

# The Reason of Principles of Construction Engineering and Management Being Necessary for Contracting Firms and Their Projects Managers

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**Abstract**—The industries of construction are in continuous growth not only in Middle East region but almost all over the world. For the last fifteen years, big expansion and increase of different types of projects has been observed. Many infrastructural projects have been developed, high rise buildings, big shopping malls, power sub-stations, roads, bridges, schools, universities and developing many of new cities with full and complete facilities. The growth and enlargement of the mentioned developed projects has been accomplished through many international and local contracting organizations. Senior management of these organizations depend on their qualified and experienced team whom are aware of the implications of project management, construction management, engineering management and resource management during tendering till final completion of the project. This research aims to find out why reasons of principles of construction engineering and management are necessary for contracting firms and their managers. Principles of construction management help contracting organizations to accomplish and deliver projects without delay. This can be maintained by establishing guidelines' details for updating the adopted system of construction management that they have through qualified and experienced project managers. The research focuses on benefits of other essential skills of projects planning, monitoring and control. Defining roles and responsibilities of contractor project managers during tendering and execution is a part of the investigated factors that will be analyzed. Other skills like optimizing and utilizing the obtainable project resources to deliver the project within time, cost and quality will be also investigated to find out how these factors are affecting the performance of contracting firms, projects managers and projects. The conclusion of the research will help senior management team and the contractors project managers about the benefits of implications and benefits construction management system and its effect upon the performance and knowledge of contract values that they have, and the optimal profit margin of the firm it.

**Keywords**—Construction management, contracting firms, project managers, planning processes, roles and responsibilities.

## I.BACKGROUND

THE working environment and the nature of construction projects in Middle East region presents unusual conditions where senior management of contracting firms think intensely during tendering phase of any project about the fastest and the cost effective construction method that makes them deliver it on time and without any delay. Many of them are focusing on the implications of construction engineering and management

to come out with the proper analysis that avoids them from any pitfall of contractual claims that cause many unexpected problem during execution phase. Construction engineering and management is a professional discipline that deals with the designing, planning, construction, and management of infrastructures such as highways, bridges, airports, railroads, buildings, dams, and other utilities. Most of civil engineers are a cross between civil engineers and construction managers. The primary concern of projects managers in construction is to deliver a project on time, within the budget, and of the desired quality. Contracting organizations and their project managers are fully aware about the benefits of implementing the principles and techniques of construction engineering and management in guaranteeing projects completion for many reasons for example proper monitoring of the work method that provides evaluation performance, staffing and construction progress. Various numbers of studies and researches participated in investigations of the causes of delays in projects, e.g. lack of skills of management of project managers, their inability of understanding projects requirements, lack of their experience in determining the project scope and, and the difficulties of understanding the technical specifications of the project. Reference [1] identified the main causes of delay in construction projects in Egypt from the point of view of contractors' senior managers stated that delay in construction projects is considered one of the most common problems causing a large number of negative effects on the status of the project and its participating parties. As a result of the fast growth of economic, large scale of construction projects has been developed by well organized contracting firms through different types of contracts. Reference [2] confirmed that, although the construction industry in the Middle East has suffered even in the gulf war, recent events in the region coupled in restructuring of economics to yield growth in construction activities. According to the conditions of traditional contracts, contractor is responsible to build the project within the agreed time, specified budget and quality standards. The implementation of the project and contract management is the responsibility of contractor project manager who should have skilled technical team, experienced resources and team of subcontractors. Many project managers in contracting sector confirmed that the new contractors' staffs attributes to the project delay mainly those who works with non-oriented construction management firms. Reference [3] stated that the construction industry around the globe almost have the same problems such as bad

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workmanship, time delays, over cost and lack of monitoring process. Well-organized process of construction management, site management, planned programs, operational cost planning and regular monitoring of expenditures, site establishment plant and materials requires special good experience by project manager who should be fully practiced to deliver the project on time. Reference [4] stated that a project may be delayed as a result of the direct action of major parties or due to their failure to act especially if they have a duty to act. Lack of communication between projects parties may cause major problems that affect the project completion which sometimes lead to disputes and claims that cause a big impact on the project. Reference [5] studied and analyzed the effect of the delays on cost and quality of the projects. Reference [6] confirmed that the delays in building projects in Thailand is caused by shortage of inadequacies in industry of infrastructure project, problems caused by client and consultant and incompetence of contracting sector firms. Reference [7] evaluated the progress reports of 164 buildings and 28 highway projects constructed during 1996-1999 in Jordan where results indicates that delays are extensive: the average ratio of actual completion time to the planed contractual duration is 161% for road projects and 121% for building projects. Many other factors contribute to the project delays caused by contracting firms like late deliveries of materials, changes and their effect in the economic conditions as stated by [8] who conducted quantitative analysis of construction delay through records examinations of 130 projects between 1990- 1997. Reference [9] identified the sources of delays caused by the clients, consultants, contractors and sub-contractors and those which are not caused by these parties to the design and construction process. Reference [10] studied and analyzed causes of delays in large building projects in Saudi Arabia and identified material related delays as the main cause of project delay. Reference [11] studied the causes of delays and cost over-run in construction projects in Nigeria and identified factors of delays is the poor contract management and improper planning. Other projects participants remain complaining from the impact of delays in spite of the adopted implications and techniques of construction engineering management that used by projects managers and planners. Project completion dates is getting changed because of the insufficient experience of some projects managers in using the system of construction management, project management and resource management during the work progress. Managing sub-contractors team, proper planning and scheduling and adequate contactor experience are necessary factors that help the team to control the work in the project. Some contracting firms don't consider these factors as a part of their objectives that cause major problems for the project team during the progress of the site activities. Reference [12] stated that the main reasons of the project delays are the changes of the contract document, inadequate supervision, late agreement with the sub-contractors and insufficient labor on the site. This affect the contractor performance that makes [13] to confirm that some of important factors attributes to projects delays e.g. Poor site

management, shortage of the supplied project material and the availability of the equipments on the site. Understanding the principles of construction engineering management by senior management and the appointed projects managers of contracting organizations help projects team to identify different factors that cause delays to projects where these principles can become guidelines to reduce and mitigate the project delays. Contractor's project managers who have enough experience must encourage the senior management and other project team to consider and adopt the system of engineering construction managements even if it costs additional budgets.

## II. RESEARCH AIMS AND OBJECTIVES

The purpose of the study is to find out why principles of construction engineering and management is being necessary for contracting organizations and their projects managers and how these principles can maintain the optimal profit margin of the organization. The responsibilities of senior management and their understanding about the effect of using the system of construction engineering management on the work performance of the projects and the team will be discussed and analyzed to find out the necessity of the system and its implications upon the project completion and the organization objectives. Some factors like successful site management and control, resource scheduling and planning, programming, operational process, cost break down analysis, evaluation of existing process of the work, preparing construction methodology, controlling and monitoring the project materials and plant, adequate site supervision of work activities, implementations of quality assurance and control, health, safety and environmental issues are essential factors for project managers that guide him to manage the project smoothly . The study also aims to identify the impact of wrong implications of the processes of construction engineering and management by the project manager and the ignorance of adopting these processes upon the contractor firms. Project manager should be fully aware about the objectives of the organization he is working for and projects under his control; he should utilize all his experience to accomplish the deadline of each main activity of the project. Much information about this study is available in researches, books, handouts and academic articles. Based on the purpose of the study a survey research methodology has been adopted for this research where target population consists of senior management and projects managers of contracting firms. Questionnaire survey developed based on the objectives of the study, which are the adoption of processes of construction engineering and management by contracting organization and the impact of its implications upon projects completion. The designed questionnaire, survey, interviews, meetings and discussion developed to evaluate level of awareness of contractor project manager about the effect of the implications and techniques of construction engineering management system into their projects and how the determined factors of delays can be mitigated to expedite projects completion.

### III. WORKING ENVIRONMENT OF PROJECTS

In Middle East, the most common type of the used contracts is traditional types of contracts where client, consultant, contractors and nominated sub-contractors are the main responsible stakeholders of the project. The main contractor responsibility is to build and construct what has been designed and approved on the drawing by the consultant and other related authorities. Drawings are developed and prepared by the project designer/consultant where project quantities are tabulated, formulated and documented in the bill of quantities. Specifications, general and particular conditions of contract and other contract documents are a part of the contract document. Project contracts documents and drawings is normally prepared and issued based on continues meetings between client and consultant who translate the project objectives into drawings, calculations and specifications. They normally meet regularly till objectives of project become very clear and ready to be developed.

Tenders department and technical management affairs are the most important two departments in most of contracting organizations, senior management are monitoring the performance and the achievements of these two departments and they always encourage the decision makers of these departments to prioritize projects within the objectives of the organization, and to avoid any conflict during tendering phase and execution phase. They must follow the implications of construction engineering and management system mainly once they determine the required resources to avoid any delay and to achieve the planned targets of the organization. The ultimate responsibility for establishing priorities rest with the top-level management. Yet even with the priorities establishment, conflicts still develop. Reference [14] has identified several reasons why conflicts still occurs between decision makers or head of departments and stated that the lower project manager degree of authority over units supporting his project, the greater the potential for conflict to develop. There are also numerous other conflicts that can occur during project execution which has to be avoided. Reference [15] provided a good discussion of conflicts types that can exist in each life cycle phase as well as ways to handle them, some of those types are manpower resources, equipment's and facilities, costs and priorities.

A part of the responsibilities and obligations of the contractor's is to build the project according to conditions of contract and to deliver it as per the specific cost, time and quality. The contractor project manager is the person who is responsible to manage all project resources based on the high level of experience and skills of implications of construction management. That's will help him to deliver the project on time without any delay. This is one of the reasons why senior management are always pushing project managers for continues training and certifications in construction engineering and management. They attend different workshops to understand conditions of contracts, principles of site establishment and management, cost analysis, resource scheduling and planning, material management and many other related issues in the same field. Spreading the

importance and necessity of principles of construction engineering management in the organization becomes more effective to achieve the organization goals and objectives and to deliver projects on time.

A submittal and approval process of projects materials requires a regular coordination and double efforts by the project team to expedite purchasing process. Reference [16] confirmed that other causes of delay are attributed to improper management of materials and hampered by lack of explicit and detail model of project materials management process. The site supervision is one of the significant responsibilities of the contractor project manager. The limited experience of project manager in construction engineering management system creates main contractual conflicts between the project participants cause major delay. Efficiency and performance of the contractors should be monitored by the senior management of the organization. It is necessary to be reported by projects mangers that process is implemented to maintain the work progress in the project.

### IV. CONTRACTORS MAIN RESPONSIBILITIES ON PROJECT

The contractors' organizations who employs directly the project construction team to execute the work and other works that can be executed through sub-contractors must have certain skills, knowledge, experience and, where relevant. The organizational capability must carry out the work safely and without risk to any of the team health. Contractors project managers must have an important role in planning, managing and monitoring their work to ensure that all identified risks are mitigated and controlled. The appointed contractors team must have enough experience and knowledge in some clauses of conditions of contracts that relates to site establishment and execution that helps them to carry out the work as specified in the contract. Providing appropriate supervision, information and instructions to the project team is one of the main responsibilities of the contractor project manager. The general responsibilities of any building contractor require adequate planning to carry out all site activities. Building contractor carries out the work progress through resource scheduling and activities planning in a manner that coincides with rules and regulations. In addition to implementing the construction plan, the contractor project manager is responsible for hiring, supervising and, at times, firing staffs who work on the specific project with the contractor. It is the contractor responsibility of obtaining materials approval for the project. Since construction projects cannot be completed without the necessary building materials, it is necessary for the project manager to order the materials in advance and bring them to the project. This can be achieved through proper coordination between suppliers, purchasing department and the site as a part of the process of material management. Contractor's organizations must establish a budget for any construction project and follow that budget as closely as possible through the project manager who should control the work activities in a cost efficient manner. Throughout the construction management processes, the contractor is also responsible for reviewing the progress and controlling changes through proper

documentation system. Contractor's project managers should also be good leaders. Senior managers of the organizations are counting on site managers to guide them about the correct road map of accomplishment. That's why skills of leadership are a beneficial and positive attribute by managers. Some of contracting organizations spread the awareness of project champion who can do everything possible to make the project successful. Reference [17] stated that the exit champions' needs to have some direct involvement in the project in order to have credibility. Since a delay in one of the important issues in construction project which hold up the entire process, it is vital that the project manager should know how to cover it by preparing the cover plan.

One of the contractor's responsibilities is liaison with the owners and designer of the project, verifying drawings with other contracts documents like bill of quantities and project technical specification through written communications. Reference [18] confirmed that even though the construction industry is a very technical oriented industry, project manager communication, team, leadership, and stakeholder management that have been identified as the human factors that contribute to success factor of Malaysian construction project.

#### V. VALUES OF CONSTRUCTION ENGINEERING MANAGEMENT

Construction project management is the overall planning, coordination, and control of a project from beginning to completion [19]. It aims to meet a client's requirement in order to produce a functionally and financially viable project. The construction industry is composed of five sectors: residential, commercial, and heavy civil, industrial, and environmental. A construction project manager holds the same responsibilities and completes the same processes in each sector. All that separates a construction project manager in one sector from another is the knowledge of the construction site. This may include different types of work functions e.g. equipment, materials, subcontractors, and possibly locations. A contractor is assigned to a construction project once the design has been completed by the person or is still in progress. This is done by going through a bidding process with different contractors. The contracting organization is selected by using one of three common selection methods: low-bid selection, best-value selection, or qualifications-based selection which depends on the experience and pre-qualifications of the bidders. [20] A contractor project manager should have the ability to handle public safety, time management, cost management, quality management, decision making, mathematics, working drawings, and human resources. Conditions of any type of contracts types is one of important issues that contracts department in the organization sector should focus on to deal with any claims or any contractual disputes, it is one of main principles of construction engineering management.

#### VI. DESIGN OF QUESTIONNAIRES SURVEY AND DATA COLLECTION

Questionnaires are designed for the purpose of collecting information to find out the value of principles of construction engineering and management to contracting firms. Level of implementations of processes, implications of techniques and level of commitment are factors to measure the necessity of principles of construction management for achieving goals and objectives of contracting firms. Table I shows the important principles that should be adopted by the project managers to complete their projects on time. The questionnaire survey is prepared to assess and review the perceptions of contractor's project leaders to the principles of construction engineering management. The survey was designed based on eight processes that have been investigated in the literature review. Participants were asked to point out the level of significance and meaning of each process. The eight processes are:

- 1) Design review process (design build contract)
- 2) Estimating and evaluating process
- 3) Constructability analysis
- 4) Procurement and long lead items strategy
- 5) Distribution of work packages in the project
- 6) Controlling changes and specifications
- 7) Recourses and site management
- 8) Risk assessment, control and analysis

TABLE I  
 PROCESSES OF CONSTRUCTION ENGINEERING MANAGEMENT SYSTEM

S. no	Question/ Process	Validity	Mean	Rendering	Standard deviation
1	Design review process	100	2.95	56%	1.552
2	Estimating process	100	2.92	54%	1.464
3	Constructability analysis	100	3.85	64%	2.743
4	Procurement and long lead items	100	3.91	67%	2.864
5	Distribution of work packages	100	2.29	49%	1.422
6	Controlling changes and specifications	100	5.01	74%	2.895
7	Resources and site management	100	3.85	65%	1.674
8	Risk and site management	100	3.45	59%	1.667

#### VII. DATA ANALYSIS AND FINDINGS

Questionnaire was distributed to contractor's project managers who work in different contracting organizations that are specialized in infrastructural projects and construction projects. The level of their experience is between 12 and 15 years in construction project management. Questions are scheduled in Table I. Participants were very interested in the implications of construction engineering management and they all confirmed during the meeting that they are very interested to respond to this study because the listed issues is a part of their daily tasks in projects. The section of this study is to find out the act upon the responses analysis that rendered through the questionnaire. The analysis is prepared based on analyzed regression founded on the estimated relationship among the variables and the calculated frequencies for providing the responded participants view to a particular question.

The aim of the collected data is to find out the effect of the applications of construction management by contractors' projects managers in contracting organizations. They all confirmed that applications are very practical and helpful tools that assists them to deliver projects on time.

Design review process factors, it is noted that the value of standard deviation is 1.552, means that the variables are notably increase across the mean 2.95. As rendered based on Table I that 56 % do care about the design review process and design management as well. Estimating process and evaluation methods during tendering is one of the main responsibilities of tendering departments and contracts as per the list of Table I, value of standard deviation of 1.464 shows that the results are greatly spread across the mean value of 2.92, that suggests that around 54 % of the respondents stated that the tender departments are using their experience before closing the tenders. The standard value deviation of constructability analysis 2.743, shows the results spreading across the mean value of 3.85 as shown in Table I where 64 % of the respondents confirmed that preparing construction method of the project is one of the main activities to find out any potential issue. Regarding the procurement and long lead items, the results are spread across mean of 3.91 as shown in Table I and standard deviation is 2.864 where 67 % of respondents recorded that long lead items and procurement processes is being considered as of the highest priorities for project managers and they all reminded by top management to avoid any delay in ordering the long lead items. The mean of the activity of distributing and analyzing the work packages is 2.29 and the standard deviation is 1.422 which indicates that 49% of the participants prefer to divide the work into packages and to do the estimation analysis of the elements of each package. 74% of respondents confirmed that controlling changes and specifications is one of the important tasks that projects managers are always focus during the project life cycle, the standard deviation of this activity is 2.895 where its mean is 5.01. The standard deviation of resources and site management is 1.674 because 65% of the respondents confirmed that it is very important activity and it is the responsibility of each of project team, the mean is 3.85 Activity of risk and site management is one of the activities that can't be ignored by any of the projects team neither project planner nor project manager, 59 % of the responders confirmed the necessity of risk assessment in regular basis. The standard deviation is 1.667 and its mean is 3.45.

### VIII. CONCLUSION

Construction engineering management concentrates on planning and management of the construction of structures such as freeways, roads, highways, airports, bridges, and buildings. It is the responsibility of the contractor project manager to deliver any of these projects in a manner that maximizes project value and organization value. Construction processes are becoming more complex due to the different kinds of projects that require greater big need and demand for specialized management personnel. Construction of projects requires experience and knowledge of principles of

engineering, skills of management construction solutions, principles and work procedures, financial implications, estimating and cost control, planning and scheduling, materials procurement, selection of equipment, productivity and human behavior. Project manager in construction direct and administer all nominated and specialized contractors and other personnel in the project. They schedule and coordinate all construction processes so that projects meet design specifications and can be completed on time. Communication with other project stakeholders is a part of the responsibilities of the project manager. Contracting firms concentrates on working through the processes of construction engineering and management because it involves many aspects of construction including technical, contractual, commercial, and managerial issues which makes project leaders and general managers of these firms accomplish their objective and strategic plans by keeping continues grow.

Senior management of contracting sector must give high priorities for the awareness of understanding the applicable processes and the key management functions of projects works of construction industry. The processes of construction management should be recognized and adopted by senior management and projects managers.

Project planning, budgeting, scheduling, programming, estimating, bidding, procurement, construction, and understanding the applicable codes, standards and regulations are the essentials of construction engineering and management that improve the efficiency and productivity of the project team and help them to deliver their projects within the specified time, agreed budget and approved specification. Completion and handing over projects on time depends on many factors, these factors should be identified by the experienced project manager who must mitigate all probable delays that may occur during the work progress. This can be achieved through preparing project risk plan and necessary actions that prevent problems and their impacts from occurring.

### IX. RECOMMENDATIONS

Project managers face complex problems in administrating wide range of activities in construction projects. Construction engineering management covers activities such as site establishment, quality control, and cost estimating, and planning for resources. Construction management is a set of complex, professional activities that require a special knowledge of the technical and contractual issues about project. As a result of complexity of the work, general managers of contracting firms became aware that there is a need for comprehensive construction management system consists of major planning and staffing, budgeting, scheduling, maintaining and updating. Many benefits can be obtained by implementing the system such as lower cost of projects, efficiency of overall construction program work, controlling the cost and reporting functioning. Construction management provides a comprehensive introduction to the key management concepts, principles and practices that contribute to project success. Senior management must establish guideline details

for updating the system annually, investigating the work methodology for continuous improvement and making sure that authority and responsibility of construction quality assurance is not separated. The system helps senior managers of contracting firms to determine standard planning values for each project or each type of contract which help them to control the performance cost management for performing construction management work. The principles of construction engineering management help contracting firms to increase and maintain an optimal profit margin of the organization and projects by encouraging their project managers to understand the fundamental of construction project management, managing and controlling the change order process, improving an effective communication plan, understanding the contractual clauses of the overall of performance of the project, identification of risk quantifications techniques and tools, reducing the possibilities of claims and disputes and adopting the best techniques of the latest software's and technology in projects.

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