses and not for other kind of facilities. All family houses were limited on to one and two floor buildings with the hight of one floor at 2.65 m.

## 6. Conclusion

This research has showed that companies can predict total cost of prefabricated housing in a relatively accurate and efficient way. This model will help construction companies in dealing with current market pressures and responding to market needs. Construction management discipline has obviously other tricks up its sleeve than traditionally accepted methods and companies should finally start to use them.

In further research some limitations have to be abandoned: e.g. the model has to be developed for facilities other than residential, the model should also consider

other than 1 floor houses. The model should also introduce administrative costs and other financial variables (i.e. net present value, return of investment etc.), as well. The model should be expanded on to traditional type buildings (brick, concrete etc.) as well, especially since its trend in Croatia. Finally, it would be very interesting to apply factor analysis on original 35 variables and try to compare the results with this set of critical variables.

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# Informal projects management with volunteers participation

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## Abstract
This article presents the results research conducted to identify key elements influencing the success of projects managed in informal way with volunteer participation. The data was collected from several "soft" projects. These projects included organisation of sporting, cultural, and charity events targeting large groups of people. The research involved discussing the following areas:

- roles and activities of volunteers,
- rules for employing volunteers ,
- factors influencing the success of the projects including:
    - the trust as the base of informal projects management,
    - intra-project communication,
    - cooperation
    - team work.

Project risk, reporting, execution control, and the role of project culture as elements influenced on project success were discussed.

## Keywords
Project management, volunteers in project.

## 1. Introduction

Volunteers are commonly and globally engaged in "soft" projects in the economic world. The primary reason for engaging volunteers is that they are offer their time and skills for free. Projects with volunteers are generally managed using the same rules that are used for managing "normal" projects. Looking at these projects, we should realize that volunteers are working without payment, have no legal agreement with project management, and are not available full time. Therefore we should pay attention to the specific character of management and execution of these projects. Management of these projects is often done in an informal way rather than by employing any well-known methodologies described in literature. Management of these projects is based on common sense, learning through experience, and the intuition of people who execute them. In this article I have tried to identify the key factors having influence on the success of soft projects involving volunteers.

## 2. Volunteers and reasons for hiring them in projects

The foundations of volunteer work are free-will, unpaid, conscious, and exceeding family relationships (and relationships between neighbors) work for others. Anyone can be a volunteer. You are a volunteer if you want to work for others without pay, just because of free-will. (www.wolontariat.org.pl; 2010). People give different reasons for working as volunteers and different expectations about working in this kind of projects. Here are the most common reasons:

- improving skills and gaining practical experience, which will increase their value in the employee market,
- new experiences,
- attractive project topic ,
- on-material benefits connected with attending this project - for example chance to attend an interesting concert,
- self-testing,
- making life more attractive, having new adventures,
- moral duty.

Project executives hire volunteers, because they work for free (we should realize that in some projects low budgets limit the ability to hire full time employees). Volunteers are usually needed for a short time, during specific periods and for specific tasks of a project. Looking at these aspects we can see that volunteers provide flexibility in this area. Volunteers usually support projects run by non-profit organizations, for example:

- non-government organizations, foundations,
- local associations of local government agencies,
- churches
- entities under public administration and supervised by the municipality.

The number of these projects is really large, but they are undervalued by project management methodology.

Detailed research was conducted on eight projects. Quality research was done by interviewing project managers and volunteers working in these projects. Research was done for the following projects:

a) organizing a musical concert for about 110 000 people,
b) preparing huge sport event with on-street marathon for about 550 runners,
c) charity event - collecting food and preparing a welfare holiday meals for 1200 persons,
d) organizing the Tall Ships' Race,
e) wedding party for about 150 guests.

The owners of all these projects said that their projects were successful. Some of these opinions were confirmed by media reports, but not all for them had an objective success indicator. The concert was given at the planned time, the charity event took place and so on. Projects did not exceed their planed budgets, but no one assed the satisfaction of people attending these events. Here is a short characteristic of these projects:

- "Soft" projects, in different areas, where results of project are not material, so it is hard to identify and measure effect of the project.
- The length of the projects is diverse: from a few months (charity event) to a few years (Tall Ships' Race). We can observe that there is increased effort connected with the delivery final product (concert, sports event and so one) at the end of the project.
- Project are executed under time pressure (for example it is not possible to change concert data.
- High complexity.
- Public scrutiny of these projects through media, and opinions that could not be ignored (but in some cases the media did not have enough data to form the correct opinion).

Volunteers were an important part of all this projects. All these projects were managed in a non-formal way, without using any project management

methodology. Managers used their intuition. Based on these projects we can postulate the following characteristics:

- Poor documentation on the management (tracking, controlling) and results of the project (low level of "paper work").
- most communication was done in through individual, informal, face to face meetings,
- decision making was neither formalized nor documented (no reasons given)
- budget was low and not specific

The organizational structure of all these projects was simple. Here are most important components of this structure:

- project manager - played a key role and was supported by an organizational office consisting of several persons,
- specialized subcontractors,
- groups of volunteers.

In some projects (e.g. the wedding party, Tall Ships' Race), but not all (e.g. concert) the number of volunteers was significantly higher than the number of employees. In all projects number of people needed for different phases of the project changed dynamically.

All projects were managed by organizations with poor awareness of project management methodology. Project managers were not certified in project management. Their knowledge in this area was fragmentary, and came from personal experience, not professional trainings. On the other hand, project managers had great knowledge about the subject matter from previous experience. Project Managers was nominated as PMs because of this.

Based on observation of these people and the assessment of their skills we can indicate some key characteristics of people who should be involved in managing huge projects (or people who are should manage major work packages of such projects):

a) the project manager should be a full time employee, chosen based on skills not on position,
b) leadership skills, ability to work with people, open, with good interpersonal skills, people who can build trust relationships,
c) enthusiastic, with ability to motivate other people, giving enthusiasm to other people (volunteers),
d) well motivated, and goal-focused,
e) possessing skills in human resource management.

You should pay attention on choosing people for project management, especial if you want to nominate volunteer as a project manager. If you are choosing a volunteer as a project manager, you should be 100% sure if this person will attend this project until the end. If this person will resign before the project ends you will experience an "information gap" and this will have great impact on the success of the project.

## 3. Rules for recruiting and hiring volunteers

There was no problem in finding people who have the qualifications and understand the general purpose of project. Volunteers were recruited through press and on-line advertisements. Some of advertisements were focused on special groups of people.

For example there were advertisements focused on students interested in sailing (Tall Ships' Race) and sports (sport event). Advertisements contained slogans like "great satisfaction guaranteed". Many volunteers were recruited through personal connections of people employed in the organization and contacts of already recruited volunteers.

People were engaged basing on oral declarations of candidates. People were declaring that they:

- would attend to the project,
- donate their free time,
- have the required education and overall skills (in some cases people were asked to prove their skills - for example show medical certificates).

In very attractive projects (e.g. concerts, Tall Ships' Race) which attracted many candidates, there was a preference for people with experience in similar projects.

It is necessary to pay attention to the interview, which was not always appreciated by managed (because of lack of time). Skills, experience and abilities were not dependent on the age of volunteers. It is important to asses all skills, to choose appropriate people, who will bring value to project, but this should be two-way relation - volunteers should be satisfied from taking part in your project. Usually the interview was the only tool to verify the skills of all volunteers. What is more interesting - in most cases all declarations were true. In most cases declared skills were followed by real, high scored, work. Of course some lack of experiences could be fixed by training. But analyzing trainings delivered during the project we can say that most were delivered as a short overview, rather than detailed training.

There was no formal agreement between volunteer and organization preparing the event. Volunteers did not ask for such agreements[17] but it is important how the volunteers enter the project. Volunteers should:

- be engaged at the right time, he or she should have enough time to understand tasks he had to do an to "feel the project",
- be assigned to the right person, who is managing project (or some aspects of project) and is a contact person, working as a mentor for a volunteer.

## 4. Roles, rules and rights of volunteers

In the analyzed projects, volunteers performed the following tasks:

- non-complex without any prerequisite skills,
- routine, repeatable tasks,
- some tasks requiring additional skills: driving, fluency in languages, first aid.

Some examples of work done by volunteers includes:

- manning information booths,
- handing out brochures,
- technical assistance, office work,
- animate events accompanying the main event,
- support for the main event (e.g. collecting food for the charity event),
- taking care for spectators, artists, sportsman or VIP,
- providing first aid.

[17] According to law in some countries it is necessary to sign agreement if volunteers are working in project for more than 30 days

Volunteers were obligated to the following:

- be punctual,
- work in uniforms provided by the organizer,
- attend meetings with management.

To do their jobs correctly, volunteers had to find information about what is happening in project (where and when) and what changes had occurred. They needed to know who was responsible for the different areas and been able to contact this person. Volunteers hired for projects had some rights stemming from oral agreements or local law. Because volunteers should not pay any costs associated with helping out, managers were responsible for providing a budget to cover the necessary expenses. For example all volunteers had to be insured against accidents, provided with meals during working hours and so on. This was an additional cost of the project. Other costs included:

- business trips,
- sundries and uniforms,
- phone, internet costs etc.

In some cases volunteers were covered small costs from their own pocket (e.g. in the charity event).

Assignments were handed out verbally during meetings with managers responsible for appropriate aspects of the projects. The following aspects were specified during meeting:

- setting scope of tasks,
- giving instructions on performing the tasks,
- setting rules for contact in the future.

After delegating tasks to volunteers, they were responsible for these tasks. In some cases formal responsibility was placed on the volunteers, but in most cases the manager who delegated task, took formal responsibility for it. In a few rare situation meeting minutes were written down.

## 5. Project planning issues

Task planning was the weakest side of projects that were analyzed. It was because of the informal character of project - informal project management caused informal scheduling. No official methods like Work Breakdown Structure and Gantt Chart were used to plan tasks. Generally project managers were focused on milestones. They estimated data for milestones as a reference data for other tasks.

Estimation of project duration was done using intuition and previous experience with similar projects. Sharing experience with specialists in different aspects of project was done only from time to time.

This informal scheduling was the source of missing tasks and wrong estimation of effort needed to finish tasks (very often assumed work was smaller than real work). This underestimation was bring to light in less inspected moments. Project managers, using intuition predicted problems started tasks early (looking at the finish data). However an early start caused lax discipline, because the perception was of appropriate time.

One of the major problems was volunteer availability - they were not available full-time. Their availability did not always match the project managers' expectations. In

some cases the declared availability did not match actual availability, due the additional work or wrong estimation of time needed for normal, everyday activities.

Non-distinct planning caused peaks in work effort required. These peaks were very high at the end of the project. Hiring additional volunteers and assigning new work to available volunteers helped to reduce this problem, but in some cases overloading caused the volunteers to reject the new tasks or were quit the project. Lack of resources at the end of the projects affected the quality of tasks and results of some task was not as good as it was expected.

## 6. Communication in informal projects

Good communication is key to efficient volunteer oriented-project execution. This conclusion was made by most PMs after their first failures. They stated that main reason for these failures was poor communication. After this conclusion owners of subtasks were obligated to make sure that all volunteers have appropriate information about duties, tasks, and the project. It was necessary to get confirmation that volunteers understood all the information. The communications applied not only to tasks and duties, but also to safety.

Over the course of a project, communication happened in the following ways:

a) informal, individual talks with volunteers - this was the primary form of communication (even in projects with large number of people). In these talks tasks were described in detail and deadlines were given. They were a great opportunity to share and discuss experiences. It is important to say that this kind of communication has some problems: they are not documented and it takes a lot of time to communicate in this way. It is natural that volunteers want to state their own opinion about the project and informal meetings take longer than expected. The volunteers were honest and were not afraid to state critical opinion (they were not afraid of losing a job).
b) two-way experience sharing between people on the same part of the project. The reason for this meeting was sharing experience, opinions, and socializing. Some people were recognized for doing a good job.
c) written, formal notes were created rarely. Written communication was very often done using real-time communicators. In some cases (Tall Ships' Race) short instruction leaflets were provided to the volunteers.

## 7. Motivating volunteers

The reasons for which volunteers take part in projects were stated at the beginning of this article. All the stated reasons can be trace back to self-motivation, which is grounded in emotions and want to partake in something special. Satisfaction from accomplishment is a primary goal for them.

Volunteers, like any other person, want and need to be stimulated to work more effectively. Well motivated people have more enthusiasm for their job and are more resistant to small failures. In the analyzed projects, managers forgot to motivate the volunteers.

Volunteers, working for free, cannot be motivated by financial gains - so they should be motivated in the different ways, to be well-engaged in projects. They can be motivated in following ways (but not all this methods were fully used in all projects):

- showing appreciation for volunteers for job well done (for example by praise and thanks or other different kinds of verbal appreciation),
- internal prizes- for example in tickets ( e.g. concert tickets, party invitation).
- networking and socializing opportunities.

At the same time, it is difficult to use punishment as a way to stimulate volunteers. It is almost impossible to use financial punishment or use legal consequences against volunteers doing a poor job. In some cases negative motivation was used - for example, people who did not do their job well did not receive concert tickets or were moved to less prestigious tasks. Motivating people by verbal appreciation and small punishments seems to be the best solution for motivating volunteers.

## 8. Risk and trust in projects with volunteers

Hiring volunteers raises some project risks (which should be managed with other project risks) like - over-optimistic task duration estimation or lack of cost control. Generally PMs did not perform a detailed risk analysis, especially for risks arising from hiring volunteers.

It is possible to identify some typical risks which occur in these projects. Here are some examples:

a) smaller than expected efficiency: wrong people are chosen and tasks are assigned to people who do not have enough time or appropriate skills, knowledge and experience,
b) volunteers quitting the project (sometimes without notifying management about this) which can bring problems especially in peak work time. Volunteers were quitting because of discouragement, which is caused by:
   - more intensive and more difficult work than expected,
   - lack of identification with project.

After identifying this risk they can be mitigated by hiring other volunteers with better sense of responsibility or hiring more volunteers then it is necessary.
All problems with volunteers are connected to the recruitment process. Each volunteer has a different personality, and declarations they gave at the interviews were not always right. Sometimes they were over-valuing their skills. Looking at the time restrictions it was not possible to perform good recruitment.

Trust plays a key role in cooperating with volunteers. Managers delegating task to volunteers trusted them and hoped that they would do their jobs appropriately. Management was more dependent on volunteers, than the other way around.

We can observe two different attitudes of management, all of them are based on life experience of management (Grudzewski, M.W. and Hejduk, I.K. … (2009)):

a) full trust - some managers were assuming that people will do their jobs well. Usually managers trusted well known people and people with references.
b) limited trust - in limited trust volunteers were regularly monitored. After good results of monitoring limited trust was changed to full trust.

The best method for monitoring was *Monitoring by Walking Around*. This method put stress on observing and talking with people (personal contact). During these meetings it was possible to give feedback to volunteers, asses their work (motivate people), give instructions, inform about changes, and so on.

## 9. Summary

Soft projects like organizing concerts, sport events, charity event are not always appreciated. Sometimes they appear to be less complicated and not so valuable as building bridges or skyscrapers. Project managers of soft projects are not as appreciated as PMs of a normal project, so in some cases it was difficult to hire skilled managers. Informal methods of project management are used, because PMs were not familiar with formal project management methodologies.

In soft projects volunteers were engaged to do some jobs. This brings benefits for both sides. Volunteers are usually enthusiastic people working for free in selected tasks. It could be hard (from a manager's perspective) to hire volunteers for a project. Sometimes they are not well-prepared and have poor skills (for the tasks they are assigned). In some cases costs and problems generated by volunteers outweigh the benefits they bring.

Key aspects which have influence on projects with volunteer participation are:

a) you should accept every volunteers who want to access the project. Skills of this person should be assessed in an appropriate way.
b) trust plays a key role in this projects,
c) Monitoring by Walking Around is good solution for monitoring volunteers,
d) communications should be accurate clear and well organized
e) non-material motivation is important for people who are by default self-motivated,
f) written communication should be done where necessary, especially in peak time,
g) real availability should be periodically reassessed,
h) a project manager should be chosen based on skill, leadership, ability to work with people, with good interpersonal skills, people

The above are guidelines for initiators and people executing projects with volunteer participation. Using these guidelines will improve the chance for success. Also Project management training should be considered for people leading these efforts.

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*AA028*

# The Greek Legal Framework on Occupational Diseases in Construction: Conformity to Risk Management Standard

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## Abstract
This paper investigates the conformity of the Greek legal framework on occupational diseases in construction with the guidelines for application of risk management as described in the Project Management Body of Knowledge, a credible international standard. The aim of this research is to identify specific provisions in the Greek legal framework that require further improvement towards an effective risk management of occupational diseases. To achieve this goal, related laws and presidential decrees are analysed and their provisions are associated – based on content – to the appropriate risk management process. The identification between the levels of compliance of legal provisions with the specifications described in the standard is performed through comparative analysis. The results reveal that the current Greek legal framework addresses the issue of risk management for occupational diseases in an unsystematic and incomplete way. The research identifies certain weaknesses and makes specific suggestions towards a legal framework aligned with the respective international standard.

## Keywords
Risk management, Occupational diseases, Construction, Health and Safety

## 1. Introduction

Occupational accidents and diseases (OAD) are of major concern in the construction industry because of health and safety, financial and legal implications. While human health must be the primary concern, the financial burden to social security systems and the managerial cost of legal actions such as complaints or prosecutions must not be neglected as well. Hämäläinen et al (2009) refer to estimations by the International Labour Organization (ILO) that raise, globally, the total costs of occupational accidents and work-related diseases up to 4% of the Gross National Product (GNP). The ILO, at the same time, estimates that 160 million people are suffering from occupational diseases globally (ILO Safety in Numbers (2003)). OAD are, also, strongly connected to the competitiveness of national economies, where the safer the occupational environment is, the more competitive is the respective economy.

Despite the fact that all interested stakeholders, including governments and industrial players, are well aware for many years of the negative impact that OAD have on the societal and economic profile of a country, serious deficiencies still

exist both in the recording and notification systems of OAD and in the strategies for treatment and their implementation (Hämäläinen et al (2009)). Two striking examples of such deficiencies are the lack of official data for OAD and the deficient legal framework for safety and health issues. Unexpectedly enough, this is the case for both developing countries and countries with established market economies such as those forming the European Union (EU).

Another critical issue is that OAD prevention activities focus more on occupational accidents than on occupational diseases (Hämäläinen et al (2009)). This is reasonable considering that:

- The impact of occupational accidents to costs and human health and life are more direct compared to the latent diseases.
- The investigation of the causes and the risk of exposure to occupational diseases are harder and more complicated considering that a disease may be the outcome of a combination of several factors (e.g. workload, working conditions, etc).
- Any corrective measure against occupational accidents has a direct and quantifiable impact, which is the reduction of the number of injuries and deaths. On the contrary, any corrective measure against occupational diseases cannot be evaluated in the short-term and its effectiveness is dependent on a large number of parameters even out of the working environment.

As a result, it is inferred that the situation with regard to the management of occupational diseases is rather vague, hence the requirement of further investigation towards the improvement of safety and health in the working environment.

## 2. Research Methodology

This paper presents the results of research work on the specific issue of conformity of the Greek legal framework on occupational diseases in construction with the guidelines for application of risk management. In the context of this research the following law (L.) and presidential decrees (P.D.) were studied: L.1568/1985, P.D. 307/1986, P.D. 85/1991, P.D. 77/1993, P.D. 397/1994, P.D. 17/1996, P.D. 90/1999, P.D. 159/1999, P.D. 339/2001, P.D. 149/2006, P.D. 212/2006, and P.D. 162/2007. These documents constitute the framework for safety and health in work and comply with the EU's respective guidelines and directives.

The research focuses on the construction sector, which is one of the most critical in terms of occupational diseases, worldwide. The European Labour Force Survey conducted by the Eurostat in 2007 (Eurostat, Statistics in Focus (2009)) ranks the construction sector as fourth across different sectors in terms of recorded work-related health problems and third in terms of exposure to factors that adversely affect physical health (Eurostat, Statistics in Focus (2009)). Given the significance of the construction sector for all national economies the focus there is well-justified.

The investigation of the case of Greece is selected because it presents the following interesting features:

1. It is a country member of the EU with an established market economy and a legal framework for occupational safety and health that complies with the EU's respective legal provisions (directives).
2. It demonstrates relatively good results between the member states of the EU with regard to work-related health problems based on the European Labour Force Survey (2007) conducted by the Eurostat (Eurostat, Statistics in Focus

(2009)). Table 1 demonstrates that the performance in Greece concerning exposure to factors adversely affecting physical health and limitations and resulting sick leaves due to work-related health problems is very close or less than the average between both the EU-15 and the EU-27 in all cases except from one (see Row 2).

| | EU-15 | EU-27 | GREECE |
|---|---|---|---|
| % of workers who experienced one or more work-related health problems | 7.5 | 8.6 | 6.6 |
| % of workers with work-related health problems who experienced limitations in normal daily activities to some extent | 48.2 | 50.1 | 58.8 |
| % of workers with work-related health problems who experienced limitations in normal daily activities considerably | 22.0 | 22.3 | 17.1 |
| % of workers with work-related health problems resulting in sick leave | 62.3 | 62.0 | 47.1 |
| % of workers with work-related health problems resulting in sick leave for more than a month | 29.2 | 27.0 | 15.2 |
| % of workers who are exposed to factors affecting physical health | 41.0 | 40.7 | 41.4 |

**Table 1**: Greece's performance in safety and health issues compared to the other member states in the European Union (Data source: Eurostat, Statistics in Focus (2009))

3. It features a construction sector with a high contribution to the total number of occupational accidents in the country. Based on data from the Greek Labour Inspectorate the construction sector in Greece ranks second – behind the Retail/Repair sector – in occupational accidents among 60 different sectors of economic activity for the time period between 2005-2008. Although, there are no specific data for occupational diseases, it is logical to assume that the sector presents equally high numbers as in the case of occupational accidents.

The research focuses on occupational diseases caused by noise, exposure to chemical factors and asbestos and musculoskeletal disorders. Based on data from the European Labour Force Survey these factors have caused a 69.04% of the total work-related health problems experienced by workers in the EU (Eurostat, Statistics in Focus (2009)). All of these factors are met in the construction industry.

For each one of the occupational diseases mentioned above, the legal framework was thoroughly examined in order to identify provisions that could be associated in terms of content to one of the risk management processes as described in the Project Management Body of Knowledge (PMBOK (2004)), a credible international standard published by the Project Management Institute (PMI). These processes are schematically presented in Figure 1.

**Figure 1**: The risk management processes according to the PMBOK

The definition of each of the processes presented in Figure 1 is given below (PMBOK (2004)):

- Risk Management Planning is the process where decision is made on the approach of the planning and implementation of the risk management processes.
- Risk Identification is the process where the risks that may affect the project are determined and their characteristics are documented.
- Qualitative Risk Analysis is the process where risks are prioritized for subsequent further analysis or action by assessing and combining their probability of occurrence and impact.
- Quantitative Risk Analysis is the process where the effect of identified risks on overall project objectives is numerically analyzed.
- Risk Response Planning is the process where options and actions are developed to enhance opportunities, and to reduce threats to project objectives.
- Risk Monitoring and Control is the process where identified risks are tracked, residual risks are monitored, new risks are identified, and risk response plans are executed and their effectiveness throughout the project life cycle is evaluated.

The aim of the research was to determine the conformity of the provisions in the legal framework for occupational diseases with the risk management framework and consequently suggest improvements that can ensure a more effective treatment of the safety and health issues in construction. The results are presented in the following section.

## 3. Results and Discussion

For the purpose of performing a comparative analysis between: a) the provisions of the current legal framework in Greece for occupational diseases and b) the provisions of the PMBOK, for the correct implementation of each one of the risk management processes, the following features have been defined:

- Feature 1: Clear definition of the process.

- Feature 2: List of specific tools and techniques to apply the process.
- Feature 3: Provision for the documentation of the process.
- Feature 4: Suggestion of templates for the documentation of the process.

These features have been defined to constitute an interface between the compared items. Therefore, when considered in relation to the legal framework, these features prove to summarize in a satisfactory way the several legal provisions that relate to the risks under study. On the other hand, the same features when considered in relation to the content of the risk management processes, they prove to accurately present all the requirements for the proper application of these processes based on the PMBOK standard. Therefore, the four defined features along with a fifth one (Feature 5: List of identified consequences upon risk occurrence) that applies only for the Risk Identification process are adequate for use in a comparative analysis.

A four-grade scale was applied to assign to each feature an assessment, in terms of the identified level of conformity between the legal framework and the risk management framework. The grades of the scale were:

- No (N): Denotes no conformity at all.
- Limited (L): Denotes very small conformity.
- Partial (P): Denotes partial conformity.
- Yes (Y): Denotes full conformity.

Having defined the parameters to compare (i.e. features) and the grading scale for the comparison, the content of each one of the legal documents that constitute the framework for safety and health in work in Greece was studied and assessed by the authors with regard to the conformity to the respective risk management process. For example for the risk of exposure to noise, the P.D. 149/2006 (2006) indicates that: "*Employers are obliged to assess the level of exposure to noise focusing especially on the kind and duration of the exposure, and the implications to health and safety of the employees*". For the same risk, the P.D. 81/1991 (1991) provides with specific equations for the quantitative assessment of the level of noise in the working environment. Since no other provision is made for this risk in the legal framework with regard to the Quantitative Risk Analysis Process, the latter is evaluated as having full conformity only concerning the reference to specific tools and techniques to apply the process (Feature 2). However, no other feature is complying with the requirements of the PMBOK standard for the application of the Quantitative Risk Analysis Process and therefore all other features are given the grade "*N*". All the specific results that were provided by the comparative analysis are presented in Table 2. These results demonstrate the following interesting and significant issues:

1. The "Risk management planning" process is not described at all in the legal framework for all the risks under study. Considering the definition of this particular process as given in Section 2, this lack of reference indicates the unsystematic way of treating risks related to occupational diseases in Greece.

2. The risk of exposure to asbestos is the only case where the risk identification process is described in the legal framework fully compliant to the risk management standard. This is also the only case with full compliance between the compared items in the total number of the risk management processes.

3. There is a complete lack of suggestions of templates for the documentation of the processes. With the sole exception of the risk identification process in the case of the risk of exposure to asbestos all other cases do not refer to such suggestions.

4. Qualitative risk analysis is not mentioned at all in the legal framework, with the sole exception in the case of the risks of musculoskeletal diseases.

| Features | | Risk of exposure to noise | Risk of exposure to chemical factors | Risk of exposure to asbestos | Risk of musculoskeletal diseases |
|---|---|---|---|---|---|
| RISK MANAGEMENT PLANNING | Feature 1 | N | N | N | N |
| | Feature 2 | N | N | N | N |
| | Feature 3 | N | N | N | N |
| | Feature 4 | N | N | N | N |
| RISK IDENTIFICATION | Feature 1 | N | P | Y | N |
| | Feature 2 | N | N | Y | L |
| | Feature 3 | Y | N | Y | N |
| | Feature 4 | N | N | Y | N |
| | Feature 5 | Y | P | Y | P |
| QUALITATIVE RISK ANALYSIS | Feature 1 | N | N | N | Y |
| | Feature 2 | N | N | N | N |
| | Feature 3 | N | N | N | N |
| | Feature 4 | N | N | N | N |
| QUANTITATIVE RISK ANALYSIS | Feature 1 | N | P | N | N |
| | Feature 2 | Y | P | N | N |
| | Feature 3 | N | N | N | N |
| | Feature 4 | N | N | N | N |
| RISK MONITORING AND CONTROL | Feature 1 | N | P | N | N |
| | Feature 2 | P | Y | Y | P |
| | Feature 3 | N | Y | Y | P |
| | Feature 4 | N | N | N | N |
| RISK RESPONSE PLANNING | Feature 1 | N | N | N | N |
| | Feature 2 | Y | Y | Y | N |
| | Feature 3 | N | N | Y | N |
| | Feature 4 | N | N | N | N |

**Table 2**: Results concerning the conformity of the Greek legal framework for occupational diseases to the risk identification process, as described in the PMBOK, for specific risks

These findings clearly indicate the great distance between the risk management framework and the way of its application in Greece in the field of occupational diseases. While, the intention of the legislator is, undoubtedly, to address the risk management approach towards a reduction of occupational diseases, it is evident that this incorporation is unsystematic, inconsistent and, eventually, poor. This should mainly be attributed to the lack of knowledge on behalf of the legislators over the proper processing of risk management as described in related standards. It is obvious that the legislators are based on previous regulations, intuition, and

common sense rather than a systematic and analytical process that could lead to a structured and complete content of provisions.

A generic proposal for the improvement of the current state is to introduce in the respective legislative process experts or at least knowledgeable persons on risk management theory and practice. It is logical to assume that in the cases of successful adaptation of the risk management framework to the legal framework (e.g. the risk identification process for the risk of exposure to asbestos compared to the same process for all other risks) the contribution of such experts was the critical success factor. It is obvious that the contribution of risk management experts in the legislative process will result to the appropriate addressing to the legal framework of both the theoretical requirements and the best practices for risk management.

Apart from the generic proposal, specific amendments to the legislative framework can be suggested to improve the current situation. Two of them are:

1. Improvement of the P.D. 159/1999, which is the basic legal document that governs safety and health issues. This improvement will be achieved by the incorporation of new clauses (e.g. listing of proposed tools and techniques for the application of each risk management process) and amendment of existing ones (e.g. Article 2, Paragraph 6) with regard to: a) suggestions for tools and techniques, definitions, and descriptions of content for each risk management process.
2. Improvement of the P.D. 397/1994, which governs the issues of manual handling of loads. This legal document is the sole that although valid has not been updated to comply with the P.D. 159/1999. This improvement will be achieved by the incorporation of new clauses (e.g. incorporation of the Manual Handling Assessment Charts (MAC) method and Key Item Method (KIM) for the quantification of risks related to musculoskeletal diseases) and amendment of existing ones (e.g. Articles 1-4) with regard to: a) definitions, b) the field of application, c) employers' commitments, and d) the ergonomy of site.

## 4. Conclusions

This paper presents a research on the conformity of the Greek legal framework concerning occupational diseases with the risk management framework as described in the PMBOK (2004) standard. Through detailed analysis of the legal documents and comparison with the requirements of the standard, it is evident that there is only partial compliance between the two compared items. Although obviously unintended, the legal framework fails to address systematically, consistently, and fully the risk management approach as described in a universal standard. Instead, it incorporates a risk management approach that is vague, incomplete, and not persuasive to the interested stakeholders (i.e. workers, employers, etc.). Considering the great impact of occupational diseases in the economy and the society, it is imperative to update the existing legal framework by incorporation of new provisions and modification of existing ones to properly address the risk management processes and, eventually, treat risks of occupational diseases in a more efficient way. Specific proposals such as those presented in the discussion section of this paper may be studied and applied. A proper application of the risk management framework to safety and health issues shall: a) increase efficiency in production, b) improve competitiveness of the economy, c) reduce costs for the social security systems, and, most important of all, d) ensure safety and health for the workers in their working environment.

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*AA030*

# The Development of a Robust Resource Constrained Project Scheduling Framework

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## Abstract
The literature on resource constrained project scheduling attempts to schedule projects with deterministic activity durations subject to various objective functions and possible additional assumptions. During project execution, however, a project may be subject to considerable uncertainty. Such uncertainty may lead to the actual realized activity durations to substantially deviate from the durations that were initially estimated in the baseline schedule and cause a serious project overdue. This paper offers a framework that deals with the project scheduling problem from the start of a project through to the finish, and therefore provides a whole robust project scheduling strategy which is more tolerant to various uncertainties. Our framework combines the buffer sizing technique, proactive project scheduling approach and reactive project scheduling approach, which are usually implemented at different stages of a given project. The proposed scheduling framework constructed based on these approaches is tested using a large experimental design in order to detect the effectiveness of each procedure.

## Keywords
Project Scheduling, buffer sizing technique, proactive/reactive project scheduling

## 1. Introduction

All Project scheduling, as a stage of project planning in the field of project management, has been shown to be an important factor to improve the success rate of the project. It aims at deciding when to start and finish which activity in a time order and optimal allocating resources to each project activity subject to various constraints, such as resource limitations, activities durations and ethnological precedence etc. This type of scheduling problem is known as Resource Constrained Project Scheduling Problem (RSPCP).

The most common practice in project scheduling is to generate a schedule before the start of the project that minimizes project duration with the assumption of complete information under a static and deterministic environment. Such schedule will then be served as the baseline schedule for the execution of the project. However, during project execution, a project may be subject to considerable uncertainty which stems from a number of internal and external sources, such as project scope change, resources supply failure, original wrong estimation, etc. As a result, the actually realized activity durations may deviate from the durations that were initially estimated in the baseline schedule (Zhu et al., 2005). With a sensitive schedule, once a disruption happens to one activity, it may pass on to its successors till the end of project and leads to a serious project delay. Therefore,

without any anticipation of variability, deterministic project scheduling is normally not robust enough to be implemented in "real-life" projects.

Due to its practicality and assuming the recognition of unavoidable uncertainties during project execution, the field of proactive project scheduling has been paid much attention recently. The proactive project scheduling approach extends the baseline schedule in order to absorb anticipated disruptions that may occur during project execution. In simple terms it inserts buffer in front of each activity based on the statistical knowledge of uncertainty (Van de Vonder et al., 2007).

The proactive scheduling is, arguably, practical and highly popular amongst practitioners; due to complexities and unpredictable characteristics of "real life" projects however it cannot guarantee that the project is fully protected against delays. It is due to this fact that there is a constant need for contingency planning that follows predictive scheduling. The purpose of that is to answer 'what if' question and continuously guide the project implementation through the unavoidable schedule disruptions that occur.

The reactive project scheduling approach is used to modify the baseline schedule when disruption occurs during project execution. The reactive scheduling action may completely regenerate a new schedule or repair an existing schedule taking into account the current state of the system (Wang 2005; Herrmann 2006; Van de Vonder et al., 2007).

The combination of these two project scheduling approaches is known as proactive-reactive project scheduling. Proactive scheduling approach is used to schedule a project time plan before the start of the project, an approach which is widely believed to be robust enough to absorb the expected disruptions; while reactive scheduling approach is used to revise (or re-optimize) the baseline schedule during the project execution particularly when disruptions occur that cannot be absorbed by the proactive schedule. Researchers have suggested that the combination of proactive project scheduling and reactive scheduling provides an effective and efficient project scheduling strategy (Van de Vonder et al., 2007). Nevertheless, one area that has not been given substantial consideration in previous scholarly studies is that of fixed project deadlines i.e. where the project deadline is assumed to be known and both the proactive and reactive approaches are calculated based on that assumption. However, the estimate of the project final deadline that must be decided at the early stages of the project has never been integrated into the proactive-reactive project scheduling field even though this is arguably a crucial input to the project time plan. If the project due time is overestimated the project will be overprotected and lead to time and resources wasting. In contrast, if the project due time is underestimated the project will still endure the risk of being overdue even though the proactive-reactive scheduling strategy has been applied. An appropriate buffer sizing technique needs to be applied to estimate the project due time with both safety and economics considered before any project scheduling approach can be calculated and implemented.

## 2. An alternative proposal

Arguably, the buffer sizing technique, proactive scheduling approach and reactive approach could be combined together as a complete project scheduling strategy in order to generate optimal and robust project schedules which should be able to protect the project due date and at the same time avoid the unnecessary costs. The

robust resource constrained project scheduling framework can be summarized as follows:

Step 1. Predict the project duration using the buffer sizing technique:
After creating the project schedule using deterministic RCPSP approaches, the project time buffer is decided using the buffer sizing technique and this buffer is added to the project schedule in order to obtain a reasonable project duration.

Step 2. Construct the project baseline schedule using proactive project scheduling approach:
Based on the deterministic project schedule and the project deadline that were generated in Step 1, use proactive project scheduling approach to create the project baseline schedule to absorb as much as possible the expected uncertainty. Such baseline schedule will then be used to guide the project execution.

Step 3. Create a project contingency schedule using reactive project scheduling approach:
When any unexpected disruptions occurred during the project execution, which leads to the realized project activities to deviate from the baseline schedule generated in Step 2, revise the project baseline using the reactive project scheduling approach.

Such a project scheduling framework can be viewed as a feedback control process as shown in Figure 1. A time control target needs to be specified first. During the monitoring, the online implementation time of activities will be compared with the plan. If the real time deviates from the predefined constraints, corrective action will therefore be required to be taken in order to ensure the project end within the deadline, as shown in Figure 2.

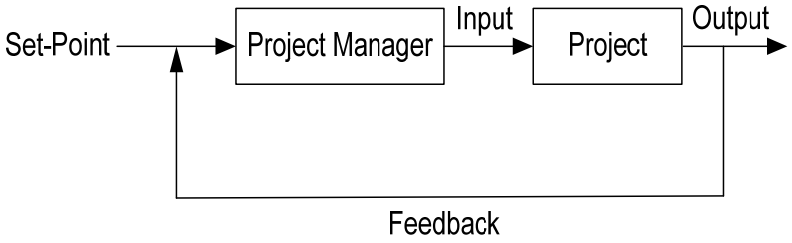


Figure 1: Closed-loop Management Control System

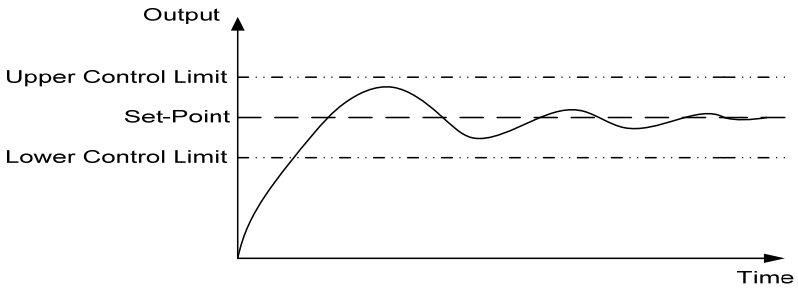


Figure 2: Stable Control System Performance

This proposed project scheduling framework provides a general routine related to the project scheduling procedure which optimizes the project at each scheduling step. Many comprehensive techniques have been developed for buffer sizing, proactive project scheduling and reactive project scheduling respectably. These approaches are based on various objectives and considerations, which may behave differently when applied to projects with different characteristics. Following this section, several popular buffer sizing, proactive project scheduling and reactive project scheduling approaches will be highlighted in Section 2. In section 3, these techniques will then be used to construct the scheduling framework that was proposed above based on various combinations. These distinguished frameworks will then be tested on the projects with various characteristics using a large experimental design set in order to evaluate their capabilities under the composite objective of maximizing both the schedule solution robustness and schedule quality robustness. Detailed knowledge of the characteristics of each strategy should enable project managers to decide which framework should be selected, based on the specific project characteristics and demands. Finally, Section 4 provides conclusions of the work presented in this paper.

In the full paper 4 buffer sizing techniques, 3 proactive project-scheduling approaches and 3 reactive project-scheduling approaches, are reviewed. However, due to length constraints the review has been omitted from this manuscript and instead we move on to testing directly. Naturally, the full review is available from the corresponding author upon request.

## 2.1. The Robust Resource Constrained Project Scheduling Framework

Four project buffer sizing techniques, namely False Positive rate (FPR), Root Square Error Method (RSEM), Adaptive Procedure with Density (APD), (APRT), three proactive project scheduling approaches, namely Resource Flow Depandant Flow Factor (RFDFF), Walk with me (VADE), Sensitivity Time Control (STC) and three reactive scheduling approaches, namely Finish to Finish (FF), Automated Bulk Provisioning (ABP) and Resource Constraint Project Scheduling Problem (RCPSP), are considered. These approaches are based on various objectives and considerations, which may behave differently when applied to projects with different characteristics. Using the robust scheduling framework proposed in Section 1, any one method from each group can be selected and combined together to construct a project scheduling procedure. Therefore, it is possible to create a total of 36 robust scheduling strategies. In this section, the 36 scheduling strategies will be tested using a series of projects with varying characteristics. The results will be used to evaluate the each individual strategy's capability under the composite objective of maximizing both the schedule solution robustness and schedule quality robustness. This process provides a guide which allows project managers to identify the proper scheduling methodology for different project scheduling environments.

## 2.2. Test Rationale

In the test, all 36 procedures described above will be investigated using a MatLab simulation. A standard test is set up at the beginning. Based on this standard test, four individual parameters that could influence the capability of the 36 approaches will be applied individually using four separate tests. This will provide an investigation into the effectiveness of the 36 approaches under different situations.

For each test, the total number of 30 random project networks with 10 non-dummy nodes will be generated using project RanGen (Demeulemeester et al., 2003). RanGen is a random network generator for generating activity-on-the-node networks with the required amount of network resources and Order Strength (OS). OS is defined as the number of precedence relations (including the transitive relations, whilst excluding the arcs connecting the dummy start or end activity) divided by the theoretical maximum number of precedence relations. The deterministic RCPSP scheduling technique will be implemented on each network created by RanGen to obtain the deterministic scheduling baseline. Based on these deterministic schedules, the 36 approaches will then be applied to generate robust project schedules.

Finally, the robust schedules generated using the 36 approaches will be compared with the realized project schedules. The realised project schedules were simulated based on various possible situations. The effectiveness of the 36 approaches was measured by the average value of SR and QR indices over the 30 networks. The project configuration measures ( $flex$ , $fldt$ , $dsrp$ ) will also be calculated for the deterministic baseline schedules to define its characteristics in order to investigate the effectiveness of various robust scheduling approaches under different project environments. All of these approaches are based on the assumption that the project is executing to a predefined baseline schedule. If an event happens which cause the activity to deviate from its baseline schedule, the reactive scheduling approach will be applied. The testing procedure is expressed in Figure 3.

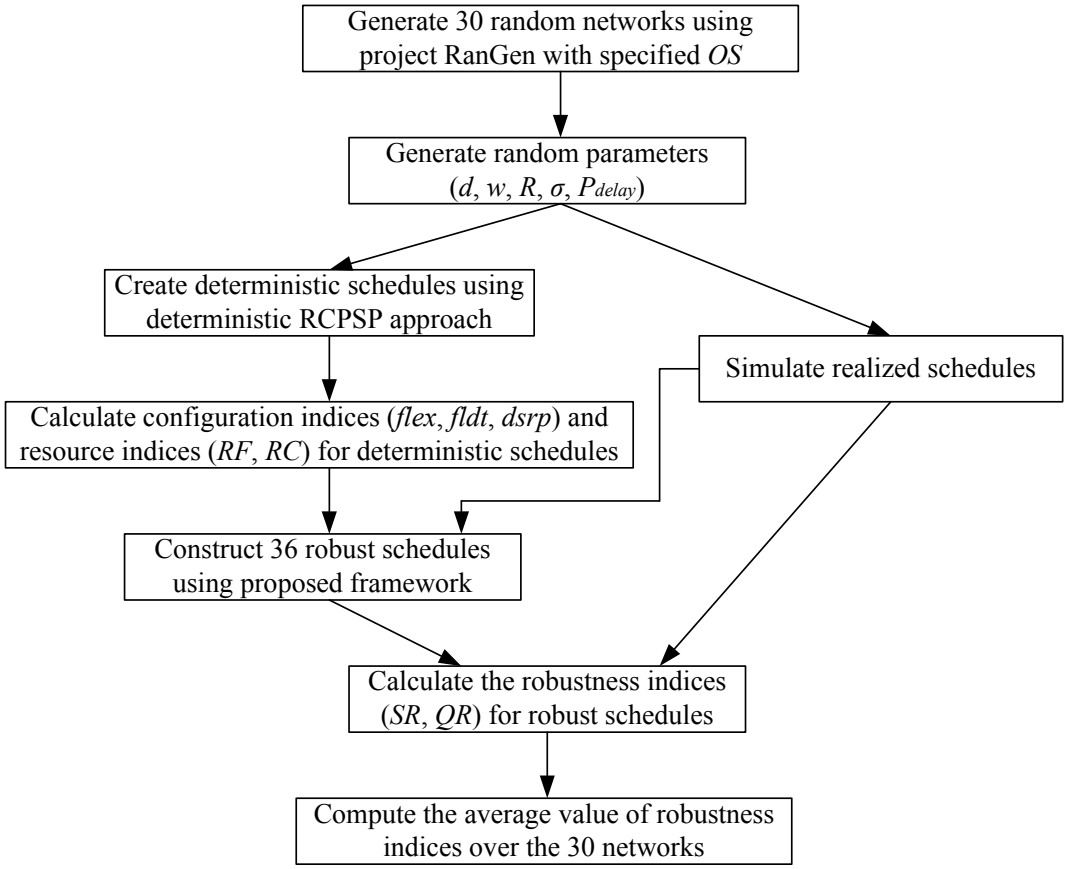


Figure 3: Testing Procedure

Each of the tests was based on the simplest single-project and single-mode RCPSP. Each has finish-start precedence constraints, zero time lag, no pre-emption and fixed renewable single resources. The basic parameter settings for the whole test are listed in Table 1.

| **Symbol** | **Description** | **Value** |
|---|---|---|
| $n$ | number of don-dummy activities | 10 |
| $d_{\max}$ | maximum duration for all the activities | 5 |
| $d_i$ | duration for activity $i$ | $d_i \le d_{\max}$<br>$P(d_i) \sim \mathrm{N}(0,1)$ |
| $r_{\max}$ | maximum resource requirement for all the activities | 40 |
| $r_i$ | resource requirement for activity $i$ | $r_i \le r_{\max}$<br>$P(r_i) \sim \mathrm{N}(0,1)$ |
| $w_{\max}$ | maximum weights for all the activities | 10 |
| $w_i$ | weight for activity $i$ | $w_i \le w_{\max}$<br>$P(w_i) \sim \mathrm{N}(0,1)$ |

Table 1: Basic configuration parameter settings

For the purpose of this case study, excluding the standard test, four variables that

possibly could influence the capability of project scheduling approaches were adjusted under each test individually. By doing so it was possible to investigate the effectiveness of each approach under various scenarios. The values for the parameter settings used in each test are detailed in Table 2.

| | Symbol | Description | Value |
|---|---|---|---|
| *Standard Test* | OS | order strength | 0.5 |
| | $R$ | total availability of resource | $r_{\max}$ |
| | $\sigma$ | estimated standard deviation of an activity duration | 1.0 |
| | $P_{delay}$ | probability of $\sigma$ not being the same as estimated | 0.2 |
| *Test 1* | OS | order strength | 0.2:+0.1:0.8 |
| *Test 2* | $R$ | total availability of resource | $1\,r_{\max}$ :+0.2 $r_{\max}$ :2 $r_{\max}$ |
| *Test 3* | $\sigma$ | estimated standard deviation of an activity duration | 0.8:-0.2:0.2 |
| *Test4* | $P_{delay}$ | probability of $\sigma$ not being the same as estimated | 0.1:+0.05:0.3 |

Table 2: Variable settings for individual tests

## 2.3. Some Test Results

The results for each of the tests are detailed within the following section. Each result was obtained through implementing the experimental designs in MatLab. Due to lenght constraints only one data set has been addressed in this paper. For the full results please contact the correponding author.

*Standard Test*:

In this test, the parameters are set as OS=0.5, $R = r_{\max}$, $\sigma = 1.0$ and $P_{delay} = 0.2$. The SR and QR indices for all the 36 approaches are listed in Table 3 and Table 4 respectively.

| FPR | FF | ABP | RRCPSP | Proactive |
|---|---|---|---|---|
| RFDFF | 202.0667 | 205.0667 | 246.4667 | 217.8667 |
| VADE | 238.5333 | 241.5333 | 274.5333 | 251.5333 |
| STC | 392.5000 | 395.5000 | 417.0333 | 401.6778 |
| Reactive | 277.7000 | 280.7000 | 312.6778 | 290.3593 |
| RSEM | FF | ABP | RRCPSP | Proactive |
| RFDFF | 163.0333 | 165.6333 | 206.4000 | 178.3556 |
| VADE | 192.7333 | 195.7333 | 230.9667 | 206.4778 |
| STC | 358.3667 | 361.3667 | 377.0667 | 365.6000 |
| Reactive | 238.0444 | 240.9111 | 271.4778 | 250.1444 |
| APD | FF | ABP | RRCPSP | Proactive |
| RFDFF | 74.3333 | 76.7333 | 115.3000 | 88.7889 |
| VADE | 89.4667 | 92.4667 | 122.1000 | 101.3444 |
| STC | 200.8667 | 203.8667 | 213.5000 | 206.0778 |
| Reactive | 121.5556 | 124.3556 | 150.3000 | 132.0704 |
| APRT | FF | ABP | RRCPSP | Proactive |
| RFDFF | 143.4333 | 146.2333 | 183.9667 | 157.8778 |
| VADE | 171.2667 | 174.2667 | 202.9333 | 182.8222 |
| STC | 330.0333 | 333.0333 | 350.5000 | 337.8556 |
| Reactive | 214.9111 | 217.8444 | 245.8000 | 226.1852 |

Table 3: SR Indices for Standard Test

| **FPR** | FF | ABP | RRCPSP | Proactive |
|---|---|---|---|---|
| RFDFF | 24.8833 | 24.8833 | 24.7833 | 24.8500 |
| VADE | 25.1000 | 25.1000 | 25.0000 | 25.0667 |
| STC | 25.8500 | 25.8500 | 25.7500 | 25.8167 |
| Reactive | 25.2778 | 25.2778 | 25.1778 | 25.2444 |
| **RSEM** | FF | ABP | RRCPSP | Proactive |
| RFDFF | 24.0833 | 24.0833 | 23.9833 | 24.0500 |
| VADE | 24.3333 | 24.3333 | 24.2333 | 24.3000 |
| STC | 25.1167 | 25.1167 | 25.0167 | 25.0833 |
| Reactive | 24.5111 | 24.5111 | 24.4111 | 24.4778 |
| **APD** | FF | ABP | RRCPSP | Proactive |
| RFDFF | 22.3333 | 22.3333 | 22.2333 | 22.3000 |
| VADE | 22.5333 | 22.5333 | 22.4333 | 22.5000 |
| STC | 22.9833 | 22.9833 | 22.8833 | 22.9500 |
| Reactive | 22.6167 | 22.6167 | 22.5167 | 22.5833 |
| **APRT** | FF | ABP | RRCPSP | Proactive |
| RFDFF | 23.8167 | 23.8167 | 23.7167 | 23.7833 |
| VADE | 24.0167 | 24.0167 | 23.9167 | 23.9833 |
| STC | 24.7500 | 24.7500 | 24.6500 | 24.7167 |
| Reactive | 24.1944 | 24.1944 | 24.0944 | 24.1611 |

Table 4: QR Indices for Standard Test

Tables 3 and 4 compare the SR and QR indices for each of the 36 approaches respectively. In Tables 3 and 4, the SR/QR indices for four buffer sizing technique lead approaches are allocated in four different sub-tables. In each sub-table, the average SR/QR indices for each reactive scheduling approach are listed in the last row, the average SR/QR indices for each proactive scheduling approach are listed in the last column, and the average SR/QR index for that sub-table expressed buffer sizing technique is displayed in the right bottom corner. Table 3 and 4 demonstrate that the APD buffer sizing technique lead group approaches have both the lowest SR and QR indices. The RFDFF approaches produce the lowest SR and QR indices compared with other proactive scheduling approaches. Table 3 illustrates that the FF approaches are with the lowest SR indices compared to other reactive scheduling approaches, and differently, Table 4 demonstrates that the RRCPSP approaches are with the lowest QR indices, however, they are not much lower than the FF approaches. Tables 3 and 4 prove that based on this standard test parameter setting, APD-RFDFF-FF is much more preferable than other approaches.

## 3. Conclusions

The purpose of this research is not to compare and contrast alternative scheduling approaches in order to conclude on relative robustness as such, but rather to prove that when seemingly competitive approaches are combined better results can potentially be realised. Therefore, commentary regarding all conclusions in this paper is based on **predetermined testing conditions**. In that respect careful project scheduling has been shown to be an important factor in improving the success rate of a project. This paper proposed a robust project-scheduling framework by combining the buffer sizing technique, with the proactive project scheduling approach and reactive project scheduling approach. The new proposed

framework deals with the project-scheduling problem from the start of the project throughout to the finish, a rationale that admittedly provides a whole project scheduling strategy that is more tolerant to various uncertainties that could potentially be encountered.

Based on four buffer sizing techniques, three proactive project scheduling approaches, and three reactive project scheduling approaches, 36 defined scheduling results were generated using the initial proposed framework of page 3. A large experimental design set was used to test each of the frameworks on projects with a variety of characteristics. It was then possible to identify the effectiveness of each procedure under different project scheduling environments using the correct scheduling methodology. The test results indicate that all of the suggested approaches provide sufficient protection against delays in project completion times and as such address pertinent cost/financial gains.

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# Planning, implementing and managing energy efficiency projects at focused local level: The RURASU project successful example and the SAVE-AGE project objectives

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## Abstract
The effort to succeed the EU's commitment of the "20-20-20" initiative-reducing greenhouse gas emissions by 20%, increasing the share of renewable in the energy consumption to 20% and improving energy efficiency by 20%, requires multi-level actions and special projects that should be focused on specific targets. Additionally to the large-scale projects, mainly focused on RES at national level, it is important to provide support and knowledge at local level, especially in the sector of energy efficiency. Local actors and citizens outside major urban areas are often unaware of techniques and measures that could add the maximum potential gains to the overall targets in the energy sector. For this reason, Pieriki Anaptixiaki-local development agency in Greece (Pieriki) has implemented successfully several projects focused on disadvantageous categories of citizens and areas. Moreover, Pieriki is launching, under the coordination of E-zavod (Slovenia), a new transnational project focusing on strengthening energy efficiency awareness among residential homes for elderly people, under the title of SAVE-AGE.

## Keywords
Energy efficiency, project management, rural areas, residential care homes

## 1. Introduction

The effort to succeed the EU's commitment of the "20-20-20" initiative-reducing greenhouse gas emissions by 20%, increasing the share of renewable in the energy consumption to 20% and improving energy efficiency by 20%, requires multi-level actions and special projects that should be focused on specific targets. Additionally to the large-scale projects mainly focused on RES at national level, it is important to provide support and knowledge at local level, especially in the sector of energy efficiency. Local actors and citizens outside the major urban areas are often

unaware of the techniques and measures that could add the maximum potential gains to the overall targets in the energy sector.

For this reason and in full accordance with EU policies, Pieriki Anaptixiaki-local development agency in Greece (Pieriki), has implemented successfully several projects (funded by European Commission's programmes and Institutions) focused on disadvantageous categories of citizens and areas; rural areas buildings (RURASU project), urban areas with no scientific support (REASURE project), social housing (ECOLISH project). Moreover, Pieriki is launching a new project (funded by the EC's European Agency for Competiveness and Innovation under the Intelligent Energy Europe II programme), under the coordination of E-zavod (Slovenia), focusing on strengthening energy efficiency awareness among residential homes for elderly people, under the title of SAVE-AGE. This project has incorporated elements of feasibility potentiality and of managing possible confronted risks, as multidisciplinary actions are required-including engineering, social sciences, physics and economics. The project's objectives tie in with European and national priorities and policies, although some times the existing legislation that governs the under focus buildings and installations and, moreover, the delay in the adaptation of EC Directives as national legislation could create important delays that could lead to jeopardising of the project in general.

## 2. Projects focused at local level supporting European energy priorities and policies

Although important work has been achieved in the sector of disseminating knowledge and increasing awareness of citizens and professionals in the sectors of RES and energy efficiency, actual results of such applications are not so easily understood due to lack of actions implemented at local level. Local actors and citizens are many times reluctant to adapt proposed technologies and techniques based on experimental and research results. Moreover, students, practitioners and professionals related to these specific sectors, are incommoded in proposing or adapting such technologies and techniques, since they are not so technically aware on their operation and/or also unaware of their installation format. Finally, there are areas in Europe, although having an important RES potential, that applications are not so important, basically due to local reactions (in a great degree due to lack of sufficient preparation and dissemination) and lack of political will. This reluctancy on behalf of individual citizens, public-sector officers, planners, building professionals, local actors, public authorities, SMEs could be faced through project focused in dispersed local areas where knowledge is not so widely spread out and training activities are not so easily organised. In this way support could be achieved at the higher possible level. These projects aim to accelerate the penetration of RES in buildings with dissemination and demonstration activities, while providing the appropriate training to professionals in order to fulfil the potential requirements of the new RES systems market.

Successfulness of these projects is reassured from the type of the involved partners, like Pieriki local development agency -their activities are prescribed by the wider European philosophy, for more essential decentralisation, with active contribution in the planning and management of the development resources, through the coordination of all local institutional authorities. Especially for Pieriki, the detection, research, promotion, support and realization of integrated proposals for the development of Pieria Prefecture is achieved through the productive

exploitation of national and European financial support and development programmes. The company's strategy determines its contribution in the evolution, exploitation, promotion, development, management and protection of the natural and human resources and the development of Pieria Prefecture.

Regarding European dimension, these projects aim to trigger local market and support training activities which will provide professionals the required skills to fulfil the needs and desires of the new market. Such local community markets could produce success stories, based on the benefits which local markets could adapt from the penetration of RES systems. It has to be mentioned that small scale RES systems and energy efficiency techniques are proposed through these projects and therefore it should be expected that a significant part of the financial benefits will remain in the local communities.

Having analysed the experience of projects' partners, the potential for proposing an initiative at European level is clear, where the experience of each partner, supports the others to achieve better results. In this sense, the projects are developed at European level because the expected results are more important and deeper than those at local level by the developed Action Plans. The success of the projects is only possible through the experience exchange among member countries and the communication and diffusion of the obtained objectives, which are the key points of these proposals. The communication and dissemination actions of the actual achieved results are transferred, as planned, at local and European level. Finally, the possible high use of RES systems in an area results to local and general environmental improvement which is the main target of these projects. It is though concluded that the projects offer added value results and a European dimension to scattered local actions.

These projects take into account the common desire of all people for improving the local and general environment while it involves local communities from North, East and South Europe which are in different climate, organization levels, financial and local conditions. The different Partners involved have various experience level which affect the final outcomes of the project. The most experienced Partners are expected to provide technical support to non-experienced Partners in order to achieve the Project's outcomes.

These projects strengthen the collaboration of organizations located in different European countries having as common target the improvement of the local and general environment through the use of RES system or solutions and energy efficiency techniques. The framework of the projects is based in a general concept of knowledge transferability: local installations to be visited by all interested parties, training courses, support actions to local authorities and to citizens, guidelines provision. Furthermore, communication strategy is drafted for all pilot actions in order to transfer the results at local level (local dissemination actions), transnational level (pair dissemination activities) and international level (conferences). An important number of communication actions is always planned in order to disseminate results all over Europe. Apart from these actions the locally based organisations, implementing the local actions, transfer their knowledge to other organisations of their countries.

## 3. The RURASU project successful example

RURASU project focused on energy problems of each involved rural area (Pieria in Greece, Allgäu in Germany, South Ayr in United Kingdom, Cordillera Subetica in Spain), aiming to support dispersed local actors like engineers, buildings designers, public authorities and consumers on the use of renewable energy sources and energy efficiency measures in the building stock. The support was continuous, throughout the project duration, and was achieved through the setting-up (in United Kingdom and Spain) and further development (in Greece and Germany) of Rural Design and Advice Support Units (DASUs).

The continuous support provided to local actors resulted in the broader use and implementation of renewable energy sources and energy efficiency techniques. Important elements were:

- Development of educational materials (Information Acquisition Tool, leaflets etc.)
- Analysis, training and consultations regarding the European Buildings Directive (2002/91/EC)
- Networking and training of the involved professionals and support of local energy management in general.

The overall objective of the action was to provide energy management, energy conservation consultancy and services in rural areas. This objective was achieved fully through the proved establishment and operation of the four Design Advice and Support Units (DASUs) of RURASU project in the involved rural areas of the four predetermined countries. Taking into consideration the current state-of-the-art, 4 DASUs have been established and are fully operating in the rural areas of the four involved countries; Pieria in Greece, Allgaü in Germany, South Ayrshire in Scotland-U.K. and Cordillera Subbetica in Spain. For the establishment process of the new DASUs and the further development of the existing DASUs, reports have been prepared. The reports of project's Work Package 2 have been revised in order to better serve the purpose of disseminating good inspiration from and experience of the participating regions to other EU regions that have similar needs and opportunities to adapt or replicate RURASU practical approach. This objective is also achieved by the creation of an Action Agenda for DASU set-up in rural areas.

The idea of supporting energy efficiency and RES in rural areas is a replicable concept. Moreover, a number of deliverables produced could be important methodology tools for other regions in Europe. In more detail, "Formulation of an action agenda for DASU set-up in rural areas" (comprising technical, administrative and financial aspects) is formulated in such a general way that it can be easily used in other EU regions. The Action Agenda was disseminated broadly, as part of the dissemination policy. Moreover, "Report on the experiences of the existing DASUs in the rural environment in Germany and Greece", "Report on the set up and operation of the new rural DASUs" and "Report on the further development of DASU work in Greece and Germany" are three important methodology tools for replication. Especially the last two have been revised in order to better serve the purpose of disseminating good inspiration from and experience of the participating regions to other EU regions that have similar needs and opportunities to adapt or replicate RURASU practical approach.

PIERIKI ANAPTIXIAKI S.A.-O.L.A., coordinating RURASU project and implementing

local actions in Greece, is identified as the energy operator for the whole Pieria prefecture and including urban and rural areas of the prefecture. From initial enquires regarding simple subjects on RES and energy efficiency to advanced enquires on sophisticated RES and energy efficiency subjects and funding possibilities, PIERIKI's offices are the first place that a citizen of Pieria visits, having implemented numerous consultations and dissemination actions on small scale installations, based on national or European funding. Moreover, the executives and managers of PIERIKI are often invited to participate in conferences and congresses organised in Pieria, Greece and Europe, as the most appropriate local actors in the sector of energy and sustainability. Actions in disseminating energy knowledge in rural areas led to the national ENERGY GLOBE AWARD for GREECE in 2006 (project RURASU). Along with its consulting and technical character, the company promotes innovative development initiatives for the more effective absorption of national resources and E.C. allocations, in collaboration with Local Administration Organizations, production - development institutions and Prefecture authorities.

## 4. The SAVE AGE project framework

More than 1,5 million residents live in 24.000 Residential Care Homes for Elderly People (RCHEP) represented under the European Association for Directors of Residential Care Homes for the Elderly People (E.D.E.). Most of these buildings are not energy efficient due to the lack of awareness of the management regarding energy efficiency benefits and due to the lack of knowledge and organization in residential homes. Moreover, RCHEP managers do not fully recognize benefits of energy efficiency nor can they afford the employment of experts with specific technical skills. This sector is also specific as every investment lays as a burden for elderly people and their relative who often pay the bills for hospitality. In addition, inevitable ageing of European population will contribute to worsening the situation in the near future.

Since employees and managers of RCHEP are mainly social care professionals, they lack knowledge on energy efficiency and in many cases also foreign language skills and in some cases even computer literacy. Therefore, the first step that has to be done is to change RCHEP managers' attitude towards more energy efficiency.

The SAVE AGE project will build upon analysis of the current situation, searching for technical, behavioural, knowledge and financial obstacles towards energy efficiency in RCHEP. Secondly, the project will use the already established E.D.E network representing 24.000 homes to convince RCHEP managers to implement energy efficiency strategy and action plan with the aim to stimulate investment and no or low-costs measures leading to energy savings in RCHEP. Thirdly, a set of educational/training activities will be developed at national level and some pilot RCHEP will be established to test the various action plans. All these actions will be heavily supported with communication/dissemination activities aiming at raising awareness in order to change behaviour of RCHEP staff and residents to become more energy efficient. Since there were no large-scale analysis on energy efficiency done in the field of RCHEP before, all the information gained through this project will also be valuable for policy-making at EU level.

## 4.1 Specific objectives of the SAVE AGE project

The main objective of SAVE AGE project is to raise awareness on energy efficiency in Residential care homes for elderly people. RCHEP are the biggest European group organized within European Association for Directors of Residential Care Homes for Elderly People (E.D.E.) covering 24.000 homes and 1,5 million inhabitants across 15 EU member states. Future demographic trends show that these numbers will double within the next 20 years, but energy efficiency problems will stay the same, if not addressed properly. The Intelligent Energy Europe programme is a good opportunity to implement energy efficiency dissemination actions on wide EU level.

Project will prepare Energy efficiency strategies through initial analysis and action plans (both at EU and national level), best and worst practices will also be identified and pilot actions to demonstrate energy efficiency needs in RCHEP will also be established. Transnational and national dissemination events will encourage RCHEP management to undertake energy efficiency soft measures and investments in order to reduce costs and greenhouse gas emissions.

Another specific objective is to educate and train Residential care homes staff on energy efficiency. RCHEP managers and housekeepers lack specialized energy efficiency knowledge and energy efficiency awareness is a low priority due to home care needs. Changing this attitude would bring big multiplication effect and short as well as long term energy efficiency. This will be achieved nationally with national seminars, trainings and internationally with E.D.E. seminars.

Furthermore, SAVE AGE project aims to accept strategic orientation of E.D.E. members towards energy efficiency. Strategic orientation for energy efficiency at E.D.E. level would have large effect on the energy efficiency of the 24.000 residential homes. E.D.E. will accept to raise the energy efficiency topic as one of the main goal of the organisation. Strategic orientation towards sustainable energy use in E.D.E. organization will contribute to raise awareness of its members and consequently to decrease energy use in RCHEP. This goal will have important long term positive effects as the strategic orientation will remain a priority even after the project's end. The E.D.E association will also organize specific management contests for promoting Energy Efficiency towards their members.

Finally, the project focus to increase energy efficiency in RCHEP across 10 EU member states, since improvement of energy efficiency in RCHEP will have large demonstrative effect among 24.000 E.D.E members. Pilot actions will introduce energy efficiency manager for RCHEP in 10 EU Member States implementing soft measures for increase of energy efficiency. Pilot visibility actions (printing and installing visibility signs) will also help reduce energy consumption in RCHEP by changing the behaviour of the RCHEP residents.

Significant impact is also expected on the energy efficiency market. Change of mindset of RCHEP managers into more energy efficiency will bring indeed numerous investments into the sector. Market potential goes even well beyond the 24.000 E.D.E. members if considering also the RCHEP that are not E.D.E. members and the fact that elderly people will need more and more residential homes in the near future.

Project will also put focus on elderly people as an important group for EU environment policies. Hopefully project will help change priorities of EU also to

energy efficiency in this specific sector. Putting more effort will be sooner or later necessary on EU and on national level since the EU ageing process is irreversible.

## 4.2 Strategic (long term) objectives of the SAVE AGE project

Long term objective (5 years from the beginning of the project) is to achieve 5% energy savings in 24.000 care homes for elderly people across 15 EU member states. In numbers this will mean saving 1700 GWh per year and consequently a reduction of 700.000 tons of CO2 per year.

After 10 years, the objective is to decrease the energy consumption in RCHEP by at least 10% and to include residential and health homes that are not included in E.D.E. energy efficiency initiative. The initiative could then also include similar organizations like hospitals.

The continuation of this initiative after the project's conclusion will be ensured by commitment of E.D.E. organisation. Financial means for continuation will be ensured by project partner organizations themselves, by public authorities and also by the private sector interested in commercial activities with homes for elderly people.

## 5. Conclusions

A lot of years of research efforts have produced a broad understanding of the implications of building energy use, as well as an increasing number of energy-efficient strategies and technologies with significant potential for energy savings. However, these strategies and technologies have not been effectively transferred to the users of the buildings and to the building design community. A great number of buildings are still designed and, moreover operated, without any energy- related considerations beyond these required by national building regulations.

One reason that this knowledge gap still exists is because building operators and designers do not have the means to assess efficiently and reliably the impact of new strategies and technologies during the operation and during building design process. One of the major barriers to the successful implementation of energy efficiency measures in the built environment is the inability to get so-called operators and professionals to understand the benefits of energy efficiency. It is therefore necessary to provide advice and information to them who have, yet, to fully realize the benefits of a more energy efficient project.

This need for design advice and support is even more important and necessary to be provided to professionals acting in regions away from large cities where provision of support is easier, as usually there are located academic institutes and other educational and technical bodies with high expertise on the subject and capability of providing support.

The involvement of Pieriki Anaptixiaki-local development agency and of other actors that operate at local level and implement the aforementioned and other similar projects in the field of sustainability with emphasis on energy saving and RES is implemented gradually and through targeted planning, in order to achieve the greatest possible public awareness and dissemination of knowledge in the most successful manner.

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*AA095*

# Reformation of local development agencies seeking conservation in their wider market

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## Abstract
Local development agencies, acting in Greece for almost 20 years, are facing important threats for their existence; the general crisis and the specific new imposed frameworks require immediate actions. Aim of this paper is to analyse this situation and to provide information on the detailed framework that could be adapted in order to succeed conservation. The analysis method is based on actual data and on actual processes that have led to successful conservation results-results that demonstrate the actual need for reformation.

## Keywords
Change management, Crisis, Local development agency, Organisation Development, Reformation

## 1. Introduction

In this time period the world, and especially Greece, is facing the worst economic crisis after the 2nd world war. This subject is the main discussion theme, inside and outside the work environment. Managers have limited possibilities to reverse this negative climate. They have, though, to take decisions on how to manipulate the results of this crisis. A method to be adapted is to operate differently, adapting differentiated way of thinking, more constructive and creative. Economic crisis should be managed under the perspective of creation and exploitation of the opportunities that are emerging from it.

An important tool to be adapted in this effort is organisational change, change related more to the spectre of potential clients and possible funding thus to organisational format. To change something implies altering it, varying or modifying it in some way. Organisations change, or adapt, what they want to achieve and how. Some organisations change mainly in response to external circumstances (reactive change); others change principally because they have decided to change (proactive change) (Cole, 1996). Local development agencies of prefectural level in Greece are organisations governed by private law and their existence is based on the income of projects and programmes and not on fixed state funding. The general uncertain environment is becoming more intense due to the changes on the legal framework within which these companies have to operate and to changes of political decisions. Having specific purpose in their statutes, these organisations are

not so common to be proactive; nevertheless they should not stay pathetic but at least react to these situations. Nevertheless, the ability to be driven up to a proactive organisation could be the optimum case.

The Local Agencies under consideration implement projects aiming to the development of their areas and in such way they do not operate as existing commercial enterprises. As a principle they do not distribute profits to their shareholders (mainly public bodies and bodies of public interest)-profits (if they exist) are invested for local development actions. Local Agencies are not being funded by the national budget or by shareholders' financial contributions, since this is against the existing legal framework. As a result, implementation of projects and programmes is the only income possibility for them; nevertheless local development is their operational framework. New entities with the participation of the Local Agencies are not created during programmes or projects, although some programmes fund the creation of new independent enterprises. Local agencies' strategy is determined by their contribution in the evolution, exploitation, promotion, development, management and protection of the natural and human resources, cultural heritage, and industrial development of their areas. Along with the consulting and technical character, the local agencies promote innovative development initiatives for the more effective absorption of national resources and E.C. programmes, in collaboration with local administration organizations, production - development institutions and local authorities.

Changes does not always imply innovation, in our case it has to do with approaching new markets and potential clients seeking income and funding-that is required for the existence of the organization. For this to be achieved organization development should be incorporated as an in-house process.

## 2. Organisation Change and Development Background Framework

### 2.1 Change Management process

The process with which "successful" companies operate their change activities has been the focus of a great number of researchers for many years. Of course definition of "success" is not common for all researchers; nevertheless growth/development above market's average and financial return could be stated as two basic and common characteristics along with innovation, which is, unfortunately, prescribed differently for each company.

Peters and Waterman (1982, 1998) identified attributes of excellence, some of which can be adapted to our case study organisations as follows:

- They have a bias towards action, once a problem is identified, it is analysed and people are expected to come up with solutions.
- They listen to customers.
- They encourage internal autonomy and entrepreneurship.
- Employees are held in high esteem, but in a performance-conscious environment, expectations are high
- They emphasize the organisation's basic values (culture) and demonstrate their commitment to them
- Control is loose yet tight; it is loose in that decision-making is pushed downwards, but tight in that certain core values/practices are insisted upon

Change management, in our focus example, is related to the required organisation development, requiring (Bechhard, 1969) an effort planned, organisation-wide and managed from the top to increase organisation development and health through planned interventions in the organisation's "process", using behavioural science knowledge. Although stated more than 40 years ago, definition of organisation development by Warren Bennis (1969) as a response to change, a complex educational strategy intended to change the beliefs, attitudes, values and structure of organisations so that they can better adapt to new technologies, markets, and challenges, and the dizzying rate of change itself, is very representative for our focus example.

## 2.2 Implementation framework and problems faced

Although organisation development has a vast literature background, managers and responsibles of implementing such processes should prepare their on methodologies and tools. Nevertheless, there are values that could create a baseline framework and these were also the basis in our analysis. In such a framework each individual should be treated with respect and dignity and the organisation climate should be characterised by trust, openness and support. Hierarchical authority and control are not regarded as effective mechanisms and people affected by change should be involved in its implementation. Finally, problems and conflicts should be confronted, and not disguised or avoided.

The Organisation Development movement has been associated with the argument that hierarchical and bureaucratic constraints are negative factors and that the caring, sharing, empowering organisation is not only a better place to work, but is financially and materially more effective.

A major barrier in organisation change and development is the resistance to change, as most people need to be persuaded to the need to change and other fear it. The reality is that every human grouping has some forces within it which keep it together and provide it with stability and others which provide it with a reason to change or adapt. Nevertheless, in our situation since change is of vital importance for the existence of the organization under consideration, we are not analyzing processes of development and re-engineering only, but also these of reformation, in order to approach new funding potentials. As a result, resistance to change requires radical action and, of course, full elimination. Since this could not be totally achieved, those resisting should be manipulated in a way that they should not influence other individuals.

Important influences in the change of processes require reformation of the operational procedure. Fundamental principle is companies/organizations to redesign their internal processes in order to minimize unnecessary elements that consume time, workforce and resources required for their implementation. Objective is the scaled change instead of the gradual change.

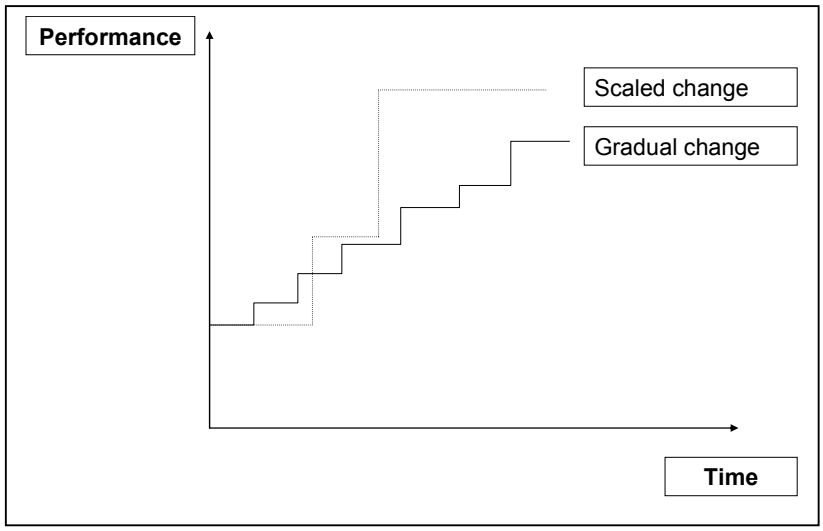


**Fig 1**: Scaled-gradual change

Due to the special circumstances that the under investigation agencies are facing, scaled change is a one way road-no time is available fro gradual change in such a severe market situation. This requires reformation of the enterprise's processes, something that the companies with excellent performance implement often as part of their working framework. In this framework, Project Manager has to study the assumptions underlying the existing problematic procedures and how to eliminate them. Due to the undergoing changes, compromises on standards and operating practices of the organization are held and the "as usual" scenario does not exist anymore, as different individuals and activities are required.
Benchmarking-as a temporary baseline with position or size decided on relevant measures and criteria, could be a useful tool for judging other circumstances. Key performance indicators in our case study could be the percentage of projects on time and the indicators of customers' satisfaction. Establishing benchmarks involves the study of very basic information, usually financial ratios that provide an average comparison rate of total efficiency of management. Wrong choice of numbers can be misleading and comparison between disparate sets of statistics is not performing satisfactorily in such a process. Much more interesting and far more potential benefits reveals to the project manager are the study and analysis of the processes behind the numbers. Framing procedures provide useful information on how to deal with these constraints, how to bypass obstacles and how to solve problems. Successful is the method of networking among project managers-the problems faced by managers are often solved more easily by others rather than themselves. The output data reference measurement has clear advantages. The comparison may include operating works: implemented into the same functional body, internal projects: carried out by the company, general works: studies related to procedures and comparison with projects having similar procedures, competitors' reference measures: comparison with competitors. Basic measure is productivity, the product produced per unit of resources employed. Categories for which objectives are set and measures are prepared are: financial perspective, internal entrepreneurial perspectives, innovations and knowledge management.

## 2.3 Alternative management process adapted

It is required to define the differences from the conventional Taylor approach since customers in crises periods tend to change their usual habits and experiment with new "packets" within which it is more easily to be allured. Reformation of the services offered to the traditional customers is required, incorporating characteristics that enhance value and discarding those that add limited value and charge cost disproportionately.

Traditional management faces the reduction in turnover as given and as such the revenue reduction. Therefore in order to maintain acceptable profitability (within healthy profit margins and liquidity) cost cuts across all activities are proposed. In addition, price reductions in order to convince reluctant customers are proposed. These trigger similar reactions from the competition and further pressure to profit margins and earnings-threatening liquidity (Paufler, 2009).

Additionally to the aforementioned, alternative procedures are required taking into consideration the prospect of economic recovery and boom. In such, facing a potential increase in sales and focus on efforts to recast the value of products that offer more creative and enticing way should be adapted. These lead to increased sales to non customers and selected cost reduction (of rejecting the relevant characteristics), while maintaining profitability, profit margins and liquidity. Economic cycles are repetitive and immanent. Businesses must learn to effectively manage the crisis and to prepare (strategically) for the upcoming recovery. Rules for this are: increase of sales and reduction of costs through product redesign, expansion to new customers, and focus not only on problems.

## 3. Case study analysis

The aforementioned framework was adapted by the local development agency of Pieria Prefecture (Pieriki) leading to the achievement of its conservation during this crisis, confronting the rest negative characteristics faced for such kind of organisations. It is important to present that although executives of different level, representing horizontal and vertical structures (general and project management) within the organisation, face reasons of change/development and problems in this process and come up with solutions to these problems, they have common views, mainly to the urgent need of change imposed from the crisis.

The Case study presented is already implemented by Pieriki and due to the successful results could be a proposal for replication. Pieriki, as an organisation operating under ISO standards, kept and improved the high quality standards of the services offered to the new range of clients.

## 3.1 Reasons for organisation development and change

- Change to the external working environment (legal framework of projects' implementation, municipalities' merge plan, technological evolution, legal framework for working conditions in local development agencies).
- Necessity for offering new services that will cover clients' new needs (municipalities, prefecture, legal bodies, social actors, etc.) and requires re-planning of the factors that define the attractiveness of the agency.
- Necessity for increase in the satisfaction of clients in order to "survive" in the competitive environment.

- Necessity to survive after the decrease of "stable" projects that come from the operational co-funded programmes
- Necessity for reaction possibility of all human resources to the chances that are offered via new funding means (at European level, transnational, etc.) that require expertise knowledge and experience.
- Necessity for adjustment to the current ways of internal operation in general (organisational breakdown structure, technological compliance, human resources management).
- Identification of risks in services offering and public procurement.
- Necessity for conservation of high morale within the agency (absences, withdrawals, climate, etc.)
- Previous and existing funding tools will not be available in the near future or their size will be decreased at important level.

## 3.2 Problems faced during organisation development and change

- Inability of personnel to react to change, psychological pressure.
- Limited financial resources that could support the possibility of funding development programmes (increased credit risk due to liquidity problems).
- Insecurity that is created by the personnel that "sabotages" adaptation to the new situation and the relation with the administration.
- Negative reaction from the personnel for acceptance of change and offering of new services. Possible need of dismissals and recruitment of expert professionals, leading to the disturbance of the working conditions.
- Changes in management create fragile internal environment of adaptation to development. High administration is possible that has not perception for the necessity of adaptation.
- The new legal framework does not allow flexible required moves (i.e. work contracts).
- Low effort for penetration in the market due to insecurity and retard of important executives.
- Unfair competition that could be generated between agencies which have either to merge or act together in a new geographical area. With the implementation of municipalities' merge plan new geographical data will be created, that will create possible risks for obligatory merging or absorptions and so changes in the internal environment.

## 3.3 Solutions implemented during organisation development and change

- Improvement of motivation and reward system.
- Rediscovery of the agency's vision.
- Seeking of new funding tools and methodologies.
- Exploitation of powerful collaborations between companies for the maximisation of the benefits
- Reformation of the relation between agency and participants (personnel, shareholders, clients, suppliers).
- Implementation of special training programmes for the executives that will embrace the agency's vision and definition of efficiency measurement tools of the new services.
- Commitment to the technological development.

- Training and development of the board of directors' members in order to have successful company profile that could implement "painless" and successful adaptation to the new situation.
- In order to prepare the personnel and face "bad" possible responses, meetings were organised with all of them or with those that were negative to change having as subject to present the new situation, the future vision and the sacrifices to be accepted. The implementation process was based in the activation of the existing principles of the in-house experts. In this way the differentiation of the external environment was faced as a "new challenge" resulting to the enlargement of the offered services. As a result it was required to implement rules for ensuring the quality standards in relation with the offered services. This factor was reassured initially with the training of the in-house experts to the new working fields along with specific co-operations that ensured quality of the produced result.

## 4. Results

Organizations must, after all, cater for the special needs and aspirations of their employees/members if they aim to exploit heir skills successfully and to retain their primary source of competitive advantage, involving changes in structure, culture and, mainly, management style employed within them. The traditional bureaucratic command and control structure will have to be jettisoned in favour of more flexible team and project-based management approached. Outcome of analysis related to motivation (Zapounidis, Kalfakakou and Athanasiou 2008) pointed that organizations motivate their employees, mainly by prompting them to participate in different levels of decision making, and are positioned closer to the participating management model, although their approach was rather unorganised and based mainly on interpersonal relations.

What is planned to be achieved with the organisational development interventions are:

- Improved organisational effectiveness, including better productivity and morale
- Better management throughout organisation
- Commitment to and involvement in making the organisation successful
- Improved teamwork
- Better understanding of organisational strengths and weakness
- Improved communications, problem solving and conflict resolution
- Creativity, openness, opportunities for personal development
- Decrease in dysfunctional behaviour-politicking, playing game
- Increased ability to adapt to changing circumstances
- Increased ability to attract and retain quality people

Nevertheless, the following possible errors that could lead unsuccessful organisational change and development (Kotter, 1995): sense of urgent is not created, powerful guidance coalition does not exist, lack of vision, insufficient vision transfer, obstacles are not removed towards new vision, omission of planning and achievement of short-term successes, quick victory declaration, changes do not keep up pace with organisational culture.

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*AA079*

# Projects for the Design of Changes

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## Abstract
According to Levy and Merry (1986), changes can be differentiated into first order changes and second order changes. First order changes describe changes in few dimensions of the identity of an organization (e.g. changes in the products & services offered) that might be performed continuously and not necessarily lead to a change of the overall identity of an organization. Second order changes include changes in many dimensions (e.g. the new organizational structures of a company, including impacts on personnel, infrastructure, budget, etc.) and lead to a new paradigm, a change in the identity of a company.

In the paper, change will be considered as fundamental, holistic change of an organization, and it will be further differentiated between "radical new positioning" (as consequence of a crises or chance) and "transformation". This "discontinuous" change can happen if strategic alliances are undergone, through the merger of companies, or through existential loss of market shares.

Such a change has an impact to all dimensions of an organization and is of high strategic importance. The high complexity of the change demands an appropriate complexity in the design of the process. On the one side, immediate measures must be taken, on the other side, projects respectively programs as temporary organizations can be used for structuring the change.

## Keywords
Project, Program, Change, Change Management, Change Roles, Project Roles, Program Roles, Change Communication

## 1. Introduction

A "change" considers the whole identity of an organization, its result is a new, altered identity [Gareis, 2008]. The establishment of change related roles and the appropriate design of communication structures are essential for the success of changes.

In changes specific change roles are required. The tasks and responsibilities of change owners, change managers, change agents, etc. have to be designed according to the change type. In 2nd order changes, change roles must be clearly distinguished and related to project and program roles. Overlapping assignments of different roles help to reduce complexity. Communication in changes is important and essential, and its intensity differs for each change type.

In this paper, special focus will be given to roles and communication in changes. As the tasks and responsibilities of change management roles may differ in each

change type, as well as different communication needs exist, the paper will focus on roles and communication in 2nd order changes.

## 2. Change

Levy and Merry [1986] differentiate between first and second order changes. Second order changes are the change types „radical new-positioning" and „transformation" (Gareis, 2010). The decision which type of change is looked at, depends on the demand and potential for change [Gareis, 2010]. In consequence, change phases can be identified and structured by processes. For the performance of changes, projects and programs might be the appropriate organisations.

Figure 1 shows the processes for the change type "transformation". The transformation processes have to be performed in parallel to the daily business. The transformation processes are performed by projects and/or programs.

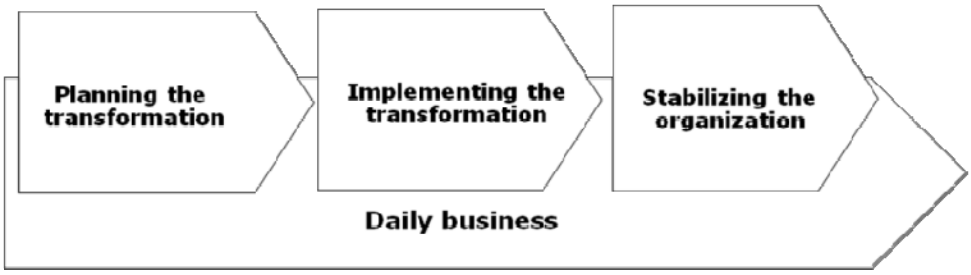


**Figure 1:** Processes of the Change "Transformation" (Gareis, 2010)

The planning of the transformation can either be performed by a temporary working group or by a project, depending on the complexity. The implementing of the change as well as the stabilizing of the organization can be performed by one or several projects or even by a program.

As the graph shows, in parallel to the transforming, the daily business is ongoing and must be secured. When structuring change by projects and programs, the establishment of project and program related roles, in addition to change management roles, becomes necessary.

It is necessary to explicitly define change roles as integrative structures for the performance of the overall change and to different those from program and project roles. Program and project roles are required for the management of distinct change programs or change projects, such as the planning of a transformation.

## 3. Change Management Roles in 2nd order changes

A change can be perceived as a chain of processes (see figure 1) and for the performance of each change process an appropriate organisation, such as a working group, a project or a program, must be defined. In consequence, it is necessary to clearly distinguish between change roles, program and project roles. (Stummer and Zuchi, 2010)

### a. Roles in 2nd order changes

For running changes professionally and assuring a continuous integration of all projects and activities within a change, specific roles and communication structures are required. Change management roles can be: Change Owner, Change Manager, Change Agents, Change Team, Sounding Board, Change Consultant, etc. (Newton, 2007). These change management roles differ from the additionally to be established project or program roles, in respect to objectives, tasks and responsibilities.

In consequence the following roles might be differentiated:

Change management roles
- Change owner, change manager, change agent
- Change expert (organization expert, marketing expert, …)
- Change team
- Change management consultant

Program roles
- Program owner, program manager
- Program team member
- Program team

Project roles
- Project owner, project manager
- Project team member
- Project team

### b. Role Descriptions "Change Management roles"

| | |
|---|---|
| **Change owner** | • Responsible for the strategic change management<br>• Responsible for the results of the change<br>• Definition of strategic requirements, making strategic decisions<br>• Assignment of the change processes<br>• Authority to stop the change<br>• Marketing of the change<br>• Assurance of resources for the change<br>• Contribution in change projects and change programmes (as owner/manager) |
| **Change manager** | • Responsible for the operational change management<br>• Management of the change<br>• Assurance of the transition between sequential change processes<br>• Assurance of compliance with change management standards of the organisation<br>• Marketing of the change<br>• Dealing with resistance<br>• Contribution in change projects and change programmes (as owner/manager/expert)<br>• Not: Content related decisions |

| | |
|---|---|
| **Change agent** | • Contribution in the change team<br>• Information of employees about decisions of the change team<br>• Dealing with resistance<br>• Implementation of change measures in the organisation<br>• Contribution in change projects |
| **Change management consultant** | • Further development of change management competences of the organisation<br>• Gathering information, development of hypothesis, planning of interventions<br>• Provision of analysis, observations, …<br>• Facilitation of meetings, workshops, documentations |

Table 1: Role Descriptions "Change Management roles" (Stummer and Zuchi, 2010)

### c. Role Descriptions "Program Management Roles"

| | |
|---|---|
| **Program owner** | • Responsible for strategic decisions<br>• Coordination of program and company interests<br>• Assignment of a program manager to perform the program<br>• Decisions about project-related issues which are beyond the decision-making authority of the program team or the relevant project owner and project manager<br>• Leading the program manager |
| **Program manager** | • Responsible for the professional fulfillment of the program management processes<br>• Realization of the program interests<br>• Ensuring the realization of the program objectives<br>• Leading the program team<br>• Representation of the program toward representatives of relevant environments |

Table 2: Role Descriptions "Program Management roles" (Gareis, 2005)

### d. Role Descriptions "Project Management Roles"

| | |
|---|---|
| **Project owner** | • Responsible for strategic project decisions<br>• Assignment and approval of a project<br>• Realization of the project-related company interests<br>• Coordination of project and company interests<br>• Provision of context information<br>• Feedback to the project team on the (intermediary) results<br>• Leadership of the project manager<br>• Marketing of the project |

| | |
|---|---|
| **Project manager** | • Responsible for the project success, together with the project team members and the project owner team<br>• Responsible for professional project management and for adequate project marketing<br>• Realization of project interests and the project objectives<br>• Leadership of the project teams and the project contributors<br>• Representation of the project toward representatives of the relevant environments |

Table 3: Role Descriptions "Project Management roles" (Gareis, 2005)

### e. Interrelationships and Differences between diverse Roles

The above described roles differ in their objectives and responsibilities. Change management roles have to consider the overall change, whereas the program and project related roles are responsible for the assigned program respectively project. The change owner has a visionary view on the overall change and takes decisions, that have consequences on the result of the identity of the overall company looked at. The change owner is responsible for the results of the change, and thus for the development of the company undergoing a change. The program or project owner on the contrary is primarily responsible for the results of the respective program or project and the herein defined results. A pre-requisite for the successful cooperation within the change is a common view on the change by all roles, so that possibly different objectives per interest groups might not lead to conflicts. (Stummer and Zuchi, 2010)

Looking at the change manager, he or she is responsible for the entire change and is in charge of the transitions between the projects and programs within this change. Where the responsibility of the program or project manager ends, the responsibility of the change manager takes over. To not lose energy throughout the long lasting change, the change manager has to secure that when some phases in the change have been successfully finished, the next phases (organized by a project or a program) are assigned by the change owner, and the continuity is assured. All managers have commonly no responsibility for the content but for the process. They all need good communication skills and need to be able to convince and lead people. The project managers will either report to the change manager or – if established - to the program manager. The change manager is responsible to report on the overall change (with the status of the single projects or programs) to the change owner respectively the change agents. (Stummer and Zuchi, 2010)

## 4. Communication in 2nd order changes

As changes disturb established patterns and functions of social systems, the systems might react with resistance. Resistance should be perceived as inherent part of change, often enhanced by lack of adequate communication. Relevant stakeholders do often not know, believe or understand that resistance is an important factor in changes (Doppler, 2006), which makes appropriate communication a success factor.

A change must be announced and explained. Communication can help to appropriately inform those concerned by the change and to prepare accordingly for the positive and or negative consequences. Though, communication might increase

the understanding and commitment of the employees for the change. One further objective of communication is that people are "moved" to change their attitudes and behavior in favour of the change.

There are different communication structures and media to be established in 2nd order changes, either to communicate within the change organization or to communicate to the external, the relevant environments.

### a. Communication within the change organization

At the beginning of the change, when having established the change management roles, the necessary communication demand within the change organization shall be agreed on. Communication media to be used for the communication within the change organization are Email, Intranet, (Social) Events, etc. The communication can be structured in regular intervals for ensuring the mutual exchange of information, to keep the energy within the change team and to get decisions in time.

The following table shows an extract of a list of possible communication structures:

| Name | Contents | Participants | Frequency |
|---|---|---|---|
| Change Owner Meeting | Information about the status in the change<br><br>Taking strategic decisions<br>… | Change owner<br>Change manager<br>Ev. Change management consultant | Every second week (eventually: telephone conferences with the change manager or change management consultants) |
| Change Team Meeting | Common development of the status in the change (Basis: progress reports by projects/programme)<br><br>Agreement on intermediate results<br>… | Change Team (Change manager, Change agents)<br>Change management consultants | Once a month, lasting 0,5 days |
| … | … | … | … |

Table 4 "Communication Structures for the Change Management Roles"

Accordingly, the communication media and structures shall also be established within eventually established program and project organizations for managing the change.

### b. Communication to relevant environments

On the basis of an environment analysis and the description of the environment relationships, where the expectations towards the change show the necessary communication intensity, a marketing plan can structure the required communication from the beginning of the change to the end and thus provide orientation for the change organization. The marketing plan may include

information on the target groups, the decided communication media, the contents, the dates, costs and responsible persons.

The communication media of 2nd order changes can be: Periodical company newsletter, information folder, periodical questionnaires, image campaigns, events, roadshows, vernissage, etc.

Supportive communication rules help to give orientation and to avoid the generation of gossips through unstructured information spreading. Such communication rules can be:

- All communication structures used are agreed in the change management team
- Standard information material has to be applied (folder, PPT presentations, etc.)
- Only contents already decided upon, shall be communicated
- Information shall not be provided too often, as this might reduce interest
- ….

An appropriate communication and marketing plan, accepted by the change organization and supported by communication rules is one success factor of changes.

## 5. Conclusions

One of the key success factors in changes is to define the appropriate roles needed for the change, as well as for the project(s) respectively program(s) herein. The objective of this paper was to contribute to the understanding of change roles and their clear differentiation from program and project roles.

The change roles required for 2nd order changes, such as "transformation", are the "change owner", the "change manager", "change agents" and "change experts". The objectives and tasks of these roles can be described. In these descriptions the relationships to other roles can be mentioned.

The change owner is responsible for the strategic management of a change. He defines the strategic requirements, makes strategic decisions, assigns new change processes, and has the authority to stop a change process. Persons performing the role change owner can contribute to change projects and change programs as owners or managers.

The change manager is responsible for the operational management of a change. He assures the transitions between change processes and the compliance with change management standards and performs change marketing. Persons performing the role change manager can contribute to change projects and change programmes as owners or managers or experts.

Change agents are responsible for the interaction with the employees of the organization and the implementation of change management measures in the organization. This includes the dealing with resistance. Change experts provide expertise for the fulfilment of the change. They usually act also as project managers or as team members in change projects.

Furthermore, adequate communication structures within the change organization give orientation to all people involved and communications with relevant environments raise acceptance for the change.

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