Construction Management Delivery System

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3.1 Introduction

Construction is all about translating an owner’s goals and objectives by the contractor to build the facility as stipulated in the contract documents, plans, and specifications within the budget and on schedule.

Construction projects are mainly capital investment projects. They are customized and nonrepetitive in nature. The technological complexity of construction projects is continuously increasing. Construction projects have become more complex and technical, and the relationships and the contractual grouping of those who are involved are also more complex and contractually varied. In addition, the requirements of construction clients are on the rise and, as a result, construction projects (buildings and other facilities) must meet various performance standards (climate, rate of deterioration, and maintenance). Therefore, to ensure the adequacy of client brief that addresses the numerous complex client/user need, it is now necessary to evaluate the requirements in terms of activities and their interrelationship. The products used in construction projects are expensive, complex, immovable,
and long lived. Generally, a construction project is composed of building materials (civil), electromechanical items, finishing items, and equipment. These are normally produced by other construction-related industries/manufacturers. These industries produce products as per their own quality management practices complying with certain quality standards or against specific requirements for a particular project. The owner of the construction project or his representative has no direct control over these companies unless he/his representative/appointed contractor commit to buy their product for use in their facility. These organizations may have their own quality management program. In manufacturing or service industries the quality management of all in-house manufactured products is performed by the manufacturer’s own team or under the control of the same organization having jurisdiction over their manufacturing plants at different locations.

Construction projects comprise a cross section of many different participants. These participants are both influenced by and depend on each other in addition to other players involved in the construction process.

Traditional construction projects involve three main groups. These are as follows:

1. **Owner**—A person or an organization that initiates and sanctions a project. He/she requests the need of the facility and is responsible for arranging the financial resources for creation of the facility.

2. **Designer (architect/engineer)**—This consists of architects or engineers or consultant. They are appointed by the owner and are accountable to convert the owner’s conception and need into specific facility (project) with detailed directions through drawings and specifications within the economic objectives. They are responsible for the design of the project and in certain cases supervision of construction process.

3. **Contractor**—A construction firm engaged by the owner to perform and complete the construction of specific facility (project) by providing the necessary staff, workforce, resources, materials, equipment, tools, and other accessories to the satisfaction of the owner/end user in compliance with the requirements of contract documents. The contractor is responsible for implementing the project activities and to achieve the owner’s objectives.

Construction projects are executed based on predetermined set of goals and objectives. In order to process the construction project in an effective and efficient manner and to improve the control and planning, construction projects are divided into various phases. Traditionally, there have been five phases of a construction project life cycle that are further subdivided into various activities. These are conceptual design, preliminary design (schematic design), detail engineering (design development), construction and testing, commissioning, and handing over.

Participation involvement of all three parties at different levels of construction phases is required to ensure completion of construction and making the project most qualitative, competitive, and economical. Construction projects involve coordinated actions and input from many professionals and specialists to achieve defined objectives. There are several types of project delivery systems and contracting systems in which these parties are involved at different levels. All these contract deliverable systems follow generic life-cycle phases of construction project; however, the involvement/participation of various parties differs depending on the type of deliverable system adapted for a particular project.
Complex and major construction projects have many challenges such as delays, changes, disputes, and accidents at the site, and, therefore, the projects need to be efficiently managed from the beginning to the end to meet the intended use and owner’s expectations. The main area of construction management covers planning, organizing, executing, and controlling to ensure that the project is built as per the defined scope, maintaining the completion schedule and within the agreed upon budget. The owner/client may not have necessary staff/resources in-house to manage planning, design, and construction of the project to achieve the desired results. Therefore, in such cases, the owners engage a professional firm or a person called construction manager (CM), who is trained and has expertise in the management of construction processes, to assist in developing bid documents, overseeing, monitoring, controlling, and coordinating the project for the owner. The basic construction management concept is that the owner assigns the contract to a firm or a person who is knowledgeable and capable of coordinating all the aspects of the project to meet the owner’s intended use of the project. In construction management type of project delivery system, consultants (architects/engineers) prepare complete design drawings and contract documents, then the project is put up for a competitive bid and the contract is awarded to the competitive bidder (contractor). The owner hires a third party (CM) to oversee and coordinate the construction. The CM brings knowledge and experience that contribute to decisions at every stage of the project for its successful completion.

3.2 Project Management and Construction Management

As per PMI PMBOK® Guide (fifth edition), project management is the application of knowledge, skills, tools, and techniques to project activities to meet the project requirements. Project management completely deals with five processes (initiating, planning, executing, monitoring and control, and closing) that are divided into 13 knowledge areas spread over 47 locally grouped project management processes. Project management involves managing all types of projects from start to finish.

Construction management is a professional management practice applied effectively to the construction project from the inception to the completion of the project for the purpose of managing (planning, organizing, executing, and controlling) schedule, cost, scope, and quality. Construction management services are generally offered by registered engineering firms/professionals having the ability and expertise to manage construction projects.

Construction management is a discipline and management system specially tailored to promote the successful execution of capital and complex projects.

Construction management mainly involves construction-related management activities such as

- Planning
- Scheduling
- Monitoring and control
- Quality control/quality assurance
- Human resources
- Material and equipment
- Safety and environmental protection
The CM is responsible for overseeing the performance of the contractor(s) toward construction-related activities (engineering design, construction process, testing, commissioning, and handover).

The CM and the project manager are different types of project delivery systems. Table 3.1 illustrates the basic differences between project manager and construction management types of project management systems.

### Table 3.1

<table>
<thead>
<tr>
<th>Project Manager</th>
<th>Construction Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Manager is a conventional method of construction administration.</td>
<td>Construction management is a progressive, more convenient method of construction project administration.</td>
</tr>
<tr>
<td>Client/owner retains full control of design and construction.</td>
<td>There are two forms of construction management.</td>
</tr>
<tr>
<td>Client/owner retains direct control over all aspects and quality of the project.</td>
<td>1. Agency CM</td>
</tr>
<tr>
<td>Client/owner has direct contract with the designer (consultant) and contractor, subcontractors.</td>
<td>2. CM-at-risk</td>
</tr>
<tr>
<td>Client/owner has direct contractual relationship with both the architect/engineer (consultant) and the contractor.</td>
<td>In the agency CM type of management system, the client/owner has three contracts. One between the owner and the designer, one between the owner and the contractor, and one between the owner and the CM.</td>
</tr>
<tr>
<td>Client/owner selects the consultant and the contractor.</td>
<td>In the CM-at-risk type of project delivery system, the client/owner has two contracts, one between the owner and the designer and one between the owner and the CM-at-risk/general contractor (GC).</td>
</tr>
</tbody>
</table>

The CM is responsible for performing the construction and calculates financial liability to complete the project within schedule and budget.

### 3.3 Roadmap for Construction Management

The Figure 3.1 represents pictorial roadmap which covers all the activities that are discussed in Sections 3.3.1 through 3.3.5.

### 3.3.1 Project Initiation

Most construction projects begin with the recognition of a new facility. The owner of the facility could be an individual, a public/private sector company, or a governmental agency. The project development process begins with the project initiation and ends with the project closure and finalization of the project records. The project initiation starts with the identification of a business case and its needs.
FIGURE 3.1
Construction management roadmap.
The owner creates the need of the project, which is linked to the available financial resources to develop the facility. The owner’s needs are quite simple and are based on the following:

- To have the best value for money, that is, to have the maximum profit or services at a reasonable cost
- On-time completion, that is, to meet the owner’s/user’s schedule
- Completion within the budget, that is, to meet the investment plan for the facility

The owner’s need must be well defined, indicating the minimum requirements of quality and performance, an approved main budget, and the required completion date. Sometimes, the project budget is fixed and, therefore, the quality of the building system, materials, and finishes of the project need to be balanced within the budget. A business case typically addresses the business need for the project and the value the project brings to the business (project value proposition). A value proposition is a promise of value to be delivered by the project. The following questions address the value proposition:

1. How the project solves the current problems or improves the current situation?
2. What specific benefits the project will deliver?
3. Why the project is the ideal solution for the problem?

Business need assessment is essential to ensure that the owner’s business case has been properly considered before the initial project brief (need statement) is developed. Table 3.2 lists the major points to be considered for the need analysis of a construction project and Table 3.3 illustrates the need statement.

Once the owner’s need is identified, the traditional approach is pursued through need analysis and then a feasibility study or an economical appraisal of the owner’s needs or benefits, taking into account the relevant moral, social, environmental, and technical constraints. The feasibility study takes its starting point from the output of the project identification need. The feasibility study is conducted to assist the owner/decision-makers in deciding what will be in the best interest of the owner. Depending on the circumstances, the feasibility study may be short or lengthy, simple or complex. In any case, it is the principal requirement in project development as it gives the owner an early assessment of the viability of the project and the degree of risk involved. The owner usually performs a project feasibility study with the help of his or her own team or by engaging individuals/organizations involved in the preparation of economical and financial studies. However, the feasibility study can be conducted by a specialist consultant in this field. Table 3.4 illustrates the qualification of a consultant to perform the feasibility study.

The objective of the feasibility study is to review the technical/financial viability of the project and to give sufficient information to enable the client to proceed or abort the project. A feasibility study is undertaken to analyze the ability to complete a project successfully, taking into account various factors such as economic, technological, and scheduling. A feasibility study looks into the positive and negative effects of a project before investing the company resources, that is, time and money.

Following are the contents of a feasibility study report:

1. Purpose of the feasibility study
2. Project history (project background information)
TABLE 3.2
Major Considerations for Need Analysis of a Construction Project

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Points to Be Considered</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Is the project in line with the organization’s strategy/strategic plan and mandated by management in support of a specific objective?</td>
</tr>
<tr>
<td>2</td>
<td>Is the project a part of a mission statement of the organization?</td>
</tr>
<tr>
<td>3</td>
<td>Is the project a part of a vision statement of the organization?</td>
</tr>
<tr>
<td>4</td>
<td>Is the need mandated by a regulatory body?</td>
</tr>
<tr>
<td>5</td>
<td>Is the need for meeting government regulations?</td>
</tr>
<tr>
<td>6</td>
<td>Is the need to fulfill the deficiency/gap of such type of project(s) in the market?</td>
</tr>
<tr>
<td>7</td>
<td>Is the need created to meet market demand?</td>
</tr>
<tr>
<td>8</td>
<td>Is the need to meet the research and development requirements?</td>
</tr>
<tr>
<td>9</td>
<td>Is the need for technical advances?</td>
</tr>
<tr>
<td>10</td>
<td>Is the need generated to construct a facility/project that is innovative in nature?</td>
</tr>
<tr>
<td>11</td>
<td>Is the need aiming to improve the existing facility?</td>
</tr>
<tr>
<td>12</td>
<td>Is the need a part of mandatory investment?</td>
</tr>
<tr>
<td>13</td>
<td>Is the need to develop infrastructure?</td>
</tr>
<tr>
<td>14</td>
<td>Is the need necessary to serve the community and fulfill social responsibilities?</td>
</tr>
<tr>
<td>15</td>
<td>Is the need created to resolve a specific problem?</td>
</tr>
<tr>
<td>16</td>
<td>Is the need going to have an effect on the environment?</td>
</tr>
<tr>
<td>17</td>
<td>Does the need have any time frame to implement?</td>
</tr>
<tr>
<td>18</td>
<td>Does the need have financial constraints?</td>
</tr>
<tr>
<td>19</td>
<td>Does the need have major risks?</td>
</tr>
<tr>
<td>20</td>
<td>Is the need within the capability of the owner/client, either alone or in cooperation with other organizations?</td>
</tr>
<tr>
<td>21</td>
<td>Can the need be managed and implemented?</td>
</tr>
<tr>
<td>22</td>
<td>Is the need realistic and genuine?</td>
</tr>
<tr>
<td>23</td>
<td>Is the need measurable?</td>
</tr>
<tr>
<td>24</td>
<td>Is the need beneficial?</td>
</tr>
<tr>
<td>25</td>
<td>Does the need comply with environmental protection agency requirements?</td>
</tr>
<tr>
<td>26</td>
<td>Does the need comply with the government’s health and safety regulations?</td>
</tr>
</tbody>
</table>


3. Description of proposed project
   a. Project location
   b. Plot area
   c. Interface with adjacent/neighboring area
   d. Expected project deliverables
   e. Key performance indicators
   f. Constraints
   g. Assumptions

4. Business case
   a. Project need
   b. Stakeholders
   c. Project benefits
### Table 3.3
Need Statement

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Points to Be Considered</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Project purpose and need</td>
</tr>
<tr>
<td></td>
<td>a. Project description</td>
</tr>
<tr>
<td>2</td>
<td>What is the purpose of the project?</td>
</tr>
<tr>
<td></td>
<td>a. Project justification</td>
</tr>
<tr>
<td>3</td>
<td>Why is the project needed now?</td>
</tr>
<tr>
<td>4</td>
<td>How is the need of the project determined?</td>
</tr>
<tr>
<td></td>
<td>a. Supporting data</td>
</tr>
<tr>
<td>5</td>
<td>Is it important to have the needed project?</td>
</tr>
<tr>
<td>6</td>
<td>Whether such facility/project is required?</td>
</tr>
<tr>
<td>7</td>
<td>What are the factors contributing to the need?</td>
</tr>
<tr>
<td>8</td>
<td>What is the impact of the need?</td>
</tr>
<tr>
<td>9</td>
<td>Will the need improve the existing situation and be beneficial?</td>
</tr>
<tr>
<td>10</td>
<td>What are the hurdles?</td>
</tr>
<tr>
<td>11</td>
<td>What is the time line for the project?</td>
</tr>
<tr>
<td>12</td>
<td>What are funding sources for the project?</td>
</tr>
<tr>
<td>13</td>
<td>What are the benefits of the projects?</td>
</tr>
<tr>
<td>14</td>
<td>What are the environmental impacts?</td>
</tr>
</tbody>
</table>


### Table 3.4
Consultant’s Qualification for Feasibility Study

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Experience in conducting feasibility study</td>
</tr>
<tr>
<td>2</td>
<td>Experience in conducting feasibility study in similar type and nature of projects</td>
</tr>
<tr>
<td>3</td>
<td>Fair and neutral with no prior opinion about what decision should be made</td>
</tr>
<tr>
<td>4</td>
<td>Experience in strategic and analytical analysis</td>
</tr>
<tr>
<td>5</td>
<td>Knowledge of analytical approach and background</td>
</tr>
<tr>
<td>6</td>
<td>Ability to collect large number of important and necessary data via work sessions, interviews, surveys, and other methods</td>
</tr>
<tr>
<td>7</td>
<td>Market knowledge</td>
</tr>
<tr>
<td>8</td>
<td>Ability to review and analyse market information</td>
</tr>
<tr>
<td>9</td>
<td>Knowledge of market trend in similar type of projects/facility</td>
</tr>
<tr>
<td>10</td>
<td>Multidisciplinary experienced team having proven record in the following field;</td>
</tr>
<tr>
<td></td>
<td>a. Financial analyst</td>
</tr>
<tr>
<td></td>
<td>b. Engineering/Technical expertise</td>
</tr>
<tr>
<td></td>
<td>c. Policy experts</td>
</tr>
<tr>
<td></td>
<td>d. Project scheduling</td>
</tr>
<tr>
<td>11</td>
<td>Experience in review of demographic and economic data</td>
</tr>
</tbody>
</table>

d. Financial benefits
e. Estimated cost
f. Estimated time
g. Justification
5. Feasibility study details
   a. Technical
   b. Economical
c. Financial
d. Time scale
e. Environmental
f. Ecological
g. Sustainability
h. Political
   i. Social
6. Risk
7. Environmental impact (considerations)
8. Social impact (considerations)
9. Final recommendation

The outcome of the feasibility study helps to select a defined project that meets the stated project objectives, together with a broad plan of implementation. If the feasibility study shows that the objectives of the owner are best met through the ideas generated, then the project is moved to the next stage of the project life cycle to deliver the intended objectives.

3.3.2 Project Goals and Objectives

Project goals and objectives are prepared by taking into consideration the final recommendations/outcome of the feasibility study. Clear goals and objectives provide the project team with appropriate boundaries to make decisions about the project and ensure that the project/facility will satisfy the owner’s/end user’s requirements and fulfill owner’s needs. Establishing properly defined goals and objectives is the most fundamental element of project planning. Therefore, the project goals and objectives must be

- Specific (Is the goal specific?).
- Measurable (Is the goal measurable?).
- Agreed upon/achievable (Is the goal achievable?).
- Realistic (Is the goal realistic or result-oriented?).
- Time (cost) limited (Does the goal have a time element?).

3.3.3 Select Project Delivery System

A project delivery system is defined as the organizational arrangement among various participants comprising the owner, designer, contractor, and many other professionals involved in the design and construction of a project/facility to translate/transform the
owner’s needs/goals/objectives into a finished facility/project to satisfy the owner’s/end user’s requirements. There are different types of project delivery systems followed in construction projects; however, each of the project delivery systems is a variation of the following basic types:

- Design–bid–build (traditional delivery method)
- Design–build (integrated system)
- Management oriented system
  - Project manager
  - Construction management
- Integrated project delivery system

3.3.4 Construction Management Delivery System

In the construction management type of management process, the owner retains control of the design and direction. It is a fully integrated design and construction process, thus minimizing changes, disputes, and delay in the completion of the project.

There are two forms of construction management systems:

1. Agency construction management
2. Construction management-at-risk

3.3.4.1 Agency Construction Management

Agency construction management is a management process where the CM acts as an advisor to the owner. The owner may engage the CM for the entire life cycle of the construction project or during a specific phase of the construction project. Normally, the CM is engaged as early in the project as possible to guide and assist the owner through all the phases of the project or for a specific phase. Agency CM can be used in conjunction with any project delivery system. The agency CM is always with the owner. This type of management is a fee-based service in which the CM is exclusively responsible to the owner and acts in the owner’s interest. With the agency CM type of construction management system, the owner holds the contracts directly with the general contractor and also assumes the risks of delivery, including cost and schedule, quality, safety, performance, errors, and omissions. The agency CM has no financial stakes in the project and does not hold any subcontracts.

The agency CM type of management system can be used with different types of project delivery systems. Given next are figures that illustrate contractual relationship of agency CM with different types of project delivery systems and their corresponding sequential activities.

Figure 3.2 illustrates the contractual relationship of the design–bid–build–delivery system using agency CM, and Figure 3.3 illustrates the sequential activities for this type of delivery system.

Figure 3.4 illustrates the contractual relationship of the multiple-prime contractor delivery system using agency CM, and Figure 3.5 illustrates the sequential activities for this type of delivery system.

Figure 3.6 illustrates the contractual relationship of the design–build–delivery system using agency CM, and Figure 3.7 illustrates the sequential activities for this type of delivery system.

Figure 3.8 illustrates the contractual relationship of the agency CM type of management system, and Figure 3.9 illustrates the sequential activities for this type of delivery system.
Figure 3.10 illustrates the contractual relationship of the CM-at-risk delivery system using agency CM, whereas Figure 3.11 illustrates the sequential activities for this type of delivery system.

3.3.4.2 Construction Management at Risk

CM-at-risk is a project delivery system. CM-at-risk is selected based on the qualification, experience, and reputation of the CM. In this system, the CM enters into a contract with the owner at an early stage and becomes a member of a collaborative project team with...
that of A/E (designer). A CM-at-risk typically contracts with the owner in two stages. Design services and construction services are contracted separately (vs. design–build, where the contracts are combined). In the first stage, the CM acts as an advisor to the owner and assists in the development of conceptual and preliminary design phase. The second phase involves development of detail design and completion of construction for a negotiated fixed or guaranteed maximum price (GMP). In a CM-at-risk arrangement, the criteria for final selection of the contactor are not based on the total construction
cost (vs. design–bid–build–delivery system where the total construction cost is a factor for final selection). GMP contracts method is typically used with CM-at-risk.

In the United States, certain states have promulgated statutory/regulatory guidelines to hire CM-at-risk to procure construction services. Figure 3.12 illustrates the contractual relationship of a CM-at-risk delivery system, and Figure 3.13 illustrates the sequential activities for this type of delivery system.
3.3.5 Establish Terms of Reference

Normally, terms of reference (TOR), also known as *design brief*, are prepared by the owner/client or by the project manager on behalf of the owner describing the objectives and requirements to develop the project. In the case of construction management, the CM assists the owner/client to prepare the TOR.

A client brief (TOR) defines the objectives for the project and guides the project team to the next stage of the project. A well-prepared, accurate, and comprehensive client brief
FIGURE 3.10
Construction management-at-risk (CM-at-risk) with agency CM.

FIGURE 3.11
Sequential activities of CM-at-risk delivery system with agency CM.
FIGURE 3.13
Sequential activities of CM-at-risk delivery system.

** > 50% design completion
(TOR) is essential to achieve a qualitative and competitive project. The TOR gives the project team (designer) a clear understanding for the development of the project. Further, the TOR is used throughout the project as a reference to ensure that the established objectives are achieved. Client brief or TOR describes information such as

- The need or opportunity that has triggered the project
- Proposed location of the project
- Project/facility to be developed
- Project function and size
- Performance characteristics of the project
- Procurement strategy
- Project assumptions and constraints
- Estimated timescale
- Estimated cost
- Initial list of defined risks
- Description of approval requirements

For the development of construction projects, TOR generally details the services to be performed by the designer (consultant), which include, but are not limited to, the following:

- Predevelopment studies, collection of required data, and analyzing the same to prepare design drawings and documents for the project
- Development of alternatives
- Preparation of concept design
- Preparation of schematic design
- Preparation of detail design
- Project deliverables
- Obtaining authorities approvals
- Compliance standards, codes, and practices
- Coordinating and participation in value engineering study
- Preparation of construction schedule
- Preparation of construction budget
- Preparation of contract documents for bidding purpose
- Prequalification/selection of contractor
- Evaluation of proposals
- Recommendation of contractor to the owner/client

In cases of the construction management type of system, some of the activities mentioned earlier are performed by the CM as he or she acts as an advisor to the owner.

Following are the requirements for a building construction project, normally mentioned in TOR, to be prepared by the designer during the conceptual phase for submission to the owner:
1. Site plan
   a. Civil
   b. Services
   c. Landscaping
   d. Irrigation
2. Architectural design
3. Building and engineering systems
   a. Structural
   b. Mechanical (HVAC)
   c. Public health
   d. Fire suppression systems
   e. Electrical
   f. Low voltage systems
   g. Others
4. Cost estimates
5. Schedules

3.4 Qualification of Construction Manager

Construction management is a process wherein professional knowledge, skills, tools, and
techniques are applied to project activities to meet the project requirements and successful
completion of project to the satisfaction of the owner/end user. The CM should be a highly
qualified person who has full knowledge of the construction management system to achieve
the project objectives. Table 3.5 illustrates typical qualification requirements of a CM.

3.5 Role of CM

CMAA’s Owner’s Guide to Project Delivery Methods states that:

In the past, most owners relied on the experience of the designer to provide a complete
and responsible set of contract documents. Recently, more and more owners have found
the value in utilizing the advice and expertise of those with overall process, program
and construction management knowledge during the design phase.

Whether provided through owner staffing or a third-party firm, the CM should be
engaged as early in the project as possible to guide and assist the owner through all
phases of delivering the project. The CM may also act as the owner’s representative
with the other members of the project team, being the point of contact for the designer,
contractor, and any other specialty consultants engaged in the project by the owner.

The construction management delivery system is a project procurement/contract manage-
ment process whereby the CM (firm or an individual with sound project manager skills)
TABLE 3.5
Qualifications of Construction Manager

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Qualification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Thorough knowledge and understanding of construction processes</td>
</tr>
<tr>
<td>2</td>
<td>In-depth knowledge of construction activities</td>
</tr>
<tr>
<td>3</td>
<td>Knowledge of projects delivery systems and their adoptability</td>
</tr>
<tr>
<td>4</td>
<td>Knowledge of contracting systems and their suitability of the project</td>
</tr>
<tr>
<td>5</td>
<td>Knowledge of project planning, monitoring, and control</td>
</tr>
<tr>
<td>6</td>
<td>Knowledge of various tools and techniques used in construction projects</td>
</tr>
<tr>
<td>7</td>
<td>Knowledge of construction codes and practices</td>
</tr>
<tr>
<td>8</td>
<td>Knowledge of applicable standards and conditions of contract</td>
</tr>
<tr>
<td>9</td>
<td>Knowledge of information technology</td>
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<tr>
<td>10</td>
<td>Knowledge and understanding of all disciplines of construction project</td>
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<tr>
<td>11</td>
<td>Knowledge of societal needs toward projects</td>
</tr>
<tr>
<td>12</td>
<td>Knowledge and skills to oversee and manage complex construction projects</td>
</tr>
<tr>
<td>13</td>
<td>Knowledge of quality management techniques</td>
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<tr>
<td>14</td>
<td>Knowledge of HSE practices</td>
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<tr>
<td>15</td>
<td>Knowledge of risk management</td>
</tr>
<tr>
<td>16</td>
<td>Excellent technical background</td>
</tr>
<tr>
<td>17</td>
<td>Communication skills (oral and written)</td>
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<tr>
<td>18</td>
<td>Strong and responsive leadership skills</td>
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<tr>
<td>19</td>
<td>Competency in construction management skills</td>
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<tr>
<td>20</td>
<td>Problem-solving skills</td>
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<tr>
<td>21</td>
<td>Ability to negotiate</td>
</tr>
<tr>
<td>22</td>
<td>Innovative and creative thinking</td>
</tr>
<tr>
<td>23</td>
<td>Collaborative thinking</td>
</tr>
<tr>
<td>24</td>
<td>Able to motivate and encourage subordinates and other team members to work as a group</td>
</tr>
<tr>
<td>25</td>
<td>Possess high-level university degree</td>
</tr>
<tr>
<td>26</td>
<td>Member of a related professional institution/society</td>
</tr>
<tr>
<td>27</td>
<td>Basic knowledge of design practices</td>
</tr>
</tbody>
</table>

undertakes to manage the work through contractors who may either be general or trade-specific contractors and oversees the performance throughout the project life cycle by systematic application of management skills and principles.

The role of the CM is to apply comprehensive management and control efforts to the project at the early project planning stages and continue until project completion. Construction management process involves the application and integration of comprehensive project controls to the design and construction process to achieve successful project delivery/completion.

The roles and responsibilities of the CM in a project may vary substantially, and can be performed under a variety of contractual terms. Regardless of the project delivery system utilized in the construction projects, the CM can play a pivotal role in all the phases of construction project life cycle.

Generally, construction projects are divided into three stages, which are as follows:

1. Preconstruction
   a. Study (predesign)
   b. Design
   c. Bidding
2. Construction
3. Postconstruction

The owner may engage the CM to oversee all the activities during all the phases of the construction project life cycle or engage the CM to perform a specific role during a specific phase of the project depending on the owner's desires and requirements for delegating responsibilities and authority. The CM is paid a fee to act as the owner's agent or advisor for a construction project. Given next are the roles played by the CM during various stages of the construction project.

3.5.1 CM Role during the Predesign Stage

During this stage, the CM acts in an advisory role, just as the agency CM, and provides the following services:

- Defining the overall performance requirements
- Defining overall project program
- Developing project’s scope of work (TOR)
- Developing project procedures and standards
- Establishing a management information system
- Preparing the project schedule
- Preparing the project budget
- Identifying critical constituents of the project
- Identifying the required approvals and permits from the authorities
- Selecting the project delivery method
- Selecting the designer (consultant)

3.5.2 CM Role during Design Stage

During the design stage, the CM works collaboratively as well as independently in a design team. The CM has to provide information and recommendations that will enable the owner to make the best design decisions possible, since the owner is responsible for the contractor (S) for design errors (Spearin Doctrine).

The CM acts as an agent to the owner and provides the following services during the design stage:

- Oversees and coordinates design
- Recommends alternative solutions
- Conducts life-cycle cost analysis
- Reviews design documents
- Conducts constructability review
- Gives suggestions to improve constructability
- Provides recommendations on construction-related activities
- Coordinates with the regulatory authorities to obtain requisite permits and license
• Recommends selection of materials, building systems, and equipment
• Provides value-added engineering suggestions
• Provides value-enhancement suggestions
• Creates construction schedule
• Estimates construction cost
• Manages budget and project schedule
• Monitors and manages project risk
• Helps the designer (A/E) to develop multiple bid packages to expedite the construction process
• Reviews final drawings and specifications
• Prepares and revises project management plan

3.5.2.1 CM Role during Bidding

The role of the CM during the bidding stage is as follows:

• Prepares bid packages
• Prequalifies bidders
• Establishes bidding schedule
• Manages bidding of documents
• Conducts prebid meetings to familiarize bidders with the bidding documents
• Answers all queries related to the bid
• Addendum to bid documents
• Receives bids
• Reviews and evaluates bids
• Analyzes and compares bids
• Holds contract negotiation
• Provides recommendations to the owner to accept or reject the proposals
• Participates in contractor selection
• Conducts preaward meeting(s) with the selected contractor
• Incorporates addenda changes into contract documents
• Prepares construction contract
• Provides notice to proceed

3.5.3 CM Role during Construction Stage

A CM’s roles during the construction stage vary depending on the type of contract the owner has entered with the CM. There are two forms of construction management processes:

1. Agency CM
2. CM-at-risk
3.5.3.1 Agency CM

As an agency CM, the CM is responsible for performing services related to the following activities:

- Ensure that contractor submitted performance bond
- Ensure that contractor submitted worker’s insurance policy
- Selects and recommends contractor’s core staff
- Selects and recommends subcontractor
- Establishes and implements procedures for processing and approval of shop drawings
- Approves construction material
- Manages contractor’s request for information (RFI)
- Change order management
- Approves construction schedule
- Supervises construction
- Quality management
- Coordination of on-site, off-site inspection
- Inspection of works
- Construction contract administration
- Conducts periodic progress meetings
- Prepares minutes of meeting and distributes it as per agreed upon matrix
- Document control
- Technical correspondence between contractor
- Manages submittals
- Monitors daily progress
- Monitors contractor’s performance and ensures that the work is performed as specified, as per approved shop drawings, and as per applicable codes
- Scope control
- Monitors construction scheduling
- Cost tracking and management
- Reviews, evaluates, and documents claims
- Maintains project progress record
- Evaluates payment request and recommends progress payments
- Monitors project risk
- Monitors contractor’s HSE plans (health, safety, and environment)
- Coordinates work of multiple contractors
- Coordinates delivery and storage of owner-supplied materials and systems
- Tests systems
- Punch list
3.5.3.2 CM-at-Risk

Under the CM-at-risk form of project delivery system, the CM acts as a general contractor. The owner transfers the responsibility and risk to the CM-at-risk contractor for the entire construction effort, performance risk including subcontract administration and coordination.

3.5.4 CM Role during Testing, Commissioning, and Handover Stage

- Testing and commissioning of systems
- Review of as-built drawings
- Review of record documents and manuals
- Warranties and guarantees
- Authorities’ approval for occupancy
- Coordination of hand-off procedure
- Move in plan
- Punch list
- Preparing list of lessons learned
- Substantial completion
- Archiving project documents
- Settlement of claims
- Project final account
- Project closure