Challenges of Best Practices for Constructability Implementation: North Cyprus Construction Industry

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Abstract

Constructability can be defined as the optimum use of construction knowledge and experience in planning, design, procurement, and field operations to achieve overall project objectives. Constructability, the integration of construction expertise into all phases of a project, can benefit cost, schedule, quality, and other key objectives. Most organizations participating in the construction industry informally integrate construction knowledge and experience in their planning and design activities. In developing countries, many owners that do not apply formal constructability programs on projects are unaware of the potential savings that are being lost by unnecessary rework, reduced quality, lower construction productivity, and increased schedule durations. Our research focus is to investigate the challenges and opportunities of best practices for constructability implementation in a developing country, the case of North Cyprus Construction Industry. We aim to 1) determine current constructability implementation practices and identify elements that contribute to successful implementation, 2) assess the existence and severity of barriers to constructability implementation and 3) propose methods for overcoming common barriers to constructability in the construction industry of a developing country and develop a framework of best practices for constructability implementation in North Cyprus construction industry. Our research includes review of background literature, interviews with managers on building projects, analysis of this information to develop findings, and extending these to develop a framework of best practices for improving constructability implementation in a developing country, North Cyprus. By carrying out an effective constructability review process in a framework of best practices, the owners and contractors will be able to optimize construction costs, time, quality and safety whilst ensuring minimum interference to existing site operations. This will assist with maintaining consistently high construction performances in North Cyprus construction industry.

Keywords: Constructability, best practices, performance improvement, North Cyprus.

1. Introduction

1.1 Background

Constructability has been defined as 'the extent to which the design of a building facilitates the ease of construction, subject to the overall requirements for the completed building' [1]. Constructability is the optimum use of construction knowledge and experience in planning, design, procurement, and field operations to achieve overall project objectives. Constructability concept is an important tool in improving the quality of a product by controlling for better constructability implementation. Product, being in desired quality is reflected in the growing demands placed on building. The built environment must be constantly developed so that the targets set by residents and the community is attained and the building expresses cultural and environmental values. The importance of the quality of the completed project is growing all the time. The constructability concept encompasses the fulfilment of developer expectations, cost and time savings, ease of construction, functional and technical durability. The owner is responsible for the end product. A good building is the one that will remain serviceable for as long as possible, it will be economic to maintain, and as energy efficient as possible during both construction and use.

Many research efforts have investigated different aspects of constructability analysis. Some researchers have focused on identifying broad constructability concerns and developing constructability improvement approaches and programs [2,3,4,5,6,7]. Others have focused on identifying design-relevant constructability knowledge to automate constructability analysis of 3D models similar to this research [8,9,10,11]. Fischer developed an automated decision support tool that provides feedback to designers on how well a designed structure considers the requirements of construction methods [8]. Fischer presented a Construction Knowledge Expert (COKE) that guides designers towards designing structures that are more constructable [12]. Patty et al. presented a computer tool that utilizes a multimedia to give the designer the capability of accessing constructability information at the point of design [13].

Constructability is increasingly becoming a major requirement in building practice. The industry's clients are continuously demanding the best value for money, in terms of the efficiency with which the building is carried out. Most organizations participating in the construction industry informally integrate construction knowledge and experience in their planning and design activities. In developing countries, many owners that do not apply formal constructability programs on projects are unaware of the potential savings that are being lost by unnecessary rework, reduced quality, lower construction productivity, and increased schedule durations. Recognizing constructability issues early in the project delivery process can help to identify design constraints that limit a constructor's ability to plan and perform construction operations effectively resulting in suboptimal project performance and increased construction costs. Today, project teams often perform constructability reviews during the design phase to ensure that construction knowledge is incorporated in the design process and constructability problems are minimized.

1.2 Constructability Reviews

Constructability Review is the phase of construction project management where an independent and detailed analysis of all of your contract drawings and construction documents is conducted before their release for construction. This critical process evaluates the "ability to construct" the project. The purpose to conduct a constructability review is simply because, during a typical construction project, the design phase can take months or even years to complete in developed countries, while the design phase takes shorter time in developing countries. The problem is that, a contractor's level of expertise and knowledge is introduced at the end of the design phase, mostly by the end of procurement phase, during the time when you bid and award projects to the contractors in order to commence the construction phase. Delaying this vital and project critical review until the later stages of the project can lead to inefficiencies. At worse this will lead to cost overruns, time overruns, substandard building quality, or even structural failure. By the aid of the review, opportunities may arise to perform a framework of best practices for constructability implementation.

1.3 Best Practices for Constructability Implementation

Application of the Constructability Concepts to a capital facilities project can be expected to reduce project costs and schedule while improving quality and project safety. Returns on investment of greater than 10:1 were widely reported. Constructability implementation tools and the roadmap for a corporate or project constructability program were shown in Construction Industry Institute (CII) Special Publications 34-1-*Constructability Implementation Guide* and RS34-2-*Preview of Constructability Implementation* [14]. As demonstrated in the case studies summarized in the publications, when methodically implemented, front-end constructability efforts were an investment that results in a substantial return. Documentation of constructability efforts showed that owners accrued an average reduction in total project cost and schedule of 4.3 percent and 7.5 percent, respectively. These savings represented a 10 to 1 return on the owner's investment in the constructability effort.

In order to commence a formal constructability program, the owners, clients or employers should be acknowledged by professions about the necessity of a formal comprehensive system and enforce them to seek a formal constructability approach. Constructability review conducted in the early stages of a project is useful in detailed analysis of all of the contract documents and construction project drawings and documents before their release for construction. The process involving a constructability implementation should be commenced with the beginning of the design phase of a construction project, sometimes even before the design phase may be useful to assess feasibility of the project in an earlier stage (before the design is commenced) and should be implemented during the construction phase until the delivery of the project. Benefits of early involvement in constructability implementation should be known by the owners in order to obtain a good performance in terms of time-cost quality triangle. Applicability and improvement of constructability approaches are directly related to the approach of the project stakeholders to the constructability concept. For improvement of constructability approaches commence of

constructability practices by the involvement of all project stakeholders is of great importance. On the other hand, cost of constructability practices for a specific project should be predicted in order to select the appropriate method or model for constructability implementation.

1.4 The Case: Overview of the North Cyprus Construction Industry

Construction industry in North Cyprus is aware and recognizes the need to modernize in order to tackle the severe problems it is encountering, namely, Profitability, Research and Development, Training, Price and Cost, Dissatisfaction of Clients and Fragmentation. The necessary conditions for competitiveness for the North Cyprus construction industry include strong and sustained levels of productivity growth, openness to innovation and new technology and a commitment to delivering value for clients' money. There is growing interest in the role of innovation within the North Cyprus construction industry [15]. Compared with other industries, there are constraints placed on innovation within construction because of the characteristics of the industry. These include the adversarial culture and fragmentation of the different participants in most construction projects, the project based nature of construction. Projects are discontinuous and temporary and there are often poor linkages between project and business processes. Also the environment within which most organizations operate is changing rapidly. Organizations failing to adapt and respond to the complexity of the new environment tend to experience survival problems, sooner or later. In this climate of change, the development, implementation and use of adequate performance measurement and management frameworks is one of the major challenges confronting organizations but can play an important role in their success.

Contractors typically hire subcontractors, who do not have contracts with the owner - even if the owner pays a high price, the subcontractor may still have to work with inadequate budgets, often compromising quality as a result. Communication tends to be via the contract. Essentially, the designer is paid to produce a design expressed in the form of specifications and drawings. The contractor is expected to use these as a means of communication, and produce the completed facility. This communication often does not work as well as it should have. Innovation is adopted very slowly. Contractors often lack the expertise or financial resources to adopt technological advances - adoption is inhibited further by fear and uncertainty. Few large companies and virtually no small companies have implemented the concept of a quality or productivity manager – the traditional approach is to depend on the experienced staff to run projects efficiently; such staffs are rarely if ever trained in optimization techniques. Profit margins are low and discontinuous in construction industry. Research and development activities carried out by contractors are insufficient. In-house training is not meeting the requirements of firms. Most of the clients are not aware of the difference between price and cost. Thus at the bidding process the lowest offers submitted are preferred by most owners. Projects are unpredictable in terms of timely delivery, within budget and to the required quality standards.

2. Objectives of the Study

Most organizations participating in the construction industry informally integrate construction knowledge and experience in their planning and design activities. In developing countries, many owners that do not apply formal constructability programs on projects are unaware of the potential savings that are being lost by unnecessary rework, reduced quality, lower construction productivity, and increased schedule durations. Our research focus is to investigate the challenges and opportunities of best practices for constructability implementation in a developing country, the case of North Cyprus Construction Industry. We aim to 1) determine current constructability implementation practices and identify elements that contribute to successful implementation, 2) assess the existence and severity of barriers to constructability implementation and 3) propose methods for overcoming common barriers to constructability in the construction industry of a developing country and develop a framework of best practices for constructability implementation in North Cyprus construction industry.

3. Research Phases

The research includes review of background literature, interviews with managers on building construction projects, analysis of this information to develop findings, and extending these to present the key strategic issues that could be targeted for continuous improvement within construction firms in North Cyprus Construction Industry in terms of constructability. The empirical data was collected through structured interviews within the main large private sector construction organizations. The paper deals with the results of a questionnaire survey conducted by research members of European University of Lefke (EUL) Department of Civil Engineering MSc. in Construction Management Program. Main topics in the questionnaire were as follows:

i. General information about organizations
    - § General functions of service areas
    - § Size of organizations
    - § Work capacity
    - § Firms' turnover
    - § Work force information
ii. Establishment of Corporate Constructability Program
    - § Identifying constructability sponsor/champion
    - § Establishing functional support organization and procedures
    - § Developing lessons-learned file
iii. Planning Constructability Implementation
    - § Developing constructability team
    - § Identifying and address project barriers
    - § Consulting applications matrix and lessons-learned file
    - § Developing constructability procedures and integrate into project activities
iv. Implementing Constructability
    - § Applying constructability concepts and procedures
    - § Monitoring and evaluating project program effectiveness
    - § Documenting lessons learned

v. Updating Corporate Program
    - § Evaluating corporate program effectiveness
    - § Modifying organization and procedures, updating lessons-learned databases

3.1 Literature Review

This stage involves a thorough review of literature about the implementation of performance measurement systems that include measures adapted to constructability and that can be a real driver for continuous improvement of project processes. The intensive literature review resulted in the identification of constructability concepts affecting the phases of *Planning* (Strategic Plan/Preliminary Feasibility/Final Feasibility), *Design* (Program or Conceptual Phase/Pre-Schematic Phase/Design Development Phase/Construction Document Phase, *Construction* (Site work/Shell/Interior), *Procurement* and *Occupancy* [14]. The concepts are;

(a) Constructability program is an integral part of project execution plan
(b) Project planning involves construction knowledge and experience
(c) Early construction involvement in development of contracting strategy
(d) Project schedules are construction-sensitive
(e) Basic design approaches consider major construction methods
(f) Site layouts promote efficient construction
(g) Project team participants responsible for constructability are identified early-on
(h) Advanced information technologies are applied throughout project.
(i) Design and procurement schedules are construction-sensitive
(j) Designed to enable efficient construction
(k) Design elements are standardized
(l) Specifications are developed for construction and procurement efficiency
(m) Designed for modularization & preassembly to facilitate fabrication & transportation
(n) Designed for accessibility of personnel, materials and equipment
(o) Designed for construction in adverse weather and remote locations
(p) Design and construction sequencing should facilitate system turnover and start-up.
(q) Contractor use of innovative construction methods

3.2 Data Collection

The second stage involved the collection of data. A questionnaire survey, which was administered to almost all the firms, which are registered to the Association of Building Contractors, has been used in conducting the survey. The survey includes four main types of information involving *Organizational Structure*, *Establishment of Corporate Constructability Program*, *Planning Constructability Implementation*, *Implementing Constructability* and *Updating Corporate Program.*

1. Organizational structure: General company characteristics were sought which include the general functions of service areas of the organizations, size of the organizations involving the production, firms' turnover, number of permanent employees, human resources and development and target group of customers.

2. Establishment of Corporate Constructability Program: This portion of the questionnaire was used to address the steps necessary in establishing a corporate-level constructability program for contractor organizations. The three steps are *Identifying constructability sponsor/champion, Establishing functional support organization and procedures* and *Developing lessons-learned file.*
3. Planning Constructability Implementation: This portion of the questionnaire was aimed to analyze the steps leading to effectively planning for constructability implementation. The four steps are *Developing constructability team, Identifying and address project barriers, Consulting applications matrix and lessons-learned file,* and *Developing constructability procedures and integrate into project activities.*
4. Implementing Constructability: This portion of the questionnaire was aimed to study the steps for implementing constructability. The three steps are *Applying Constructability Concepts and Procedures, Monitoring and Evaluating Project Program Effectiveness,* and *Documenting Lessons Learned.*
5. Updating Constructability Program: This portion of the questionnaire was aimed to investigate the steps for updating a corporate program. The two steps are *Evaluating corporate program effectiveness* and *Modifying organization and procedures, updating lessons-learned databases.*

The questionnaire was designed using a nominal scale for the real values of the independent variables. In evaluating the dependent variables, a scale of 4 intervals (with a '0' value given to no effect, '2' to a middle value, and '4' given to maximum effect). The respondents were asked to check a number on the scale, which reflects their assessment regarding the different factors (constructability concepts and barriers). A list of all contractor organizations within the construction sector was obtained from the Association of Building Contractors. The list consisted of a total of 30 organizations. An attempt was made to contact every single organization. In this particular survey, the sample size n = 20. During the survey 30 organizations were contacted and 20 (%66) of these questionnaires were evaluated. Contact personnel in the companies for the questionnaire survey were either the top management or senior management in their respective departments, therefore their level of knowledge expected to provide responses was acceptable for the purpose of validity of the survey results.

4. Findings

This section of the study discusses the opportunities and challenges of the implementation of constructability implementation considering construction firms' strategic planning as well as to the conditions for the North Cyprus construction industry to lesser the barriers for constructability implementation.

4.1 Determination of Importance Indices

The participating contractors provides numerical scoring concepts expressing their opinions on the significance of each concept in determining the establishment, planning, implementing and updating the constructability program and presenting the key strategic issues that could be targeted for continuous improvement within construction firms in North Cyprus Construction

Industry. The weighted average for each factor was calculated and then it was divided by the upper scale of the measurements in what is referred to as "important index" therefore the level of importance of the fourteen factors of the seven phases of the constructability implementation process were calculated using the formula [16]:

Level of Importance (Index) = [Σ(aX) x 100] / 4

a= the score given to the factor by each organization (varying from 0-4)

X= n/N

n= Frequency of organizations

N= Total number of participant organizations

					PLANNING			DESIGN					CONSTRUCTION			PROCUREMENT		OCCUPANCY	
		RANK	PHASES / CONCEPT		Strategic Plan	Preliminary Feasibility	Final Feasibility	Program or Conceptual Phase	Pre-schematic Phase	Schematic Phase	Design Development Phase	Construction Document Phase	Sitework	Shell	Interior	Prior to Completion of CD's	After completion of CD's	Prior to Completion of CD's	After completion of CD's
Σ	682		Constructability program is an integral part of project execution plan	SUM	54	54	68	46	36	36	36	36	36	36	36	54	54	54	46
Mean of Imp. Index	28.50	6		IMP.INDEX	42.75	42.75	57	28.5	14.25	14.25	14.25	14.25	14.25	14.25	14.25	42.75	42.75	42.75	28.5
				MEAN	3	3	4	2	1	1	1	1	1	1	1	3	3	3	2
Σ	752		Project planning involves construction knowledge and experience	SUM	54	54	54	68	54	54	54	54	36	36	36	54	54	54	36
Mean of Imp. Index	36.10	2		IMP.INDEX	42.75	42.75	42.75	57	42.75	42.75	42.75	42.75	14.25	14.25	14.25	42.75	42.75	42.75	14.25
				MEAN	3	3	3	4	3	3	3	3	1	1	1	3	3	3	1
Σ	712		Early construction involvement in development of contracting strategy	SUM	54	54	68	54	49	49	49	49	30	30	30	68	30	68	30
Mean of Imp. Index	32.30	4		IMP.INDEX	42.75	42.75	57	42.75	28.5	28.5	28.5	28.5	14.25	14.25	14.25	57	14.25	57	14.25
				MEAN	3	3	4	3	2	2	2	2	1	1	1	4	1	4	1
Σ	593		Project schedules are construction-sensitive	SUM	54	54	68	49	30	30	30	30	30	30	30	49	30	49	30
Mean of Imp. Index	23.75	14		IMP.INDEX	42.75	42.75	57	28.5	14.25	14.25	14.25	14.25	14.25	14.25	14.25	28.5	14.25	28.5	14.25
				MEAN	3	3	4	2	1	1	1	1	1	1	1	2	1	2	1
Σ	609		Basic design approaches consider major construction methods	SUM	30	49	49	68	54	49	30	30	30	30	30	54	30	30	46
Mean of Imp. Index	24.70	13		IMP.INDEX	14.25	28.5	28.5	57	42.75	28.5	14.25	14.25	14.25	14.25	14.25	42.75	14.25	14.25	28.5
				MEAN	1	2	2	4	3	2	1	1	1	1	1	3	1	1	2
Σ	579		Site layouts promote efficient construction	SUM	30	49	30	54	54	68	54	30	30	30	30	30	30	30	30
Mean of Imp. Index	23.75	15		IMP.INDEX	14.25	28.5	14.25	42.75	42.75	57	42.75	14.25	14.25	14.25	14.25	14.25	14.25	14.25	14.25
				MEAN	1	2	1	3	3	4	3	1	1	1	1	1	1	1	1
Σ	720		Project team participants responsible for constructability are identified early-on	SUM	46	54	54	54	54	68	54	54	30	30	30	54	30	54	54
Mean of Imp. Index	35.15	3		IMP.INDEX	28.5	42.75	42.75	42.75	42.75	57	42.75	42.75	14.25	14.25	14.25	42.75	14.25	42.75	42.75
				MEAN	2	3	3	3	3	4	3	3	1	1	1	3	1	3	3
Σ	756		Advanced information technologies are applied throughout project.	SUM	30	49	54	54	68	54	54	54	54	54	54	49	49	49	30
Mean of Imp. Index	36.10	1		IMP.INDEX	14.25	28.5	42.75	42.75	57	42.75	42.75	42.75	42.75	42.75	42.75	28.5	28.5	28.5	14.25
				MEAN	1	2	3	3	4	3	3	3	3	3	3	2	2	2	1
Σ	627		Design and procurement schedules are construction-sensitive	SUM	30	30	30	54	68	54	54	54	30	30	30	54	30	49	30
Mean of Imp. Index	27.55	8		IMP.INDEX	14.25	14.25	14.25	42.75	57	42.75	42.75	42.75	14.25	14.25	14.25	42.75	14.25	28.5	14.25
				MEAN	1	1	1	3	4	3	3	3	1	1	1	3	1	2	1
Σ	622		Designed to enable efficient construction	SUM	30	30	30	54	54	68	54	54	30	30	30	49	30	49	30
Mean of Imp. Index	26.60	9		IMP.INDEX	14.25	14.25	14.25	42.75	42.75	57	42.75	42.75	14.25	14.25	14.25	28.5	14.25	28.5	14.25
				MEAN	1	1	1	3	3	4	3	3	1	1	1	2	1	2	1
Σ	619		Design elements are standardized	SUM	30	30	30	54	54	54	68	54	30	30	30	30	30	49	46
Mean of Imp. Index	26.60	10		IMP.INDEX	14.25	14.25	14.25	42.75	42.75	42.75	57	42.75	14.25	14.25	14.25	14.25	14.25	28.5	28.5
				MEAN	1	1	1	3	3	3	4	3	1	1	1	1	1	2	2
Σ	536		Specifications are developed for construction and procurement efficiency	SUM	30	30	30	30	30	54	68	54	30	30	30	30	30	30	30
Mean of Imp. Index	20.90	16		IMP.INDEX	14.25	14.25	14.25	14.25	14.25	42.75	57	42.75	14.25	14.25	14.25	14.25	14.25	14.25	14.25
				MEAN	1	1	1	1	1	3	4	3	1	1	1	1	1	1	1
Σ	646		Designed for modularization & preassembly to facilitate fabrication & transportation	SUM	30	30	30	54	54	54	68	54	30	30	30	54	49	49	30
Mean of Imp. Index	28.50	7		IMP.INDEX	14.25	14.25	14.25	42.75	42.75	42.75	57	42.75	14.25	14.25	14.25	42.75	28.5	28.5	14.25
				MEAN	1	1	1	3	3	3	4	3	1	1	1	3	2	2	1
Σ	603		Designed for accessibility of personnel, materials and equipment	SUM	30	30	30	54	54	54	68	54	30	30	30	30	49	30	30
Mean of Imp. Index	25.65	11		IMP.INDEX	14.25	14.25	14.25	42.75	42.75	42.75	57	42.75	14.25	14.25	14.25	14.25	28.5	14.25	14.25
				MEAN	1	1	1	3	3	3	4	3	1	1	1	1	2	1	1
Σ	598		Designed for construction in adverse weather and remote locations	SUM	30	30	30	49	54	54	68	54	30	30	30	30	49	30	30
Mean of Imp. Index	24.70	12		IMP.INDEX	14.25	14.25	14.25	28.5	42.75	42.75	57	42.75	14.25	14.25	14.25	14.25	28.5	14.25	14.25
				MEAN	1	1	1	2	3	3	4	3	1	1	1	1	2	1	1
Σ	689		Design and construction sequencing should facilitate system turnover and start-up.	SUM	30	30	30	30	49	54	54	54	68	54	54	54	49	49	30
Mean of Imp. Index	31.35	5		IMP.INDEX	14.25	14.25	14.25	14.25	28.5	42.75	42.75	42.75	57	42.75	42.75	42.75	28.5	28.5	14.25
				MEAN	1	1	1	1	2	3	3	3	4	3	3	3	2	2	1
Σ	531		Contractor use of innovative construction methods	SUM	30	30	30	30	30	30	30	30	68	49	54	30	30	30	30
Mean of Imp. Index	19.95	17		IMP.INDEX	14.25	14.25	14.25	14.25	14.25	14.25	14.25	14.25	57	28.5	42.75	14.25	14.25	14.25	14.25
				MEAN	1	1	1	1	1	1	1	1	4	2	3	1	1	1	1
				Rank	11	9	8	3	4	2	1	5	12	14	13	6	10	7	15
Phases carrying the highest levels of Importance				Sum	622	687	715	856	846	884	893	799	622	589	594	773	653	753	588
				Mean of Imp. Index	21.79	25.15	27.66	36.88	36.04	38.56	39.40	33.53	20.96	18.44	19.28	31.01	21.79	27.66	18.44

Table 1. Matrix showing the variations in the level of Importance Indices of the factors

Table. 1 shows a matrix of variations in level of important indices of the factors (constructability concepts and barriers) during the constructability implementation phases. The X-axis of the matrix indicates the processes categorized into five phases. The three concepts believed to have influences on the constructability implementation process were listed in the Y-axis of the matrix with their index values. The matrix also includes the calculated sum, mean and the rank orders of

all the phases of the process listed at the bottom of X-axis with their index values. Studying the matrix the first three concepts carrying the highest level of importance are; *Advanced Information Technologies are applied throughout project*, *Project planning involves construction knowledge and experience* and *Project team participants responsible for constructability are identified early-on*. In observing the three highest ranked phases of the processes, it can be noted that all these phases belong to the "Design" process and carry almost similar level of importance. These are; *Design Development Phase*, *Schematic Phase* and *Program or Conceptual Phase*. The Level of Importance Indices for the concept "Advanced Information Technologies are applied throughout project", the Level of Importance Indices for the concept "Project planning involves construction knowledge and experience" and the Level of Importance Indices for the factor "Project team participants responsible for constructability are identified early-on" are shown in Figure 1., Figure 2. and Figure 3. respectively.

4.2 Discussion of the Survey

The concept "Advanced Information Technologies are applied throughout project", is ranked #1 and is found to have an influence on the "Pre-schematic Phase" considerably with a value of importance index, 57. This indicates that there must be an efficient utilization of Information Technology tools for the storage of historical data. These data are stored by computerized databases. These databases must include lessons learned from the constructability program as part of the project control system (e.g. budget amounts, change orders, and purchase orders).

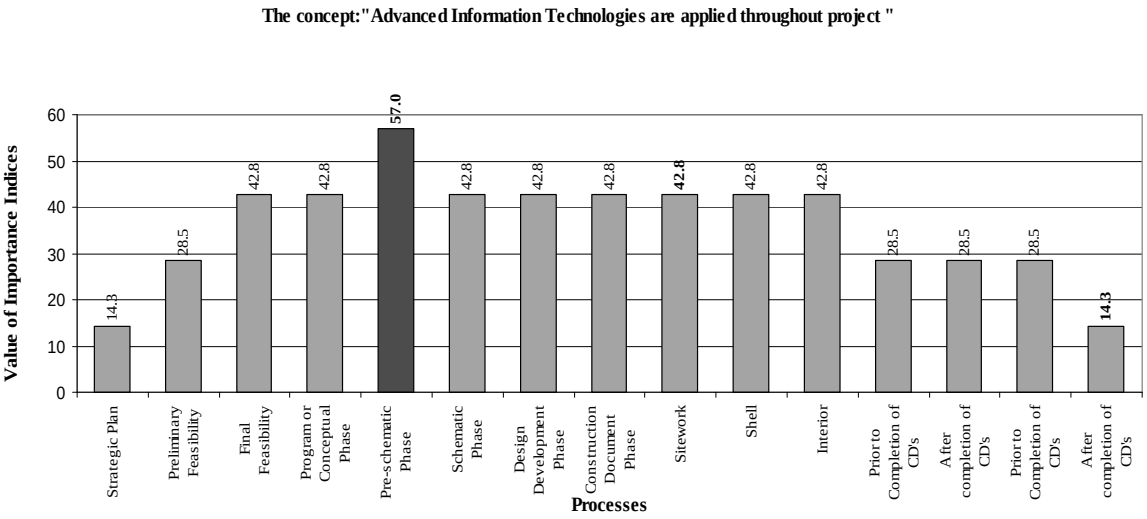

Figure 1. Level of Importance Indices for the concept "Advanced Information Technologies are applied throughout project".

The concept "Project planning involves construction knowledge and experience", is ranked #2 and is found to have an influence on the "Program or Conceptual Phase" considerably with a value of importance index, 57. This indicates that gaining knowledge from past experience is essential to any successful constructability program. Lessons learned are usually communicated

by project kick-off meetings, informal conversations, project meeting notes and post-project review meetings.

The concept "Project team participants responsible for constructability are identified early-on", is ranked #3 and is found to have an influence on the "Schematic Phase" considerably with a value of importance index, 57. This indicates that at the design phase an organizational chart must be drafted identifying the constructability team participants and delineating their roles.

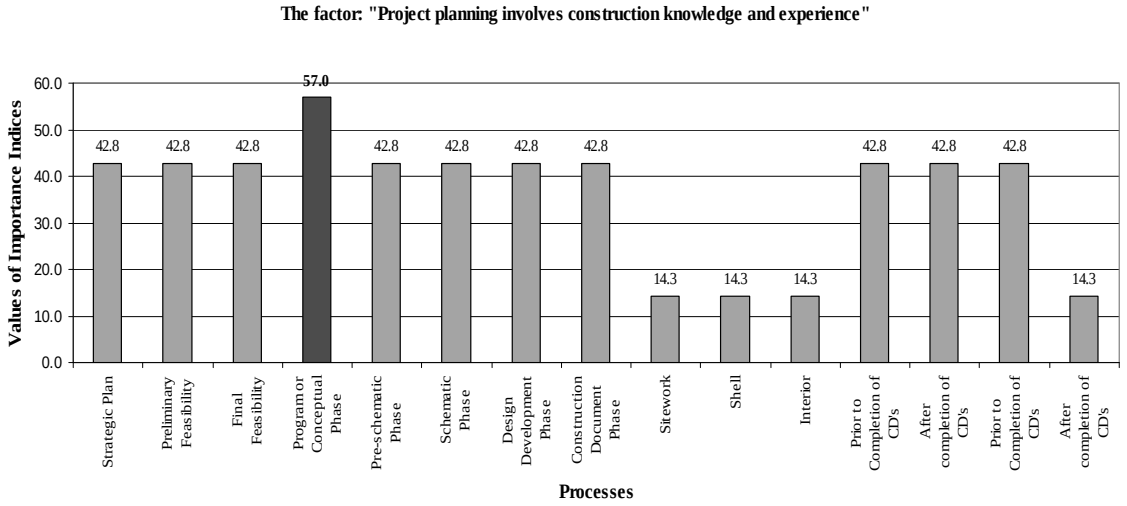

Figure 2. Level of Importance Indices for the concept "Project planning involves construction knowledge and experience".

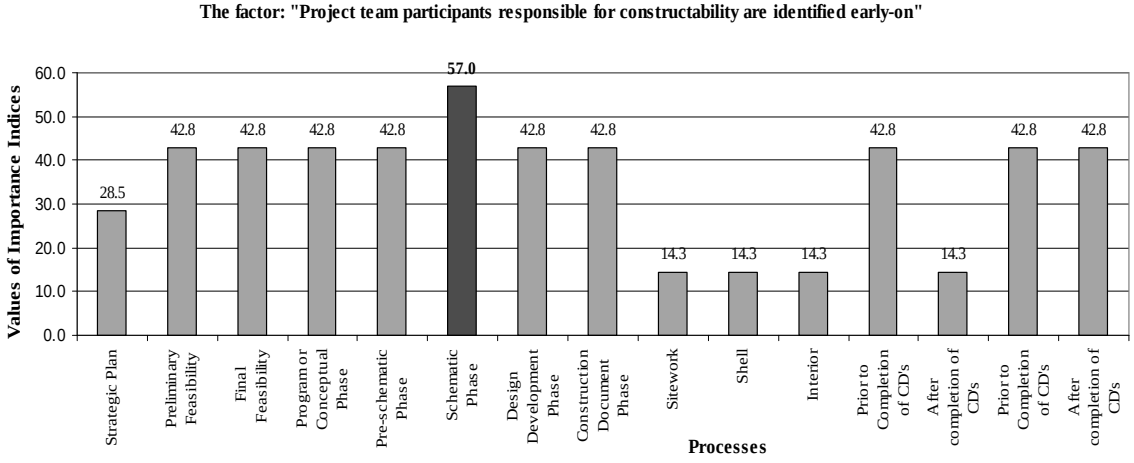

Figure 3. Level of Importance Indices for the concept "Project team participants responsible for constructability are identified early-on".

The survey verifies that the *design* sets the pattern for all that follows. A 'good' design will mean that a 'good' project will follow but a good fabrication and installation cannot compensate for a poor design. It needs to be recognised that design goes through various stages, i.e. concept,

scheme, feasibility, detail and production drawings. Furthermore, between each of these stages there is often a break in time, sometimes a change in responsibility and there can even be a change in philosophy and priorities. What has to be achieved therefore is a transition between these various stages without a break, or at the very least with strong links and ties, whilst clearly identifying the responsibilities within each stage. It is important to identify those areas, which, the design must take cognisance of if maximum efficiency is to be obtained.

5. Conclusions

This paper investigates the challenges and opportunities of best practices for constructability implementation in a developing country, the case of North Cyprus Construction Industry. The findings verify that by carrying out an effective constructability review process in a framework of best practices, the owners and contractors will be able to optimize construction costs, time, quality and safety whilst ensuring minimum interference to existing site operations. This will assist with maintaining consistently high construction performances in North Cyprus construction industry. It is found that the concepts "Advanced Information Technologies are applied throughout project", "Project planning involves construction knowledge and experience" and "Project team participants responsible for constructability are identified early-on" hold the highest level of importance. From the phases point of view, "*Design Development Phase"*, "*Schematic Phase"* and "*Program or Conceptual Phase"* are the three phases of the "Design" process to be highly affected by the concepts mentioned above.

In North Cyprus, clients are increasingly becoming aware of the benefits of constructability review. They require buildings to be completed on time and within the tender price. These buildings should be of sufficient quality and easy to operate and maintain. Good constructability has been shown from experience to speed up construction, improve standards and lower costs. The time or cost 'saved' in the design process by inadequate attention to constructability is, lost over and over again during construction. Poor constructability can lead to lower standards of construction. The more complex the assembly of the structure is, the greater the number of operations and specialist trades required. New developments in the construction industry highlight the importance and continued relevance of constructability.

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