

Techniques of Construction Management in Civil Engineering

Mamoon M. Atout

Abstract—The Middle East Gulf region has witnessed rapid growth and development in many areas over the last two decades. The development of the real-estate sector, construction industry and infrastructure projects are a major share of the development that has participated in the civilization of the countries of the Gulf. Construction industry projects were planned and managed by different types of experts, who came from all over the world having different types of experiences in construction management and industry. Some of these projects were completed on time, while many were not, due to many accumulating factors. Many accumulated factors are considered as the principle reason for the problem experienced at the project construction stage, which reflected negatively on the project success. Specific causes of delay have been identified by construction managers to avoid any unexpected delays through proper analysis and considerations to some implications such as risk assessment and analysis for many potential problems to ensure that projects will be delivered on time. Construction management implications were adopted and considered by project managers who have experience and knowledge in applying the techniques of the system of engineering construction management. The aim of this research is to determine the benefits of the implications of construction management by the construction team and level of considerations of the techniques and processes during the project development and construction phases to avoid any delay in the projects. It also aims to determine the factors that participate to project completion delays in case project managers are not well committed to their roles and responsibilities. The results of the analysis will determine the necessity of the applications required by the project team to avoid the causes of delays that help them deliver projects on time, e.g. verifying tender documents, quantities and preparing the construction method of the project.

Keywords—Construction management, control process, cost control, planning and scheduling, roles and responsibilities.

I. BACKGROUND

CONSTRUCTION management is considered as the overall planning, coordination, and control of a project from beginning to completion. It aims to meet client requirements in order to produce a functional and viable project. It includes different types of projects like residential, commercial, civil environmental and industrial types. It is the management of all aspects of planning and construction for any given project that requires strong communication, knowledge of the building process, problem solving and technical specification. It is a complex field that requires specific knowledge in many different areas including contracts law, finance, quality and many other areas.

Mamoon Mousa Atout is with the Dubai Electricity and Water Authority, United Arab Emirates (phone: +971504593461; e-mail: mamoon.atout@dewa.gov.ae).

Reference [1] pointed out that construction covers a wide range of products, services, and activities that are directly related to site and design activities and building material products, but the construction team ignores much of the associated activities, and that this might cause a major delay to project delivery. The reasons attributed to the delay of projects in the construction industry are recognized and reported by many researchers through several studies, e.g. the lack of experience of contractor's project managers/construction managers, project consultant/designers and the client representatives of identifying the exact requirement that complies with the project objective. Reference [2] identified and analyzed the causes of delays in large building projects in Saudi Arabia and identified material related delays as the main cause of project delay. In construction management contract, clients appoint a manager with his own staff to organize the supervision of construction contracts which are placed by the client. Project design might be prepared by the client team or can be placed as a separate design package. However, [3] confirmed that the disadvantage includes the separation of client design requirements from construction supervision, and the extra cost of the manager and his staff. Resource planning, site establishment, cost control, managing the design process, monitoring the work flow progress are some skills that the construction manager should have once he is assigned for such project. It was pointed out by [4] out that the traditional challenge of contracting is not a small one where the experience of the contractor's staff is required and that they should be pre-qualified to win the job. The experience of the project manager in internal and external communications with project stake holders is a must, ignoring a communication plan can cause major delay in projects delivery. Reference [5] stated that the close personal contacts which exist between operatives and management make a formal communication system. Delays can be caused if the communication plan is not well prepared because of the week experience of project managers in this field, where this component might be considered the most routine elements. Reference [6] identified the sources of delays caused by the Client, the Consultants, the Contractors and Sub-Contractors, and others which are not caused by these parties to the design and construction process, and means the communication process is very poor between all project participants. The communication plan is prepared based on the information requirements of all stakeholders. The plan should meet the stakeholder's needs. Many applications and techniques have been adopted by project managers of the construction industry, and while these practices are being in used in many projects, many of external stakeholders of these

projects are still having problems with projects delivery regardless. Projects or construction managers should be aware of the principles of construction management to avoid such delays, and act as advisors with other involved contractors, who are selected by the client in addition to the architect and engineer. The main role of construction managers is to advise the team on the feasibility of the chosen design, providing advice and information on the pricing throughout the design phase and inspect the work during the construction. Once the work commencement starts, time must be set aside to get organized. Correspondences from the various design consultants will be incoming, while responses to all of their questions and comments will be marked outgoing. Organizing the project team is one of the principles and processes of construction management. According to [7] that the process must be simple; individual project managers must adhere to standard office/site filing procedures to ensure that everyone in the office follows the same method of documentation. Understanding the techniques and procedures of construction management helps project managers to identify potential issues at a very early stage of the project that will mitigate the level of delays and eliminate the causes of delays during design and construction, especially if the project is design and build.

II. RESEARCH AIMS AND OBJECTIVES

The aims and goals of the research are to introduce the implications of principles of construction management in the construction industry, mainly civil engineering projects by project managers. It determines the potential benefits of the processes and techniques of construction management by the management/construction team on site, and the serious level of considerations of the implications during project development and construction phases to ensure that the project will be delivered on time. It aims also to determine the factors that contribute to project completion delays if projects managers do not engage their roles and responsibilities in a professional way. The findings will determine the needs of the adopted applications by projects managers and construction managers, e.g. mastering and managing methods of the whole project through the applications of construction management, project scheduling and resourcing, optimizing and utilizing to complete and deliver projects on time. Important topics will be demonstrated such as site establishment, starting of the construction processes, organizing the project team, estimating, subcontracting, change orders, quality control and quality assurance, project documentation plan, communication plan, material management, health and safety, environment and post contract review. In addition, the study will focus on the affect impact of misusing the techniques of construction management by the project team. The construction manager must be aware of the project activities that involve a series of tasks which need and require certain types of human and non-human resources. The information for this research was collected from different sources such as literature review, questionnaires survey and interviews with project managers. Other references relating to managing projects, construction

management in practice, the effect of cultural factors in construction management, construction engineering management, construction process, and the principles of construction management. A questionnaire is developed to understand the level of adopting practices of the construction management by project managers on the site based on their level of understanding of its basics and techniques. Cultural factors result in many difficulties to the human resources of the project during design and construction due to the differences of traditions and habits, which can lead to many problems in communication. It was suggested by [8] that the most suitable definition of culture could be introduced as the entire heritage of a society transmitted by the word, literature that includes all traditions and habits. Culture has the potential to impact on construction activities. The importance of culture and national cultural differences has become more critical, especially for construction companies that mainly work in mega projects and who have employees from different nationalities. It is important that contractors consider the various cultural concepts in their daily work activities, in order to successfully run the scheduled tasks and to maintain the workflow productivity. Culture and cultural differences are important issues for every organization in every industry. As [9] stated, these concepts become more critical in construction due to the nature of contracting, internationalization of procurement, joint venturing, and partnering in this industry.

III. CONSTRUCTION PROJECT MANAGEMENT

Construction management can be introduced as a process of directing and coordinating human and non-human resources throughout the life of a project by adopting modern management techniques to achieve the predetermined objectives of time, cost, and quality. Construction Management is a professional service that applies effective management techniques to the planning, design and construction of a project from inception to completion for the purpose of controlling time, cost and quality. Organizing the project resources, planning and coordination with other project stakeholders is a part of the construction management processes that can be applied to all types of projects, mainly residential and commercial projects. It includes different types of work activities depending upon the size and type of the project, and requires certain types of skills such as strong communication, technical experience, self confidence, and knowledge of the building process.

Construction project managers should have the enough experience of planning that should comply with project criteria based on the technical standards and specifications identified by the client and the consultant. Failing to do so will result in major delays to project delivery.

One aspect of the role and responsibilities of the construction project manager is to ensure the work progress of the project is always within the plan. They must manage and control the project to ensure that it will be delivered on time within the agreed budget based on the approved design that complies with the codes and standards to meet the client's

needs and requirements which are the objectives of the project.

It was confirmed by [10] that the role of the construction manager is too efficiently and economically apply the required resources to realize the constructed facility of acceptable quality within the time frame and budget costs specified. Some common responsibilities of a construction manager can be categorized and classified as project management planning, site management, cost control management, resource management, time control management, material management, quality assurance management, contract management, and health and safety management. Construction firms of an organization must have certain types of processes of evaluating and prioritizing projects to enable them to identify the required resources based on the priorities related to the time, cost and quality of the project. The project manager should have specific skills in management that makes them able to manage the process of materials submittals and approvals, as this process requires continuous follow-up and coordination with the project team to expedite purchasing the approved project materials. Reference [11] confirmed that other causes of delay are attributed to the improper management of materials and hampered by the lack of an explicit and detail model of the project materials management process. Some of the important tools like resources planning and scheduling, project activity planning and control are important tools that projects managers and construction managers should always practice and adopt before they start the project. Many project managers fail to meet project deadlines due to the lack of information in managing construction projects. The approach of preparing the methodology plan by the project manager and his team prior to work commencement is more sufficient than starting the immediate execution processes. Verifying contract documents including the bill of quantities and drawings is essential to avoid any conflicts or delays. Developing a precise construction methodology helps all project participants, mainly the construction team and their consultants to overcome any potential problems or any identified risks in advance.

IV. CONSTRUCTION MANAGEMENT AT-RISK

Project risk management is prepared and developed to avoid any unexpected surprises once design or executing the project starts. During the devolvement of the project plan, risk should be identified, and analyzed where action should be taken by the project manager to avoid any potential problem. Risks can be unfavorable to the project in the sense of causing it to finish late or result in additional cost. Risk identification process can be prepared with the project manager, construction manager, project sponsor, internal and external stakeholders and other team members. Senior management and project managers must be very thorough when verifying any contract documents or project documents to reduce and mitigate technical, environmental and financial risks, and all are required to be identified for the project requirements to be delivered on time. The usual form for the identified risks is the common risk

register, where the project manager in coordination with the risk manager records each of the identified risks and associated data for use in the later stages of risk management that includes risk identification, analysis, risk response plan and ongoing monitoring and control of the risk management process. One of advantages of construction management is giving the clients the opportunity to identify potential risks during the concept design phase. It is an alternative procurement process similar to long standing private sector construction contracting. Overall construction is a risky business and risk management is the responsibility of the construction senior management. Reference [12] confirmed that the major business risks faced by construction companies are the health and safety of its employees, injury to third parties, damage of construction works, and loss or damage of vehicle and construction equipments

V. QUESTIONNAIRE DESIGN, SURVEY AND DATA COLLECTION

A questionnaire was developed and arranged to collect information to answer the study and research questions. The questionnaire comprises of signs and information on the level of understanding and adoption processes and techniques of principles of construction management that advance the progress of work in the project, as indicated in Table I. The questionnaire is designed based on the scale of the main listed nine points that ranges from the view point of participants and directly related to the level of implications of construction management.

- 1) Feasibility study and business plan,
- 2) Project delivery method,
- 3) Team leader selection criteria,
- 4) Programming and scheduling,
- 5) Conceptual and detailed design,
- 6) Construction documents plan,
- 7) Health and safety plan,
- 8) Quality assurance and control, and
- 9) Risk assessment and analysis.

TABLE I
ELEMENTS OF THE CONSTRUCTION MANAGEMENT PROCESS

S.No	Question/ Process	Validity	Mean	Rendering	Standard deviation
1	Feasibility study and business plan	100	2.03	38%	1.83
2	Project delivery method	100	2.56	40%	1.97
3	Team leader selection criteria	100	3.64	49%	2.01
4	Programming and scheduling	100	4.01	53%	2.55
5	Conceptual and detailed design	100	3.42	47%	1.97
6	Construction documents plan	100	4.33	57%	2.79
7	Health and safety plan	100	4.42	59%	2.86
8	Quality assurance and control	100	3.38	46%	1.96
9	Risk assessment and analysis	100	4.25	56%	2.65

The questionnaire and survey was developed to assess and estimate the perceptions of the contractor's construction

managers and project managers with regard to the definitions and implications of construction management, and the level of contributions of these processes to the causes of project delays. Then survey was developed based on nine elements founded through many resources including books, journals, and literature review. Participants were asked to mark the level of importance of each element.

VI. ANALYSIS OF COLLECTED DATA AND FINDINGS

This part of the research explains the analysis of the responses and rendering of the data of the questionnaire. The analysis of questionnaire responses is prepared based on regression analysis founded between the calculated frequencies and the variables to present a view of the number of participants responded to each question. The purpose of the results analysis is analyzing the data that have been gathered about the study of the level of awareness of the implications of construction management by project managers and construction managers in construction projects. A questionnaire covers the elements and questions that were distributed to project and construction managers from different contracting companies at the senior level are identified in Table I. The response and feedback shows that all participants consider the implications of construction management are very essential. They have recorded that elements, topics and applications are very practical tools that always support them to control the projects and deliver them on time. A total of 13% of respondents confirmed that project completion depends on the kind and type of contract that can be delivered on time using project management contracts or a design build contract, where the experience of the project manager and team participate in the project completion on time. For the analysis of the feasibility study and business plan of the project, the value of the standard deviation is 1.83, which means the variables are notably increased across the mean 2.03, based on the rendering data of Table I, 38% analyze and study the feasibility study of the project. Project delivery method is one of the main activities that project managers must focus on, as shown in Table I. The standard deviation of 1.97 shows that the results are greatly spread across the mean value of 2.56, which suggests that around 40% of respondents, committed themselves to this task during the preconstruction phase of the project. The standard value deviation of team leader selection is 2.01, which shows the results spreading across the mean value of 3.64, as shown in Table I where 49% of respondents stated this activity is essential before actual activities starts. Regarding programming and scheduling in projects, the results are spread across mean of 4.01, as shown in Table I, where the standard deviation is 2.55. It is found that 53% of respondents agree that programming and scheduling is a must for any project. The means of the activity of conceptual and detailed design is 3.42 and the standard deviation is 1.97, which indicates that 47% of the participants prefer to check and review the schematic and detailed design based on the conceptual design to control the cost. The construction documents plan is a very important task that should be controlled by all project managers, as confirmed by 57% of

respondents. Its standard deviation is 2.79 for the mean of 4.33. For the intention of the health and safety plan, the analysis of standard deviation value is 2.86, which means the variables are notably increased across the mean 4.42, and 59 % of respondents follow a health and safety plan during the project progress. The standard deviation of quality assurance and control is 1.96 and the mean of rendering is 3.38, where 46% of respondents have QA/QC engineers/managers on site. The mean value of the last activity, which is risk management, is 4.25 and its standard deviation is 2.65, which indicates that 56% of project managers consider risk assessment and analysis as a very serious issue in the project.

VII. CONCLUSION

Construction managers must spend enough time on the site observing the work activities. It is important that CMs understand many factors that might delay the project, such as weather and site conditions, and the shortage of materials that can affect the cost, time and quality of the project. Accurate planning contributes to the successful completion of a project. Planning begins before the project starts, and includes selecting the best construction methodologies, preparing the construction schedule/program and organizing the required resources. It also recommends following up the work progress on a daily bases to ensure that all activities are completed on time. Construction is all about teamwork and good communication is essential for every project manager. They must communicate with their team, clients, consultants, local authorities, subcontractors, and suppliers. The construction phase can start once the bidding process is completed. Although the phases of engineering construction management for projects are different than traditional project management, there are some common factors which include the same principles. Construction project managers who adopt and apply the applications of construction management should be familiar with the phases of project management, as per the project management institute. At the initiation phase they must develop the business plan to determine if the project is feasible. During the planning phase, the project team should prepare a plan that should be followed. The project manager must develop the project management plan that comprises of a formal, approved document to guide the execution and control, work breakdown structure, communication plan, scope of work, and risk management plan. At the execution phase, the project team appoints the resources, sets and executes the construction management plan in coordination with the project management plans, through developed tracking systems to implement the tasks, and update the project schedule. At the monitoring phase, the performance should be evaluated to ensure that activities are within the progress plan. At the closing phase, project managers and the rest of the team should focus on the learned lessons and close all the contract documents. Once the design is complete for any construction project it leads to the tendering phase, where the specifications and engineering drawings will be submitted to the contractor who will execute the project. During the pre-construction phase, the contractor is appoints the project team,

comprising of a project manager and superintendent, who oversee the team preparing the site ready for construction. They conduct a site survey, test soil, and identify any possible unexpected situations. At procurement, the project team purchases the required equipment, materials, and labor. The procurement stage is when the team purchases whatever they need to complete the project. Construction commencement on the site is organized by the construction manager who will arrange a pre-construction meeting with the subcontractors and material suppliers, in order to establish the guidelines for the working process and the team, who must be ready to the start construction, completing activities such as setting up temporary storage facilities, securing the site, and establishing safety programs that allow the construction activities to begin. Testing and commissioning starts once the construction activities are completed, the project team must test the systems and equipment to make sure everything is working correctly before handing over the completed building to the client. The team must then train the client's personnel in the operation and maintenance of the systems in the newly completed project/building.

VIII. RECOMMENDATIONS

To understand construction management and to practice it to the maximum level to deliver projects on time without any delays, the senior management of the contracting firm should be familiar with the principles of construction pricing and contracting. Contractors commence the work on site once they are officially assigned for the project; it is based on the type of contract they have bid, which can be lump sum or unit price contract. Cost estimating and budgeting, and quantity surveying, are essential topics that projects managers should be always monitor; the cost estimation of project elements and quantities should be prepared to control the financial issues of the project, as well as modifications and unnecessary expenditure in order for the project to complete within the approved budget. It is the responsibility of the professional quantity surveyor and cost estimator to control and monitor cost of the project where both should report directly to the project manager to achieve the task of keeping the project within the budget. Cost control monitoring is another field to control the cost of the project. Project managers must create a process and develop certain types of forms to monitor project costs. The sooner the cost control monitoring phase being prepared, the faster project managers will be able to identify potential problems. Senior management should be aware of organizing and scheduling construction activities that normally depend on size, type and location of the project. Contract Management is another important factor to clearly define the roles and responsibilities for the project team members who are managing the project and the project staff responsible for managing the contracts and documents. Contract procurement planning is the most important factor, as project managers must ensure that the procurement activities fit with the project plan. Some of the tasks they have to manage include setting the expected contract price, creating the scope of work for each contract, and standardizing the

procurement documents. In addition, the elements of the construction plan should be prepared by the project manager and the construction team on the site that comprise of understanding scope definitions, project objectives, plan assumption, solving the pending decision, as well as having some alternative solutions to unique problems, understanding the execution strategy through qualified staffing, and understanding the overall project plan, project budget.

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Mamoon Atout was born in the West Bank in 29/01/1964. He has PhD: Engineering and Construction Management- University of Glamorgan, Wales, United Kingdom 2006. MSc in Engineering and Project Management- University of Glamorgan, Wales, United Kingdom 1997. BSc in Civil Engineering- University of Detroit, Michigan, United States of America, 1986.

Diploma of Civil Engineering, Trinidad State Junior College, Trinidad, Colorado, United States of America 1984.

He has recently become the Head of Project Management Office in TP of the Dubai Electricity and Water Authority, United Arab of Emirates. Previously he was the Dean of College of Design at American University in the Emirates; he is a professional trainer in Middle East and Gulf region. He was the Deputy General Manager of project Management and supervision affairs at Al-Torath Engineering Consultants in the UAE. He has 30 years of experience in Engineering Project Management and Construction Project Management in the Gulf region Specifically in Dubai, Doha, Jordan and Kuwait. In 2014 He was assessor for the Excellence Award Program of Dubai Government His background is Civil Engineering and Infrastructure Projects, Contracts, Claims, Variations, Planning, Risk assessment, Feasibility analysis, Real-estate Development, Arbitration, Projects Evaluations and Monitoring and Interior Design. He worked in the Gulf region with many Developers, Project Managers, Consultants, Contractors and Interior Designers in various positions. He had conducted and lectured many Professional and Training courses in Society of Engineers and Society of Contractors in UAE and many

other places in Gulf region, Middle East and Europe and Asia. He presented many topics in many universities as a visiting lecturer, he also taught many different courses in different topics in Engineering Project Management and Construction Management, Value Engineering, Strategic Planning, Risk plan and assessment, Quality Assurance and Control, Human resources Management, Claims and Contract Management, Interior Design, Operation & Production Management Feasibility and business plan analysis and Facility Management.

Dr. Atout Presented many Scientific Papers in many International and local Conferences over the world in System Management, Construction Management and Project Management in Construction Industry. He published more than 32 articles and topic in different areas in Contracts, Strategic Planning, Value Engineering, Risk Assessment and analyses, Feasibility Study and business plans, Implications of Project Management in Construction, Contract Procurement Strategies, Principles of Design Management and methods of completing the projects on time without a delay. Dr. Atout participated in two international conferences with WASET that took their places in UK and USA during 2015-2016 and published two scientific research papers with them. He also was one of the technical committee of these two conferences.