

## DYNAMIC APPROACH FOR CONSTRUCTION PROJECT MANAGEMENT

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### SUMMARY

This paper investigates the project dynamic status and project management dynamic behaviour. The dynamics for project management is from the interactions between the project dynamic status and the project management dynamic behaviour. These interactions are driven by both external changes and internal changes, which are called unattended dynamics. The study suggests that the implementation of project management is subject to both planned programmes and activities, and various unexpected changes. It introduces the dynamic approach which requests the dynamic behaviour when decision-making is taken for changes. It emphasizes the development of the ability of prompt decision-making continuously along the whole construction process.

**KEY WORDS:** construction, dynamic approach, dynamics, project management

### INTRODUCTION

Management approach has been through a long development process, from scientific management approach or classical approach, to human relations approach or social science approach, to systems approach, and to contingency approach or dynamic approach. The classical management approach or scientific management approach focuses on productivity and formal or bureaucratic organisation structure. Human relations approach emphasizes the informal and democratic organisation structure and participation of individuals. Systems approach considers the importance of consistence, production process and the relations between organisation and its outside. And the dynamic approach focuses on the changes, contingencies, flexibility and team participation.

In systems approach, construction project management is defined as a system composing planning, organising, control, co-ordination of a project from conception to completion on behalf of a client [1]. The input to this system is the proper identification of a client's objectives in terms of utility, function, quality, time and cost, the procurement of project resources including staff, materials, labour, plant, finance, and the establishment of their relationships. The outcome from the system is the completed project meeting the client's objectives.

The systems approach for construction project management emphasizes the integration of different parties involved in a project, and relies on the establishment of suitable and certain relationships between resources within the system. However, these designed relationships and structures cross the serious difficulty in practice where the ever-changing environment bring changes to the system throughout the whole project construction process. For example, the uncertainties in appointing suppliers and subcontractors will bring changes to the resources arrangements, the organisation structure, etc. to a pre-designed project management system. In fact, many different kinds of uncertainties exist in a project management system. The existence of these uncertainties shows the dynamic environment which will bring changes to a project management system in the whole construction process. It also shows the weakness of pure systems approach which considers the operation of the system with designed structures and conditions.

To deal with the uncertainties in project management, risk management methods have been introduced. Previous works [2] suggest a risk management system including risk identification, risk analysis and risk response. Risk management assumes that all risk factors can be identified and evaluated before they happen, and therefore necessary response strategies or preventive methods can be applied, in particular, through contractual arrangement [3]. Nevertheless, this classical risk management approach has found limited application. The difficulty of properly identifying risks in early stage and, particularly, the difficulty of quantifying the risk results in probability form have limited this technique's practical application to a large extent.

Dynamic approach is the development of systems approach. It considers construction project management as a dynamic system which is subject to changes from both internal and external environment. Project management team deal with changes, contingencies and new demands through the whole process of planning, organizing, motivating, directing, and controlling. In dynamic approach, changes and variations are not only expected but also treated as important power or dynamics for the management of the system.

This paper will be a pilot study of discussing the principle of dynamic approach for construction project management system. It will demonstrate the dynamic nature of the system and investigate the major dynamics driving or holding back the system. The procedures of the approach will be discussed.

## **DYNAMICS IN CONSTRUCTION PROJECT MANAGEMENT**

Construction project management is attached with a process which is under a changing environment. These changes are due to the construction project's dynamic nature and various environmental dynamics. Dynamics is a kind of power or forces that can produce change, action or effects on a system for progressing forward. The dynamics acting on a project management system basically come from two kinds of sources: planned activities and uncertainties. Those planned activities are such as the established operation programme, the arrangements of staff's daily duties, the planned operation on materials and plant, etc. All these activities will bring changes - the progress of construction works. The project management dynamics from planned activities can be called attended dynamics. On the other hand, those uncertainties or unexpected events will also affect the operation of the system. They can bring the project progress forward or backward due to different natures. This kind of dynamics from unexpected events can be called unattended dynamics. Both two kinds of dynamics bring a construction project to a dynamic status through the whole construction process.

### **Project dynamic nature**

The dynamic nature of a construction project is determined by its characteristics which are commonly described as [4]:

- each project is unique and not repetitious;
- a project works against schedules and budgets to produce a specific results;
- project management team cuts across many organizational and functional or professional lines;
- projects come in various shapes, sizes and complexities;
- a project works against very restrictive logical sequential relationship among activities.

A construction project starts as a result of the influence of environmental dynamics upon the client who propose and decide to develop that particular project. The project management team will work against the impacts of environmental dynamics. All these characteristics will be subject to the environmental dynamics such as economic, technological, sociological, political, legal, economic, or institutional variations, etc., or the combinations of these forces.

Furthermore, in the project process, different parties will input different amount of resources, ideas and constraints at different stages, but each of them will be on the other hand restricted by various constraints. The continuing changes in external environment will directly affect all parties.

The dynamic nature of a construction project demands a dynamic approach in construction project management in order to cater for the changes in the construction of a project.

### **Attended dynamics**

Any established system will work under various planned programmes, activities or called dynamics. Project management team will plan a set of programmes and activities logically in order to implement the operation of construction works. These activities will act as dynamics to bring forward the progress of management objectives. The major attended dynamics for project management system are as follows:

#### *Decision making*

In dynamic approach, decisions are most initial dynamics for driving any business activities. Decisions are made from large number of specialists involved in the process. The process of decision making is interrelated with the organization structure in such a way that information, feedback, advice, etc., are received by the decision maker from the appropriate contributors such as site manager, foremen, subcontractors, etc., at the appropriate time.

#### *Techniques and technology*

Techniques and technology are basic dynamics for implementing the operation of any system. They include the level of education/knowledge that the staff have, management skills, information techniques, and various facilities and machines within a firm. The techniques employed and the way of their application are fundamental to achieving the objectives planned by management team.

#### *Behavioural responses*

Individual behavioural responses are the direct attended dynamics for the operation of any system. Their effects are closely related to motivation, education background, role relationships, and their personal goals and values. The behavioural responses will directly affect the effectiveness of management performance. The effectiveness can be improved to a large extent if human behaviour factors can be properly looked after by management.

## *Organisation structure*

Organisation structure is the framework of construction project management system. It defines the roles and the relationships of the members and individual departments within an organization. It also establishes the ways and paths in which information, feedback, and advice are generated and transferred for decision making. Consequently, it influences individual members and departments' responses to the demands placed on them.

## **Unattended dynamics**

Unattended dynamics are from those unexpected events or uncertainties causing changes to project management. These changes will affect the performance of the management system. For example, the change in economic environment or conditions can affect client's requirements or objectives and force client to modify his original objectives. The change in building legal terms may require changes to the project design. The major sources for unattended dynamics in a construction project environment can be divided into two categories: internal uncertainties and external uncertainties.

### *Internal uncertainties*

The major internal uncertainties exist in the following areas:

- Project-related uncertainties - Those are the uncertain areas about a project itself, such as: uncertain location conditions, uncertainties in contract, uncertain duration for individual activities, uncertain costs of resources, uncertain complexity of technical requirements, uncertain resources availability or limitations.
- Organisation-related uncertainties - Organisation for a construction project has the ad hoc nature. Different project stage requires different skills, different contributors and other resources to the project. The participants in a project organisation structure will be different through the construction process.
- Finance-related uncertainties - Company's financial capability/policies can be changed due to the changes in economic conditions. The changed financial status from any party within the construction project team can affect or even jeopardize the construction of a project.
- Interest-related conflicts - Although all parties involved in a construction project want to get a project completed as specified quality, on schedule and within project budget, their different constraints and interests will often cause conflicts between them. This will hinder the cooperation in dealing with changes, thus affect the management performance.
- Human-related uncertainties - Fryer [5] points out that people and situations need to be treated on their merits - a contingency approach is needed. The effectiveness of human resources is affected by personal characteristics, personal social background, personal religion, customs, life style, education level, work conditions, etc. This dynamic nature causes a major concern in the management of complex projects, in particular, those international projects.

### *External uncertainties*

The implementation of construction project management is subject to a wide range of external uncertainties. The external environment changes will impose changes on internal operations in a system. A typical example is that the construction operations shall suit the change of the governmental requirement or regulations. External uncertainties for a construction project mainly exist in the following areas:

- Government-related uncertainties - Changes in governmental policies, or government's interventions can bring a big change in project management. A new act from government is usually very costly to a project client. The impact from a change in regulation can also affect project manager's profitability. For example, the enforcement of noise control policy requires the use of pneumatic plant for piling operation rather than percussive plant, and the extra costs of using pneumatic plant will be either born by contractor or past to client. Furthermore, changes in government policies about taxation and investment, which are commonly adjusted to control the level of economic activity, can affect the project planning at the initial decision stage.
- Economy-related uncertainties - Uncertain inflation rate, uncertain interest rate, unstableness in currency exchange rate, etc. under economy environment will affect the implementation of a construction project in term of cash flow, costs of materials, costs of salaries, etc. Changes in economy conditions will also affect the state of competition, the effect of monopolistic phenomena, the availability of finance, materials and labour, etc. For example, high economic activity can produce high level of demand on the construction industry, resulting in shortages of materials, which may delay the project. The changes in economic conditions may also affect the project suppliers' financial situation. Project suppliers include a wide range of professions such as: those providing finance, labour input, distribution of concrete, rebar, brick, and hardware, and etc. The shortage in supplying resources will directly affect the project programme and the engagement of all parties for undertaking project works.
- Social uncertainties - Social influence is mainly from the public acceptability to the activities in a project and the impact of a project to the society. For example, the recruitment of overseas construction workers is restricted by the resistance from community. On the other hand, the construction of a building may have adverse social consequences due to its special nature and location. This can cause very strong resistance from society, thus affect the whole construction process for a project. The changes in social background will also affect individual staff's behaviour to large extent, and affect the

industrial relations within a project.

- Legal uncertainties - The changes in legislation directly affect a project client's objectives through the implementation of such as new safety law, new planning law, new building regulations, etc. These changes will particularly affect the construction operational procedure, construction programme, thus change the total costs of a construction project. Legislation changes also influence the contractual relationships between different parties within a project through implementing new contract law.
- Technological uncertainties - The project technology consists of the physical or mental processes. The physical aspects of the technology range from materials used to equipment used. The human participation are knowledge and skills of project managers, architects, engineers, and other consultants. New technology can directly influence the design and the construction works in a project. Technological uncertainties include all those possible changes in using materials, techniques, labours, facilities, machines, etc. The impacts of changes on the technology can result in redesign, use of new/alternative materials. The development of bored piles, for example, resulted in displacement of many caisson works formerly used in foundation design. The development of new materials or machines, or new staff with better skills or education can normally help improve management efficiency and effectiveness in planning, scheduling, organising, cost control, quality management, co-ordinating, and other decision-making areas.
- Institutional influences - Interference from professional institutions can affect the conduct of construction professionals through conditions of engagement, fee scales, etc. The rules of conduct of professionals and education regulations can affect the project organisation structure and decision making process.
- Physical conditions - Externally physical conditions for implementing project management include infrastructure / transportation, capacity and degree of saturation, district development plans, access to the site for material and labour transportation, etc. The uncertain availability and adequacy of these conditions can bring either a big loss or a big saving to project management.
- Force majeure - The uncertain weather/nature forces such as flooding, earthquake, tropical typhoon, etc. can bring a construction project to a total failure.

In dynamic approach, both attended and unattended dynamics for project management system are considered. It emphasizes the continuous monitoring over these dynamics through the whole construction period.

## **DYNAMIC APPROACH FOR CONSTRUCTION PROJECT MANAGEMENT**

Under the action of various dynamics, a project exhibits ever-changing levels of cost, time, and quality performance as the project progresses through its life cycle. The changes brought require proper and often quick responses or decision-making in order to achieve the objectives set by project management. To response these changes, the project management team will continue to establish the new relationships between resources, and adjust the mix of resources assigned to various parties involved in the project. Such approach to response quickly the changes in a dynamic environment can be called dynamic approach. The major benefit of the dynamic approach is to monitor and manage various dynamics towards the management objectives. As the effects of dynamics on management system can be in line with management objectives or against the objectives, those are in line with management objectives can be called positive dynamics, and those against the objectives are called negative dynamics. All those attended dynamics are positive and most of those unattended are negative. Dynamic approach is to help management improve the effects of positive dynamics and reduce the effects of negative dynamics.

### **Principle of dynamic approach**

Dynamic approach focuses on changes over time. The realization and acceptance of project management as a dynamic system is important. However, by nature, many people are resistance to changes. People are afraid of failing at something new. They prefer the stability afforded by established patterns of relationships in their personal and professional lives. And the security we feel from orderly and familiar ways of doing things can be threatened by changes, so can our status, authority, autonomy, and discretion. Changes sometimes also make old skills obsolete and requires us to develop new skills. For example, a threat to economic security may lead to losing a job; having to learn new ways of doing things can bring inconvenience and difficulty for life, etc.

To manage attended dynamics, various project management techniques have been developed and can be effectively applied, such as planning techniques, building technologies, contract management, operation researches to obtain maximum efficiency from the utilization of resources, etc. The management of unattended dynamics is much more complicated. It is a systematic process including identifying the sources of unattended dynamics; assessing the nature of such dynamics, whether a positive dynamics or negative dynamics; and approaching methods to deal with those positive dynamics in an effective way, and reduce to the largest extent the effects of negative dynamics.

The adoption of proper management methods is to response to those changes. When changes happen, they should be dealt with as soon as possible. For example, at the project initial stage, gross development value, land cost, construction cost, time and profit are the main concern of project developer or client. When the economy environment changes such as reduction in land supply, shortage of labour, etc., the developer or client will change his plan or strategy such as the size of flat, the number of basements etc., so as to reduce or eliminate the negative impacts from the changes. As a result, the objective of the project is adjusted. The proper and positive responses to changes requires the application of various management techniques and environmental knowledge.

Methods used in risk management approach can be applied in dynamic approach. For example, risk identification techniques can be applied to identify those unattended dynamics. However, dynamic approach is much more comprehensive compared to risk management approach. Risk management is to develop various techniques of dealing with individual risks. The dynamics approach is to consider all attended dynamics and all risks along with the whole construction process. It requires the prompt decision regarding to the changes. In a previous study [6], it reveals that managers consider the experience and prompt subjective judgement are most effective way for responses. Contractors have to use proper project management techniques to adjust the changes and to forecasts the problems induced. The following major measurements are for implementing dynamic approach for project management.

### **Planning**

The recognition at the planning stage of the dynamic nature in construction project management is important for overcoming resistance to changes. Many techniques have been developed for project management planning. In a dynamic environment, planning is to interpret the ideas and decision into plan of actions and to implement such plan to make room for the dynamic nature. For example, buffers are allowed in the planning of resources. Setting proper communication channels within the organisation and establishing administration structure of the plan with greater flexibility are the crux of success for managing a dynamic system.

### **Organizing**

Organizing is to allocate tasks to people, set deadlines, request resources and co-ordinate all the tasks into a working system. In dynamic state, matrix organization structure which defines the responsibility well for the line function and staff function and caters for the required flexibility in handling changes. For such purposes, the differentiation, specialization and careful integration of contributors to the project are important.

The impacts of changes on organisational structure will lead to the re-distribution of duties, jobs, and other resources, etc. New departments or divisions may be established and old ones dissolved. For example, a QA department may be formed to improve quality. New technological changes may also necessitate structural adjustments. For example, the computer expertise developed leads to the establishment of computer services department in almost any construction company.

### **Commanding**

Commanding involves leading, delegating, communicating, motivating, co-ordinating, cooperating with and disciplining people. Under a dynamic environment, a management hierarchy needs to be set up, and the approach of management by objectives will be more effective. By this approach, management will assign people against specified targets rather than tasks. This approach has the essential benefit that people have freedom to choose techniques for dealing with any changes in the dynamic environment. The improvements or corrections on changes can be obtained by modifying employees' behaviour without changing the technology or the organisation structure in the project process. For example, quality and efficiency may be enhanced through on-the-job training of operative employees. These training efforts are designed to modify behaviour in favourable directions. Similarly, managerial effectiveness can be improved by implementing development and training programs in such areas as decision making, leadership, and employee/supervisor relationships. Managers need social skills for persuading, negotiation, inspiring confidence, loyalty and trust.

In particular, co-ordinating is one of the most important commanding measurements. In a dynamic system, an effective information system should be developed to enhance the integration of different parties to the projects. The construction projects often require massive capital investment and they require rigorous management of progress, finance and quality. The amount of finance and other resources in such projects may be too great for one contractor to invest, in which case the participation of several parties such as contractors, subcontractors, consultant and clients are important.

### **Controlling**

One of the traditional ways in which the project manager exerts overall control of the project is by setting contingencies and controlling their release [7]. Controlling process is one of the key measures to manage the dynamic nature of project management. It is to find deviations from the plan and take corrective measures. In essence, control is to assess whether the effort is progressing in conformance with plans.

The existence of dynamics requires the implementation of continuous control measurements throughout the project process. Project control is the process through which managers assure that actual ongoing activities meet the planned requirements in terms of cost, time, quality, safety, environment. However, random fluctuations - unattended dynamics tend to cause the outputs to differ from planned objectives. By controlling, management establishes standards and methods for measuring performance (cost, quality, time, behaviours, ) as indicators. The performance are reported periodically and compared against performance standards, and deviations can be identified.

## **CONCLUSIONS**

This paper looks at the application of dynamic approach for construction project management system. The paper considers the construction project management system as a dynamic system which is subject to both attended dynamics and unattended dynamics. Whilst the establishment of proper relations between resources and the identification various risks are very important before the commencement of a project, this study emphasizes particularly on the continuing control process by realizing the effects from changes. It also consider the negativeness and positiveness of project dynamics and suggests to counterbalance each other in the management process. Thus, dynamics management approach is to consider the maximum utilization of positive dynamics and minimum effects of negative dynamics.

The study concludes the importance of developing the ability of properly identifying project dynamics, in particular, those unattended ones, and developing the ability of prompt decision-making to changes within the construction project management system.

## REFERENCES

1. **The Chartered Institute of Building** *Code of Practice for Project Management for construction and development*, The Chartered Institute of Building, U.K., 1992. , pp.3.
2. **Healy N J.** *Risk Management in Giant Civil Engineering Projects: A Study for Science and Research Council*, British Library, 1983.
3. **Liu A & Shen L Y.** Risk Allocation and Contractual Claims, *Proceeding of International Conference: Investment Strategies and Management of Construction CIB W92*, Brijuni, Croatia, 1994, pp.205-212.
4. **Ritz George J.** *Total construction project management*, 1994, pp.7-20.
5. **Fryer, B.** *The Practice of Construction Management*, William Collins, 1985.
6. **Shen L Y.** *Project Risk Management in Hong Kong*, Working Paper, Department of Building & Real Estate, Hong Kong Polytechnic University, 1995.
7. **Barnes M.** Construction Project Management, *International Journal of Project Management*, Vol6 No2 May 1988, pp.69-70.