

PROJECT MANAGEMENT SUCCESS IN CONSTRUCTION: A CASE STUDY OF
AN EPCM PROJECT

by

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ABSTRACT

PROJECT MANAGEMENT SUCCESS IN CONSTRUCTION: A CASE STUDY OF AN EPCM PROJECT

A construction project's success depends not only on its completion but also on effective project management, which ensures value delivery and sustains a company's market presence by securing new or returning clients. This research aims to guide project managers and stakeholders in understanding and maximizing the benefits of project management knowledge areas that enhance project performance. This research adopts a case study approach focused on an EPCM project, utilizing both primary and secondary data. Data was gathered from project documentation such as reports, forms, matrices, letters, and drawings as well as from face-to-face interviews with key professionals and direct observations. This data collection was complemented by an extensive literature review covering construction project phases, sector-specific project management standards, project management knowledge areas, and performance measurement models that contribute to project success. The analysis highlights that integration, scope, schedule, cost and quality management are important determinants for the project management performance, while resource, procurement and financial management have lesser impacts. Furthermore, time, cost, and quality and client satisfaction emerge as essential attributes of successful project outcomes, with project manager experience identified as the most critical success factors. The multi-criteria performance measurement framework developed in this study provides a practical tool for construction project stakeholders to establish an internal performance measurement system and integrate key performance indicators. This framework maintains awareness of project progress across various metrics. By implementing this tool, project managers and stakeholders are expected to enhance project outcomes and contribute to more sustainable success within the construction sector.

ÖZET

EPCM PROJESİ ÖRNEK ÇALIŞMASI İLE İNŞAATTA PROJE YÖNETİMİ BAŞARISININ İRDELENMESİ

Bir inşaat projesinin başarısı sadece tamamlanmasına değil, aynı zamanda değer teslimini sağlayan ve yeni veya geri dönen müşterileri güvence altına alarak bir şirketin pazardaki varlığını sürdüren etkili proje yönetimine de bağlıdır. Bu araştırma, proje yöneticilerine ve paydaşlara, proje performansını artıran proje yönetimi bilgi alanlarının faydalarını anlama ve en üst düzeye çıkarma konusunda rehberlik etmeyi amaçlamaktadır. Bu araştırma, hem birincil hem de ikincil verileri kullanarak bir EPCM projesine odaklanan bir vaka çalışması yaklaşımını benimsemektedir. Veriler raporlar, formlar, matrisler, mektuplar ve çizimler gibi proje belgelerinin yanı sıra kilit profesyonellerle yapılan yüz yüze görüşmelerden ve doğrudan gözlemlerden toplanmıştır. Bu veri toplama işlemi, inşaat projesi aşamaları, sektöre özgü proje yönetimi standartları, proje yönetimi bilgi alanları ve proje başarısına katkıda bulunan performans ölçüm modellerini kapsayan kapsamlı bir literatür taraması ile tamamlanmıştır. Analiz, entegrasyon, kapsam, program, maliyet ve kalite yönetiminin proje yönetim performansı için önemli belirleyiciler olduğunu, kaynak, tedarik ve finansal yönetimin ise daha az etkiye sahip olduğunu vurgulamaktadır. Ayrıca, zaman, maliyet, kalite ve müşteri memnuniyeti başarılı proje sonuçlarının temel nitelikleri olarak ortaya çıkarken, proje yöneticisi deneyimi en kritik başarı faktörleri olarak belirlenmiştir. Bu çalışmada geliştirilen çok kriterli performans ölçüm çerçevesi, inşaat projesi paydaşlarına dahili bir performans ölçüm sistemi kurmaları ve temel performans göstergelerini entegre etmeleri için pratik bir araç sunmaktadır. Bu çerçeve, çeşitli ölçütler arasında proje ilerlemesine ilişkin farkındalığı sürdürmektedir. Proje yöneticileri ve paydaşların bu aracı uygulayarak proje sonuçlarını iyileştirmeleri ve inşaat sektöründe daha sürdürülebilir bir başarıya katkıda bulunmaları beklenmektedir.

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LIST OF ACRONYMS/ABBREVIATIONS

ANSI	American National Standards Institute
ANS	American National Standard
AFNOR	French Standards Association
APMG	Association of Project Managers Group
BIM	Building Information Modeling
BS	British Standard
BSC	Balanced Scorecard
BSI	British Standard Institute
CBPP	Construction Best Practice Programme
CII	Construction Industry Institute
CPI	Cost Performance Index
CPM	Certified Project Manager
CSF	Critical Success Factor
DETR	Department of Environment, Transport, and the Regions
DTI	Department of Trade and Industry
DIN	German Institute for Standardization
EPCM	Engineering, Procurement and Construction Management
EP2M	Effective Progress and Performance Measurement
EFQM	European Foundation for Quality Management
ERP	Enterprise Resource Planning
GDP	Gross Domestic Product
HR	Human Resources
HSE	Health, Safety and Environment
ICB	Individual Competence Baseline
IPDS	Integrated Project Delivery System
IPMA	International Project Management Association
ISO	International Organization for Standardization
JIS	Japanese Industrial Standard

JISC	Japanese Industrial Standards Committee
JPMF	Japan Project Management Forum
KA	Knowledge Area
KPI	Key Performance Indicator
NF	French Standard
OGC	UK's Office of Government Commerce
P2M	Project and Program Management for Enterprise Innovation
PMAJ	Project Management Association of Japan
PMBOK	Project Management Body of Knowledge
PMI	Project Management Institute
PRINCE	Projects in Controlled Environment
PSC	Project Success Criteria
QA/QC	Quality Assurance/Quality Control
SAS	Swiss Association for Standardization
TS	Turkish Standard
TSE	Turkish Standards Institute
TQM	Total Quality Management

1. INTRODUCTION

The construction sector plays a significant role in economies around the world. It is involved in a variety of large-scale projects, and project management plays a crucial role in creating global value for the economy. In today's landscape, project management employs tools and techniques that aim to improve the efficiency of projects (Pheng & Hou, 2019). Project management, as a methodology, is designed to facilitate the successful execution of projects, highlighting its paramount importance (PMI, 2021).

Construction project management involves the simultaneous management of numerous processes and cross-disciplinary collaboration, requiring a significant allocation of resources. Given the complexity of construction projects and the potential for unforeseen events and unpredictable scenarios, the need for an integrated system to oversee planning, design, and the overall project environment becomes evident. Professional project management standards are a key requirement for project management companies and embody the concept of project management as a set of information, tools, techniques and methods that are essential for achieving project objectives (Allan, 2018).

In the context of this thesis, an extensive literature review was undertaken to examine project management methodology as applied in the construction sector. This review had several objectives, including a broad understanding of project management within a general framework, an exploration of project management practices in the construction industry, and the identification of critical factors that underpin the successful evaluation of a project. In line with these objectives, the initial focus was on the concept of a project, followed by a comprehensive review of project management processes, standards, knowledge areas, and the concept of project success. This was followed by a review of existing research in the literature on criteria for measuring success, and a list of critical project success factors identified by various researchers.

Following the literature review, an integrated framework for evaluating project management performance based on the selected EPCM projects was formulated. This

framework is leaning towards the twelve knowledge areas outlined in the PMBOK Guide (PMI, 2017), which serve as key determinants of project performance. In addition, this assessment was conducted in the context of project life cycles, providing insight into the evolution of project management practices throughout the life of a project.

This thesis employs a single-case study methodology to provide a comprehensive examination of the factors that contribute to project management success within the particular context of an EPCM project. The instrumental case study approach was selected because the EPCM project in question serves as a means of exploring the broader themes that underpin project management practices within the construction industry. The EPCM project contract type allows the project owner to retain full control while entrusting the EPCM contractor with the management of the engineering, procurement, and construction scope from inception to delivery while comprising every project phase and utilizing the processes under the knowledge areas to the most extent. Therefore, by examining a single case, this study is expected to delve deeply into the complex dynamics of project management success, capturing nuances and contextual factors that are often challenging to uncover through multiple-case comparisons.

The case study was followed by an in-depth exploration of the factors influencing project success through face-to-face interviews with key industry professionals, all of whom contributed to the selected case study. Given the extensive expertise of the interviewees, the discussions within the study revolved around several key themes.

It is anticipated that this work will add significantly to the body of knowledge surrounding performance studies in the construction industry and will serve as a guide for construction companies seeking to improve their practices through effective project management.

1.1. Research Background

For most countries, building is a major economic activity, both through its contribution to GDP and total employment, and as a market for materials and products produced by other economic sectors (Salazar-Xirinachs et al., 2014). Therefore, understanding project

management performance in construction is vital, as effective project management is key to achieving higher performance levels in this sector (Demirkesen & Ozorhon, 2017a).

Different types of projects require varied management approaches tailored to their specific needs, with project managers selected for their appropriate skills (Crawford, 2005; Müller & Turner, 2007). To assess project management success, many researchers have proposed performance models or evaluation frameworks that incorporate various internal and external factors (Ali et al., 2013; X. Jin, 2013; Kagioglou et al., 2001; Lin & Shen, 2010; Takim & Akintoye, 2002; Wang, 2010).

The nature and definition of project success have been the subject of extensive debate in academia and practice, yet no consensus has been reached (Demirkesen & Ozorhon, 2017a). Commonly used terms to describe project success include completion on time, within budget, meeting specifications, and achieving business objectives (Bannerman, 2008). The success of a project also depends on stakeholder expectations, perceptions, and the timing of the success assessment (De Wit, 1988).

1.2. Problem Determination & Statement

Performance measurement is critical in assessing construction companies' project management performance, yet it poses numerous challenges (Kagioglou et al., 2001; Robinson et al., 2005).

Project execution processes depend on the type of contract and are ideally managed through centralized and standardized mechanisms for collecting and distributing information to achieve the project's objectives. Previous research confirms that the correct application of project management know-how, including processes, tools, and techniques, significantly increases the chances of project success (Rwelamila, 2007; Zwikael, 2009).

It has been suggested that when selecting a project management methodology, the project sponsor or manager should identify relevant success criteria, determine the appropriate success

factors to increase the likelihood of achieving these criteria, and then select a methodology that delivers these factors (Müller & Turner, 2007).

Extensive research has focused on identifying project management knowledge areas, which form the basis for standardizing processes in project management methodologies and understanding why companies need to measure their performance (Huerta et al., 2006; Kerzner, 2022; PMI, 2017; Powers, 2006).

The PMBOK Guide (PMI, 2017) proposes twelve knowledge areas for project management, with its Construction Extension (PMI, 2016) adding two more to standardize construction project management. Despite these guidelines, construction projects often fail to meet time, budget, and quality requirements (Akinsiku & Akinsulire, 2012; Apolot et al., 2013). This may indicate inconsistent application of knowledge areas in construction project management.

1.3. The Aim and Objectives

The construction sector accounts for a significant proportion of the economies of both developed and developing countries around the world. Both technology and the scale of projects undertaken have developed significantly in recent years. Large projects present significant challenges to companies in the sector, and as projects grow, the competition between companies intensifies.

In the context of an increasingly globalized construction industry, the effective and professional utilization of project management techniques can facilitate the creation of value in construction projects on a global scale, thereby contributing to the sustainability of the industry as a whole. A construction project is characterized by a high level of intensive work capacity across all processes, from inception to completion.

In the context of an evolving construction industry, the challenge of project management is intensifying as the intricacy and scale of contemporary projects continue to expand. The increased competition requires systematic study to ensure the success and future sustainability

of the execution of construction projects. With these challenges in mind, the concept of project management has become increasingly important. This requires meticulous planning. Project management serves to guarantee that the project is realized in accordance with the established objectives, despite the potential for risks and complications to arise during the construction process. The effective utilization of project management methodology ensures success in terms of time, cost and quality performance in projects. The transformation of corporate capabilities into products, services and outcomes without the wastage of resources is achievable through the implementation of professional project management.

Therefore, the aim of this thesis is to develop a comprehensive, multi-criteria performance measurement model that is specifically tailored for evaluating construction projects. The model will be applied to a selected EPCM case study with the objective of assessing both the level of project success and the effectiveness of project management practices. The evaluation framework will be based on the knowledge areas outlined in the PMBOK Guide (PMI, 2017) and its construction extension (PMI, 2016), thereby ensuring that the model aligns with established standards in project management. Through this application, the study seeks to offer insights into the strengths and limitations of project management practices in achieving successful project outcomes within the project management approach and provide guidance to project managers and stakeholders on effectively leveraging relevant project management knowledge areas to enhance their project management practices. By doing so, it is anticipated that the performance of managed projects will improve, leading to more successful project outcomes. The objectives of this thesis are as follows:

- To identify and validate KPIs and critical factors influencing construction project success. This includes identifying essential project management knowledge areas and determining critical metrics to track performance. The validation process will involve industry expert feedback to ensure practical applicability.
- To analyze the impact of project management knowledge areas on project success. A case study from the construction industry will be used to investigate how specific

knowledge areas contribute to project performance, while also examining their interrelations based on literature and case findings.

- To propose strategies for enhancing project management practices. These strategies will be formulated according to project management knowledge areas and will include recommendations for engaging key stakeholders for improved project outcomes.

1.4. The Scope and Limitations

The scope of this research involves applying Project Management knowledge areas to an international airport project as case study with the involvement of many contractors, suppliers and institutions undertaken by an international company under EPCM contract type. Under the EPCM model, the contractor does not engage in actual construction work; instead, they develop the design and manage the construction process on behalf of the Owner (Loots & Henchie, 2007). In other words, the EPCM contractor acts as the Owner's agent and creates direct contractual relationships between the Owner and the suppliers and construction contractors. As a result, the primary potential liabilities of the EPCM contractor pertain to breaches or negligence in the following areas:

- the performance of the design work,
- the preparation of the budget cost estimate,
- the preparation of the estimated duration of the work,
- managing, supervising and coordinating the scope of the contractors,
- coordination of design and construction between contractors.

EPCM is a type of contract that requires the EPCM contractor to manage relations and works with all project stakeholders to retain control of the complete project life cycle. Thus, it is anticipated that this type of project would allow for the evaluation of all twelve knowledge areas outlined in the PMBOK Guide (PMI, 2017). Although selecting an airport type project as the case study may appear to be a limitation, the broad scope of an airport project encompasses

industrial systems, civil works, mechanical and electrical works, and design integration which makes it applicable to several types of construction projects.

The interview questionnaire developed as part of this research reflects the opinions of those who played key roles in the case study project. However, a limitation of this research is that interviewees may have interpreted the questions differently.

Another limitation of this study is that as the case study strategy focuses on a single project it was difficult to transfer the findings of the thesis onto a broader area. Furthermore, the key project personnel were selected as the interviewees for the interviews. This might have led to the possible inclusion of biasness from their side, as they might hide certain information which they feel would bring defame to their organization or project. Additionally, certain factors during the data extraction process from the case study project may have influenced the study's outcomes.

The findings and their validity are also considered limitations of this research, as the survey was conducted on a small sample size and is constrained by the subjective nature of some performance metrics. Although key personnel were carefully selected for the project, the number of interviewees could be increased. To ensure the accuracy necessary for a sector-wide analysis, future studies should include larger sample sizes.

1.5. The Organization of the Thesis

This thesis consists of six chapters. The first chapter, which introduces the study, outlines the investigation's flow and the data presented within the context of project management in construction. It provides a general overview of the research in relation to the study's background. This chapter presents the research problem, research questions, limitations, and rationale.

In the second chapter, a review of the relevant literature is presented, where a detailed study was conducted on Project Management Methodology in the Construction Sector. This includes topics such as Project, Project Management, Project Management Standards,

Measuring Performance through defined indicators, and Project Success Criteria. The project management knowledge areas, as outlined in the PMBOK Guide (PMI, 2017) and its construction editions, are reviewed, and the findings of previous studies related to this study are presented.

The third chapter presents the research methodology and the conceptual framework for project management performance.

The fourth chapter presents a case study of an EPCM project, which is evaluated using the post-project report method, with consideration of the project management knowledge areas.

The fifth chapter details the findings and results of interviews conducted with professionals who worked on the project evaluated in the case study.

The sixth chapter discusses the findings of the thesis, and the seventh chapter presents the strategies classified by their relevant knowledge area along with the respective stakeholders aside from the conclusions and recommendations for future research.

2. PROJECT MANAGEMENT PERFORMANCE IN CONSTRUCTION

2.1. Project & Project Phases

2.1.1. Project Definitions

A project is often defined as a complex assembly of interdependent activities executed to generate a unique output within a predetermined timeframe, subject to specific constraints (J. K. Pinto & Prescott, 1988). Despite debates over certain elements of this definition, there is a broad consensus that a project represents a purposeful endeavor designed to produce a distinct outcome while adhering to constraints such as time, schedule, quality, and resources.

A project can be conceptualized as having a defined start and end (time constraints), specific objectives (performance specifications), a series of interconnected activities, and a finite budget (J. K. Pinto & Slevin, 1988a). Munns & Bjeirmi (1996) further define a project as the achievement of a designated objective through a series of resource-consuming activities and tasks. Adding a political dimension, they view projects as activities bound by time and space, aimed at achieving defined goals, and influenced by political, economic, and social contexts.

Turner (1990) emphasizes the essence of a project as a resource-organized effort to complete a distinct scope of work within budget and schedule constraints while meeting predefined objectives. Turner & Muller (2002) expand on this by describing a project as a temporary organization aimed at effecting change through a flexible, goal-oriented, and staged process. This process is characterized by uncertainty and transience, yet distinguished by its uniqueness and innovation. They discuss various functions of a project, including transience, production, change facilitation, resource utilization, and uncertainty management, ultimately defining a project as a temporary organization that allocates

resources for a unique, novel, and transient endeavor to achieve predetermined goals amidst uncertainty.

Illustrative examples of projects include developing new products or services, initiating changes in an organization's structure, implementing or adapting information systems, constructing buildings or infrastructure, or introducing new business processes or procedures (PMI, 2017). The goal of each project is to achieve its objectives, leading to either successful completion or termination (PMI, 2017). Another perspective describes a project as a series of multifunctional activities requiring limited budgeted resources, all directed towards achieving a specific objective within predefined specifications (Kerzner, 2022).

Finally, the Project Management Association of Japan (PMAJ, 2017) succinctly defines a project as "Activities that can actualize desires and dreams within a specific time limit."

2.1.2. Project Classification and Phases

Due to the unique aspects of construction projects, classifying the wide range of possible projects is particularly challenging (Young et al., 2011). Nonetheless, several authors in the construction management field have developed methodologies for effective project classification. Each classification scheme has a specific domain of application depending on the method employed. The use of these schemes by EPCs (Engineering, Procurement, and Construction firms), governments, general contractors, and researchers depends partly on the project's phase and the specific information required (Safa et al., 2015).

Safa et al. (2015) conducted a review to identify various methodologies for project classification in construction management, highlighting that each methodology has an optimal domain of applicability, ranging from general guides for rapid project classification to detailed schemes for project scheduling.

- Rule-of-Thumb Classification

Santana (1990) breaks down construction projects into three categories: singular, complex, and normal. This hierarchy orders a project according to decreasing degrees of social, economic, and environmental impact, and decreasing numbers of specialists, consultants, and contractors employed.

- Classification by Complexity:

According to Baccarini (1996), one method could be organizational / technological differentiation and connectivity. This method views the projects as complex systems consisting of many dimensions such as organizational, technical, environmental, informational, and decision making. Shenhar & Dvir (1996) propose assessing construction project complexity based on scope and technological uncertainty as another method of classification.

- Function-Based Classification

Tan & Lu (1995) suggest that construction projects can be grouped based on the type of construction work being undertaken.

- Project Classification for Supply Chain Management

According to Safa (2013), the construction projects could be classified with respect to their size, complexity, and risk tolerance (i.e.: mega projects, large, complex and basic).

- Project Parameters-Based Classification for Machine Scheduling

Brucker et al. (1999) propose a classification for project scheduling that describes the resource environment, activity characteristics, and objective function of the project, allowing for the modeling of project schedules with stochastic activity durations.

- **A Posteriori Project Classification Using Linear Discriminate Analysis**
Dvir et al. (1998) proposed a more natural, empirical project classification scheme using linear discriminant analysis to identify success factors across different project classes. Three major classification constructs emerged from his research; pure software vs. hardware projects, project scope (or complexity), and project outcome (i.e., a new facility, building renovation, etc.).
- **Project Classification for Strategic Portfolio Management**
A research comprised in (CII, 2011) interviewed a set of owners and contractors to extract the most common grouping approaches. As reported by contractors, prioritization is usually client and/or resource driven for contractors. This is due to the fact that client turn-around dates; construction windows, operating priorities, budgets, and human resources are significant determinants of a project's schedule.
- **Reference Class Forecasting**
According to Kahneman & Tversky (1979), introduced a method by framing the project in terms of previously completed projects in its reference class, an experience-based estimate of a project's performance. This research demonstrated how errors in judgment are systematic and predictable instead of random.

Regardless of classification, all projects exhibit a life cycle composed of distinct phases (PMI, 2017). While different industries and project sizes dictate diverse phase categorizations, Kerzner (2022) conceptual, planning, testing, implementation (execution), and closure phases are widely adopted. This sequence parallels (PMI, 2017) initiating, planning, monitoring and controlling, execution, and closing processes. These divisions constitute the project life cycle, a sequence of phases spanning project initiation to completion (PMI, 2017). The initiation phase establishes strategic institutional goals within the project's scope, selects key personnel, defines objectives, and outlines stakeholders. Planning involves strategizing to achieve project goals, followed by the execution of the plan in the Implementation Phase. The Closure Phase entails delivering outputs, transferring documents, closing contracts, and notifying stakeholders (Barron & Barron, 2020). Figure

2.1 illustrates the generic life cycle of a project, depicting resource requirements at their lowest levels during the early phases.

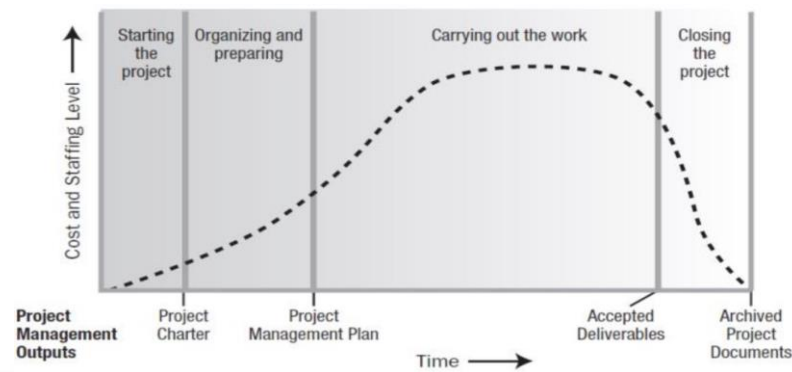


Figure 2.1. Staffing over the Life Cycle of the Project (PMI, 2017).

Below Figure 2.2 demonstrates how the phases interact with each other, and the flow of information in a subset of each phase.

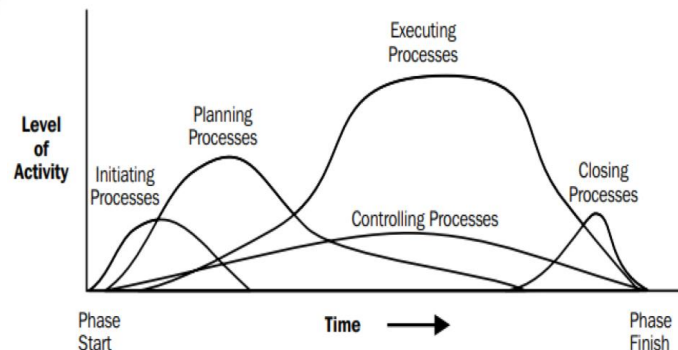


Figure 2.2. Process Groups (PMI, 2017).

A core skill set for everyone within the industry is the ability to manage projects, whether you work in project development, architectural design, engineering design, construction or facilities management. According to The Construction Extension to the PMBOK Guide (PMI, 2016) the project life cycle varies depending on the stakeholder's perspective. Figure 2.3 illustrates different perspectives in a project with a prediction lifecycle. For the developer, the project lifecycle begins with the formal decision to

undertake the project; for the developer, the lifecycle begins with the decision to tender, and the transition from the tendering to the engineering, contracting and/or construction phases takes place if the contract wins.

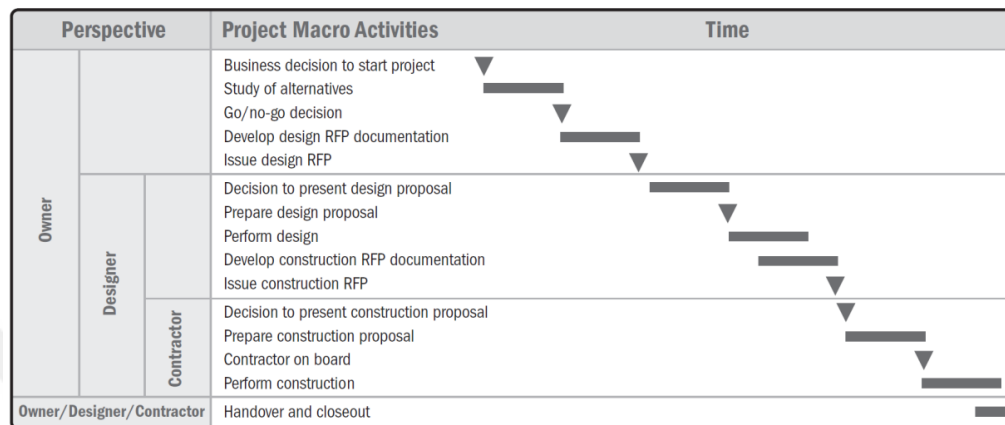


Figure 2.3. Various Perspective for a Project Life Cycle (PMI, 2017).

2.2. Project Management Standards

The term "standard" originates from medieval English and Old French languages. Historical evidence suggests that standards were employed in ancient civilizations like those of Egypt and Sumer, focusing on aspects such as urban planning and construction materials. The Babylonian civilization used standardized mass measurements and preserved original standards. During the Middle Ages, measurements such as inches, strokes, steps, fingers, and feet were standardized based on various body parts (Sönmez, 2010).

The concept of modern standardization began to take shape in the early 20th century, leading to the establishment of the BSI, the first national standards organization, in 1901. BSI defines a standard simply as an agreed-upon and replicable approach to conducting tasks. The latest 2023 BSI (BSI, 2023) definition of a standard is as follows:

"a standard is an agreed way of doing something. It could be about making a product, managing a process, delivering a service or supplying materials – standards can cover a huge range of activities undertaken by organizations and used by their customers."

The aftermath of World War II highlighted the challenge of using parts, materials, and ammunition produced by different nations, emphasizing the importance of international standardization. This led to the establishment of the International Organization for Standardization (ISO) in 1946. ISO is a globally recognized standards developer, defines a standard as;

"A standard is a document established by consensus and approved by a recognized and authoritative body that encompasses rules, guidelines, or characteristics of an activity or product for general and repeated utilization in a specific sequence and at an appropriate level."

With more than 1,000 Standard Developing Organizations worldwide, over half a million standards have been created. BSI, ANSI, DIN, AFNOR, TSE, JISC, ISO, and SAS are among the principal organizations publishing standards. Notable standards from these organizations include BS, ANSI, NF, TS, JIS, and DIN Standards.

Project management standards delineate the proper execution of project management practices, defining essential terms, responsibilities, phases, processes, methodologies, techniques, and tools. Applying identical processes and methodologies to all projects can impede success. Project management professionals must be adept at selecting suitable processes and methods for each project. To achieve this, they reference project management standards that articulate project management knowledge (PMI, 2017). These standards must be adaptable and free of excessive compliance requirements, allowing customization based on sectors (Sönmez, 2010).

In recent years, project management standards have shown increasing uniformity in structure and content. While variations exist in finer details, project management standards generally encompass the following elements (Ahlemann et al., 2009):

Terminology: Crucially, project management standards organize project management terminology, facilitating clear communication among practitioners.

Functions: Project management standards typically incorporate a functional breakdown of project management, achieved through sub-functions known as knowledge areas or by outlining primary tasks within project management knowledge areas. The functional breakdown typically does not prescribe the sequence for implementing project management functions.

Process Descriptions: Project management standards segment project management into processes executed to ensure successful project realization. Each process is characterized by inputs, the techniques and tools employed, and resultant outputs. Process descriptions elucidate the relationships between inputs and outputs required for processes.

Organizational Models: Increasingly, standards incorporate organizational models essential for project implementation.

Notably, construction projects, especially in project management, as (Lock, 2007) describes, entail unique risks and challenges in organization and communication. As a result, to meet sector demands, standards for managing construction projects have emerged from various organizations.

2.2.1. Construction Management Association of America (CMAA) and CMP

Founded in 1982, CMAA is North America's sole organization solely dedicated to construction and program management. With over six thousand members comprising engineers, architects, public and private sector professionals, CMAA prioritizes project excellence, encompassing timely completion, prudent cost management, and optimal resource utilization (CMAA, 2010).

CMAA's objective is to advance leadership, professionalism, and excellence in construction project and program management. The association strives to become a recognized authority in managing and developing construction projects and programs, guiding the acceptance and advancement of construction management as a professional

discipline. This is achieved through training, construction project management certification programs, and international conferences. Simultaneously, Standards of Practice for Construction Project Management (CMP) have been developed to guide construction project management.

CMAA asserts that a quality-focused, cost-effective, competitive, and risk-free professional construction management service necessitates a resolute commitment to managing processes aimed at achieving project objectives. The demand to address the intricacies of contemporary major projects, time sensitivity, unforeseen events, and the importance of integrated planning, design, and execution have been highlighted. Construction projects entail comprehensive endeavors demanding attention throughout conceptualization, design, construction, and project owner objectives fulfillment (CMAA, 2010).

The CMP standard, developed by CMAA for professional construction management, serves as an essential guide for engineers, architects, investors, educators, and more. The CMP standard delineates processes, project management knowledge areas, tools, techniques, and methods indispensable for successful construction project management.

Structurally, the CMP standard relies on a matrix encompassing six project management knowledge areas and five project management processes. These knowledge areas encompass tools, techniques, and methods required for effective construction project execution and include six core functions (Sorguç & Kuruoğlu, 2002):

- Project management
- Cost management
- Time management
- Quality management
- Contract implementation
- Safety management

These functions intertwine rather than operate independently, forming interrelated components of the project management process. The five project management phases in which construction project management knowledge areas are assessed are as follows:

- Pre-design phase
- Design phase
- Procurement and procurement phase
- Construction phase
- Post-construction phase

2.2.2. PMI and PMBOK

PMI was founded in 1969 in the USA by six project managers, PMI has primarily engaged with engineering, defense, and construction sectors during its initial ten years. By 2010, PMI had extended its reach to about 250 chapters in 70 countries, with over 420,000 registered members. The organization's primary mission revolves around bolstering the project management profession.

PMI's founding objective centers on promoting project management expertise and principles worldwide and elevating project management to a practiced profession adopted, assessed, and utilized by organizations. In pursuit of this, PMI has developed tools and techniques over four decades that span various activities. Activities range from individual certification and professional growth programs to developing standards for project management professionals, organizational competence programs, publications, individual career development programs, and project management research and development (Ata, 2009). PMI propels organizational transformation, advancement, innovation, and heightened competitiveness in project, program, and portfolio management (PMI, 2017).

PMI orchestrates professional development programs, seminars, conferences, and training worldwide to further project management's acceptance and development as a practiced profession. Additionally, PMI considers the PMBOK standard, developed by PMI,

a fundamental reference for professional development programs and certifications (PMI, 2017). PMI continually updates the PMBOK Guide (PMI, 2017) to reflect current practice. The first edition was endorsed in 1983 by an academic report entitled "Ethics Standards, Accreditation Committee Final Report", with subsequent editions in 2000 and updates culminating in the publication of PMBOK Guide (PMI, 2017) in 2017. According to this guide, a body of knowledge has been identified and accepted as sound practices in project management.

The PMBOK Guide 6th Edition (PMI, 2017) was phased out from 31 March 2022, and with significant changes, the PMI released the 7th Edition (PMI, 2021) of its PM standards book on 1 August 2021.

The PMBOK 7th Edition (PMI, 2021) shifts from a process-based approach to a principles-based approach. Project delivery focuses on principles and outcomes instead of processes, inputs, outputs, tools and techniques. Knowledge Areas no longer exist in the PMBOK as they are replaced by Performance Domains. The project performance domains are broad areas of focus for project management and project delivery that will have a focus on results. The eight Project Performance Domains mentioned above, which are (PMI, 2021);

- Stakeholders
- Team
- Development Approach and Life Cycle
- Planning
- Project Work
- Delivery
- Measurement
- Uncertainty

The 7th edition of the PMBOK (PMI, 2021) eliminates the five project domains of the 6th edition (PMI, 2017) and replaces them with 12 new project management principles.

These principles define the "what" and "why" of project delivery. Project delivery principles also describe a fundamental truth, norm or value and are not prescriptive. Therefore, in order to ensure the intended results of project delivery, project team members are advised to follow the following principles (PMI, 2021);

- Stewardship
- Team
- Stakeholders
- Value
- Holistic Thinking
- Leadership
- Tailoring
- Quality
- Complexity
- Opportunities & Threats
- Adaptability & Resilience
- Change Management

Finally, previous editions of the PMBOK Guide (PMI, 2017) consisted of 5 process groups: Initiate, Plan, Execute, Monitor & Control, and Close. In the PMBOK Guide 7th Edition (PMI, 2021), The Standard for Project Management will now cover the Value Delivery System, with its focus on delivering valuable results and value to the organization and its stakeholders (PMI, 2021).

2.2.3. International Project Management Association (IPMA) and ICB

IPMA intends to promote the development of project management professionals and the advancement of project management practice by formulating this standard. IPMA believes that in order to promote the project management profession, it is essential to establish a common project management language, similar to the ICB and PMBOK Guide. The ICB identifies a total of 46 competency components in three areas: technical

competencies, behavioral competencies and conceptual competencies. Each element contains the title, the content, the processes and the empirical evidence. At the end of each description, the relationships between these components are outlined (Ata, 2009).

IPMA's ICB encompasses essential terms, tasks, competencies, functions, management processes, methodologies, techniques, and tools commonly employed in project management. While detailed descriptions on how these components should be applied to projects are not provided, ICB forms the basis for certification programs and national project management associations affiliated with IPMA.

ICB emphasizes competencies essential for project managers rather than outlining project management processes and procedures. Accordingly, IPMA's "eye of competence" symbolizes these competencies, categorized as technical, behavioral, and conceptual, each forming a pillar of IPMA's project management philosophy (IPMA, 2006).

2.2.4. OGC and PRINCE 2

In 1975, the OGC initiated the "PROMPTII-Project Reporting, Organization & Management Planning Technique" project to foster project management's professional acceptance and develop management practices. In 1989, this initiative was renamed "PRINCE-Projects in Controlled Environments." The objective was to create a system for managing projects through logical, appropriate, coordinated, and well-defined activities. In 1996, supported by the British government and private sector, the PRINCE methodology was re-launched in a more generalized form, applicable to all public projects, and renamed PRINCE2.

PRINCE2, an English project management standard developed by the UK government, is an acronym for "PProjects In Controlled Environments". The addition of "2" signifies the second iteration of the PRINCE project. Initially targeted at the IT sector, the methodology evolved for broader applicability. PRINCE2's management and accreditation are overseen by the APMG, specializing in accrediting and certifying project management.

PRINCE2's adoption has extended beyond the UK to nations like the Netherlands, Belgium, Germany, Spain, South Africa, Australia, Poland, China, Denmark, and the USA (Ata, 2009).

PRINCE2 encompasses the formulation of standards governing project management practices and the certification of project management experts based on these standards (Ata, 2009).

2.2.5. PMAJ and P2M

The P2M project management system was established in Japan in the early 1980s to solve yield problems in agricultural companies. This model past experiences and studies on agriculture play an active role in the creation of played a role. In 1999, as global interest in project management continued to grow, the Japanese Ministry of Economy, Trade, and Industry proposed a unified system and practical guidelines to apply Japanese experience and knowledge to project and program management. This vision aimed to enhance Japanese industry's competitiveness (Sönmez, 2010).

With this vision, EAA established the Innovative Project Management Model Development Committee, chaired by Prof. Shigenobu Chara of Chiba Institute of Technology and staffed by project management experts with backgrounds in various sectors. After three years of research and development, the committee laid the groundwork for "P2M-Project and Program Management for Enterprise Innovation" (PMAJ, 2017).

In the late 1990s, extensive project management research was conducted in Japan. A robust project management department was established at Chiba Institute of Technology in 1997, and the JPMF emerged in 1998, fostering cross-industry communication and development among project management professionals, practitioners, educators, and sales experts. JPMF hosted Japan's first international project management conference in 2001, introducing "P2M-Project and Program Management for Enterprise Innovation" to the world (PMAJ, 2017).

According to P2M project management systematics characteristic features power of comprehensive thinking, power of strategic thinking, leadership, prudent behavior, realistic thinking, adaptability, successful human relations, results the ability to monitor is defined as a lifestyle (Caupin, 2006).

P2M aims to usher in a third generation by further evolving. Restructuring all systems holistically is essential in Japan, with corporate business structures, public works, and public services needing adaptation in response to environmental changes. This breakthrough necessitates holistic thinking rather than analytical skills. It involves a wide-ranging perspective, value appreciation, intuitive richness, forward-thinking, and the ability to envision future possibilities, enabling the grasp of holism. P2M's project management philosophy is centered on resolving intricate issues, interpreting and evolving breakthrough missions, and identifying appropriate solutions through programs involving reciprocal project relationships. In essence, P2M extends project management knowledge areas or competency standards to total project management (Sönmez, 2010).

2.3. Project Management Knowledge Areas

Across the globe, the construction sector holds significance as a driving force for a nation's economy, owing to its capacity to bolster national progress through amplified production, income, and employment (Unegbu et al., 2022). In today's rapidly evolving business landscape, marked by its dynamism, the construction industry faces the ongoing necessity to adapt and refine its project management approaches to effectively cater to escalating demands for quality that align with the diverse anticipations of stakeholders (Jeremiah et al., 2019). A significant proportion of projects within the construction domain encounter challenges and hurdles that lead to deviations from their intended objectives (Bassam, 2001).

As highlighted by Zwikael (2009), skillful project management is nurtured through their adept application in project administration. Consequently, an organization's adeptness and competitiveness within its sector can be gauged by its capacity to educate its project

management experts in the adoption of evolving project management methodologies for project oversight (Chou & Yang, 2012). This, in turn, amplifies project performance, as well as the general proficiency and efficacy in project management.

The incorporation of project management principles and methodologies plays a vital role in mitigating project failures (Angarita & Gallardo, 2018). The preeminent global body of knowledge in this area is outlined in PMBOK Guide (Zwikael, 2009). PMBOK Guide has evolved into a highly standardized framework (Bolooki & Bridge, 2007). It plays a central role as a fundamental reference for this approach and is endorsed by the globally renowned Project Management Institute.

A process can be defined as a series of interconnected tasks that must be executed to generate a predetermined product, service, or outcome (PMI, 2017). These processes serve as conduits to ensure a seamless progression of the project across its entire lifecycle. PMBOK Guide (PMI, 2017) categorizes project management processes into ten interconnected knowledge areas. While debates can arise about the precise number of these project management knowledge areas, the importance of these areas for achieving project success is universally acknowledged. These are as follows:

- Project Integration Management
- Project Scope Management
- Project Schedule Management
- Project Cost Management
- Project Quality Management
- Project Resource Management
- Project Communications Management
- Project Risk Management
- Project Procurement Management
- Project Stakeholder Management

The Construction Extension to the PMBOK Guide (PMI, 2016) introduced two additional knowledge areas (Project Health, Safety, Security and Environmental Management, Project Financial Management) to enhance the comprehensive management of construction projects.

Numerous researchers have also examined project management knowledge areas from a variety of industries and perspectives, shedding light on their importance in different contexts. The PMI-proposed knowledge areas have served as a foundation for numerous research investigations.

Crawford & Pollack (2007) conducted a cross-sectional study that spanned countries, industries, and application areas, examining nine project management knowledge areas. Hwang & Ng (2013) synthesized several project management knowledge areas in their research on green building. Oun et al. (2016) linked project management knowledge areas to factors contributing to project success. Rocha et al. (2015) assessed the relevance of project management knowledge areas for project success in the Portuguese construction sector. Zwikael (2009) examined the relative importance of nine project management knowledge areas in project planning. Some studies have concentrated on augmenting risk management (Hwang & Ng, 2013), fostering innovation (Toole et al., 2010), and enhancing technology and integration management capabilities (O'Connor & Yang, 2003) within construction firms.

In a different perspective, Dobgegah et al. (2011) identified 18 distinct project management competency areas, suggesting that the conceptualization of project management should extend beyond the traditionally emphasized project administration skills.

2.3.1. Project Integration Management

Integration refers to the coordination of processes, and integration management is a key component of project management that spans all areas of a project. This management

aspect ensures the successful synchronization of project activities. As highlighted by Asif et al. (2010), integration involves a purposeful process of constructing a governance structure, which imparts a more systematic approach to managing crucial stakeholder requisites. Eisner et al. (1993) defined integration management as a principal element of systems engineering. They introduce the concept of "integration engineering" delineating requirements, interfaces, interoperability, impacts, testing, software verification and validation, along with architectural development as key constituents. Furthermore, they elucidate integration management, where they specify the primary components as scheduling, budgeting and costing, configuration management, and documentation. These foundational constituents underpin systems engineering.

Project integration serves to aptly harmonize project activities. Hence, comprehending the impact of integration management on project success proves essential, enabling project managers to leverage the favorable aspects of well-coordinated project endeavors. A substantial body of existing research has amply underscored the critical role of effective integration within the domain of project management research (Berteaux & Javernick-Will, 2015; Halfawy & Froese, 2007; Ospina-Alvarado et al., 2016; Ozorhon et al., 2014; Tatum, 1990).

"It can be defined as interrelated and integrated processes that commence with outlining a project in the project charter and culminate in its closure" (Wysocki, 2011).

Furthermore, it can be refined as the process of harmonizing all dimensions of project planning, consolidating concurrent processes, aimed at fulfilling client and stakeholder expectations (Heldman, 2018).

Project integration management includes activities and processes aimed at identifying, designating, merging, consolidating, and synchronizing the processes and activities inherent to project management. In this area, choices regarding resource allocation and trade-offs between objectives and alternatives need to be made (PMI, 2017). Richman (2011)

characterizes project integration management as the process of overseeing all project activities, ensuring their cohesive alignment, consolidation, and integration.

According to the PMBOK Guide (PMI, 2017), the concept of project integration management comprises the skillful coordination of various project management components. This involves making trade-offs between objectives and changes to better meet stakeholder expectations. It entails processes that describe and ensure the necessary elements for project management integration, with three major processes: project plan development, project plan execution, and integrated change control. These processes play a pivotal role in construction management. Within project integration, five fundamental sequential steps are implemented:

- Initiation
- Planning
- Execution
- Monitoring and controlling.

In the context of project management, the integration management knowledge area delineates project boundaries and embodies unification, consolidation, articulation, and integrative means for all pivotal activities necessary for successful project completion (PMI, 2017). This role constitutes a core responsibility of any project manager, entailing the cohesive orchestration of all project components (Mulcahy, 2013). The integration management knowledge domain necessitates a comprehensive perspective on the project from inception to closure (Mulcahy, 2013).

Within the project integration knowledge area, the project's boundaries and critical aspects such as assumptions, success criteria, and the extent of the project manager's authority are delineated. Inadequate application of integration management knowledge can hinder the integration of key project constraints. These constraints include cost, time, scope, quality, risk and resources (Mulcahy, 2013).

According to the PMBOK Guide (PMI, 2017), integration management knowledge comprises six processes: developing a project charter, devising a project management plan, directing and managing project execution, monitoring and controlling project work, performing integrated change control, and closing out projects or project phases.

2.3.2. Project Scope Management

The statement of project scope represents an agreement between the customer and the project, explicitly defining the project's production parameters. Project scope management involves the processes required to ensure that the project encompasses all necessary work for successful completion, excluding extraneous efforts (PMI, 2017). Managing project scope primarily involves defining and controlling the inclusions and exclusions within the project. This concept of inclusion and exclusion is vital in construction project scope management. In the initial stages of a construction project, client requirements and needs might be incomplete or inaccurate (T. C. Williams, 2011).

Project scope management includes the delegation of functions and the development of scope data to establish boundaries and break down the work into manageable components. Furthermore, this process ensures the verification of completed planned work (Heagney, 2012). It includes all activities related to the implementation of the project and involves distinguishing tasks that are relevant to the project objectives (Alwaly & Alawi, 2020).

According to Heldman (2018), the scope of project management includes product scope description, product acceptance criteria, project deliverables, project exclusions, project constraints and project assumptions. In addition, it involves processes aimed at defining all tasks, operations and project requirements, while identifying and eliminating irrelevant components.

One of the reasons for project failure lies in ill-defined processes, tasks, and their associated needs. To ensure project success, requirements must be meticulously defined through continuous communication with project stakeholders (Wysocki, 2011). Earlier

researches confirms that organizations systematically implementing all processes within the scope management knowledge area enhance their chances of project success and improved business outcomes (PMI, 2017).

PMBOK Guide (PMI, 2017) describes the project scope management as a set of essential procedures to confirm the project's comprehensiveness and effective completion. According to the PMBOK Guide (PMI, 2017), project scope management knowledge comprises six processes: plan scope management, collect requirements, define scope, create WBS, validate scope and control scope.

2.3.3. Project Schedule Management

Time management can be said to be the act of planning, scheduling and exercising conscious control over the limited amount of time spent on project specific activities, particularly to increase their effectiveness, efficiency or productivity (Oburu, 2020).

Lewis, (2007) considers project time management as an extension of individual time management, where efforts are directed toward establishing achievable schedules and ensuring their adherence.

Kerzner (2022) details key processes within project time management, including defining actions, organizing tasks, estimating resource needs, predicting activity durations, creating schedules, and maintaining control.

Heldman (2009) defines this area as concerned with estimating activity durations, devising project schedules, and overseeing schedule deviations. Effective time management maintains project alignment and on-time delivery.

Richman (2011) defines project schedule management as the effective and efficient utilization of time to accomplish project tasks, preventing delays in project delivery.

According to Solis-Carcaño and Corona-Suarez (2016), the delays on the deliveries are one of the most frequent problems affecting project with close to 47%, resulted from a poor application of project time management.

PMBOK Guide (PMI, 2017) outlines the evolution of Project time management from simple methods to sophisticated computer-assisted techniques like CPM and graphing for various applications. For smaller projects, a bar chart suffices for effective time management, though its use requires discretion to avoid oversimplification. As per the PMBOK Guide (PMI, 2017), project schedule management knowledge comprises six processes: plan schedule management, define activities, sequence activities, estimate activity durations, develop schedule and control schedule.

2.3.4. Project Cost Management

Project cost management refers to a collection of processes essential for orchestrating cost-related aspects of a project. These processes encompass planning and estimating costs, budgeting, project funding, financial resourcing, and the oversight and regulation of project costs to ensure the project's successful realization according to the predetermined plan (Aničić & Aničić, 2019).

This domain of knowledge, referred to as project cost management, encompasses the management of project costs and budgets, the intricacies of cost analysis, and the identification of funding sources. The aim is to ensure project delivery and the smooth flow of funds in line with the approved budget (Heldman, 2009).

The accomplishment of a project within the stipulated timeframe and allocated budget is a task fraught with challenges. The effectiveness of project planning, starting from the initiation phase, plays a pivotal role in determining the success of this endeavor. The prevalence of exceeding budgets and timelines leads to discontent among stakeholders Ramabodu and Verster (2013) and undermines the credibility of the project management discipline. In a project environment, the interdependence of project time management and

project cost management is strikingly evident, as highlighted by Mulcahy (2013). Consequently, project delays often coincide with cost overruns in many projects.

The PMBOK Guide (PMI, 2017) asserts that project cost management encompasses the necessary procedures to ensure adherence to the approved budget and the successful completion of the project. It provides an overview of resource allocation, cost estimation, cost planning, and cost oversight. As per the PMBOK Guide (PMI, 2017), project cost management knowledge comprises four processes: plan cost management, estimate costs, determine budget and control costs.

2.3.5. Project Quality Management

Project quality management is defined as the process in which quality is assured and controlled in all activities and inputs of project, using quality assurance and quality control techniques, where project quality is assessed and reviewed in a continuous and regular manner (Westland, 2006). Therefore, project quality management is the process in which quality is assured and monitored using quality assurance and quality control techniques, and project quality is assessed and reviewed in a consistent and regular manner (Westland, 2006).

Hendrickson & Au (1989) reports that inadequate project quality management leads to substantial costs and delays.

Mulcahy (2009) explains that quality management encompasses overseeing processes and activities to ensure a project fulfills the specific requirements anticipated from the customer's perspective. In essence, this equates to executing the project without deviations from its intended obligations. Quality administration involves the steps of designing quality, executing quality assurance, and performing quality control.

Muldoon (2014) affirms that quality management is relevant across all projects and emphasizes the significant risks and trade-offs associated with maintaining quality. He

emphasizes a crucial distinction between 'grade' and 'quality', where quality refers to the extent to which requirements are met, while grade refers to design considerations.

As per the PMBOK Guide (PMI, 2017), Project Management encompasses the necessary processes to ensure the project aligns with its intended purpose. In industries like construction, this involves verifying that project requirements and processes align within the established timeframe and budget. It encompasses all activities within general management that govern quality plan objectives and tasks, directing them through methods like quality planning, assurance, control, and enhancement, all within the framework of the quality arrangement.

The PMBOK Guide (PMI, 2017) also highlights the importance of integrating quality into the planning, design, and construction phases rather than relying solely on inspection. The expense of preventing errors upfront is generally far lower than the cost of rectifying them after detection through inspection (PMI, 2017).

The PMBOK Guide (PMI, 2017) recommends three distinct processes to ensure project quality: plan quality, perform quality assurance, and perform quality control. Implementing these processes systematically would elevate the project's quality right from the planning phase, effectively curbing the need for rework and the subsequent escalation in both time and cost overruns.

2.3.6. Project Resources Management

Lewis (2007) defines project human resource management as the process of identifying the people needed to complete a project, defining their roles and responsibilities, and obtaining those people. He notes that this does not include the day-to-day management of individuals.

Heldman (2009) expands on Lewis' definition by stating that project human resource management also includes the training, motivation, and performance evaluation of project

team members. She also notes that the project manager must use different communication styles and management techniques depending on the specific needs of the project team.

Buchner (2015) defined the process of considering the physical resources, such as materials and equipment, that will be needed to complete a project and when they will be needed and added the fact that in the event of a resource shortage, proper procedures should be taken to mitigate the impact.

Resource Management refers not only to the human workforce, but also to the physical resources (such as materials, equipment, licenses, etc.) that can be part of a project and contribute to its success according to the PMBOK Guide (PMI, 2017). As per the PMBOK Guide (PMI, 2017), involves estimating and allocating the right resources to the right opportunity and utilizing them efficiently for successful project delivery. There are six major processes for Project Resource Management in the sixth edition of PMBOK Guide (PMI, 2017): plan resource management, estimate activity resources, acquire resources, develop team, manage team and control resources.

2.3.7. Project Communications Management

Project communication's management can be described as the 'process aimed at ensuring that essential information reaches decision-makers promptly to mitigate project risks, while also archiving project data and information for future use (Heldman, 2018).

Effective communication benefits both the successful completion of projects and the overall atmosphere of the workplace. The practices of arranging meetings, developing ways of contacting other team members, deciding on communication techniques and encouraging co-operation are all examples of how project management objectives can help to create or improve the ability of teams to communicate with each other. Setting communication-related goals can support the overall goals of the project, which can make teams more productive (Shanthi et al., 2023).

In order to sense and react quickly and to ensure rapid decision-making, lines of communication should be the shortest possible between all levels of the organization. People with the most knowledge must be available at the source of the problem, and they must have decision-making authority and responsibility (Kerzner, 2022).

In essence, this domain encompasses the essential procedures and actions required to ensure flawless information transfer at the right moment, encompassing communication planning, information distribution, performance reporting, and stakeholder management (N. K. Nassar, 2005).

Recognizing the significance of communication management is pivotal for any CPM because their entire undertaking hinges on effective communication. It is estimated that project managers dedicate as much as 90% of their time to communication-related activities (Mulcahy, 2013).

PMBOK Guide (PMI, 2017) emphasizes that effective communication provides a vital link between the various stakeholders involved in a project, bridging different cultural and organizational backgrounds, different levels of expertise, and different perspectives and interests regarding project delivery or outcomes. "Project communication management encompasses communication planning, information dissemination, stakeholder relationship management, and performance reporting".

Given the paramount importance of communication, it is imperative for CPMs to ensure the robustness of their communication management processes. The PMBOK Guide (PMI, 2017) recommends following three distinct processes to ensure seamless communication management in a project setting: plan communications management, manage communications and monitor communications.

2.3.8. Project Risk Management

"Project risk management is defined as the process of devising plans and scenarios to address the uncertainty inherent in our ever-changing environment, ensuring that project activities are carried out within the expected timeframe and budget" (Meredith & Mantel, 2012). Therefore, risk management constitutes a systematic practice aimed at identifying and mitigating threats within the project and its surrounding environment.

Risk management stands as a fundamental element in ensuring project success, yet it is frequently either overlooked or insufficiently prioritized (P. A. Thompson & Perry, 1992). The process of risk planning initiates during the project development phase and continues throughout the definition and planning stages (Verzuh, 2016)

According to the PMBOK Guide (PMI, 2017), the focus of a Certified Project Manager's (CPM) work should be on prevention rather than problem-solving, while also providing solutions if issues do arise. The PMBOK Guide (PMI, 2017) outlines seven key processes for project risk management: plan risk management, identify risks, perform qualitative risk analysis, perform quantitative risk analysis, plan risk responses, implement risk responses and monitor risks. Adherence to these processes can help to ensure that potential threats are addressed in a proactive manner before they materialize (Stern & Arias, 2011).

2.3.9. Project Procurement Management

PMBOK Guide (PMI, 2017) defines procurement as the process of procuring supplies of goods and services to successfully execute a project within prescribed time and quality standards.

Duncan (1996) asserted that project procurement management encompasses the essential procedures for acquiring services and goods from external organizations. In the broader context, construction projects are typically not overseen by the end users or project

owners; instead, they are managed by different service providers under the guidance of a CPM. The efficient management of procurement is of utmost importance in realizing the project's objectives. Consequently, procurement assumes a pivotal role within the project management process (Pautz et al., 2003).

According to Lewis (2007), procurement represents an essential aspect of securing services and goods for the project, serving as the logistical component of job management. It encompasses decisions regarding what needs to be procured, the issuance of requests for bids or quotations, vendor selection, contract administration, and the closure of contracts upon project completion.

Procurement management's success requires accomplishing a variety of factors, prominent among which are good relations with suppliers, capability to purchase in large quantities confront emergencies that may occur, multiple sources of supply, availability of negotiating team capable of obtaining the best purchase conditions, capability to meet project needs at the minimum level of materials (Olateju et al., 2012).

The PMBOK Guide (PMI, 2017) provides three structured procurement processes that CPMs should adhere to, with consideration of risk management processes and all other organizational processes as valuable assets to ensure project success, even in the face of potential challenges. These procurement processes are as follows: plan procurement management, conduct procurements and control procurements.

2.3.10. Project Stakeholder Management

The term stakeholder is defined as “any group or individual who can affect or is affected by the achievement of the firm's objectives” (Freeman, 2010). According to (PMI, 2017), a stakeholder is defined as an individual or entity that has a vested interest in a project, either as an active participant or as a party whose interests could be affected by the project's implementation or termination.

Construction involves several complex activities. Each stakeholder has a different level and type of investment and stake. The involvement of stakeholders before a decision is made is considered crucial for construction projects (Eschenbach & Eschenbach, 1996).

According to Cleland (1999) and Karlsen (2002), successful project delivery depends on managing multiple stakeholders and maintaining an acceptable balance between their interests. Jergeas et al. (2000) also proposed that in order to achieve alignment between the project team and the stakeholders, it is essential to first ascertain the purpose of the project and to solicit feedback from the latter. It is possible to overcome many problems if the stakeholders are engaged in the early stages of planning and integrated into the project team. Furthermore, if a systematic approach is used to identify and manage stakeholders throughout the project delivery process, this will also have a positive impact on the project (Jergeas et al., 2000).

Project stakeholder management involves processes aimed at the identification of individuals, groups, or organizations that can influence or be impacted by the project. Subsequently, it entails the analysis of stakeholder expectations and their potential influence on the project (PMI, 2017).

PMBOK Guide (PMI, 2017) recommends following four distinct processes to ensure seamless project stakeholder management as; identify stakeholders, plan stakeholder engagement, manage stakeholder engagement and monitor stakeholder engagement.

2.3.11. Project Health, Safety, Security, and Environmental Management

In the construction extension of the Project Management Institute (PMI, 2016), safety management is defined as comprising the procedures necessary to ensure that a construction project is executed with due consideration for accident prevention. Accidents resulting in property damage, personal injuries, and even fatalities have long been and continue to be a major concern within the construction industry.

The objective of safety management is the safe delivery of a project without accidents, injuries or damage (Zack, 2004). Construction projects, by their very nature, have an impact on the environment. Environmental management of projects is thus vital, particularly in terms of ensuring that future generations are not worse off than the present in terms of sustainable development. It must ensure that a project operates within the boundaries set by legal approvals and that there is no violation of various government approvals, regulations and conditions (Zack, 2004).

As T. M. Williams (2000) has recommended, it is imperative to enhance site safety, especially in light of the increasing complexity of modern construction projects. Construction sites are characterized by a high density of workers engaged in various high-risk tasks, such as working at heights, outdoor activities, and the operation of heavy machinery and equipment (Tam et al., 2004). Construction sites are considered to be one of the most dangerous working environments. Therefore, attention to safety and the management of safety is crucial (Fisk & Reynolds, 2010).

Human performance is undeniably intertwined with safety (Bottani et al., 2009). This concern stems from both humanitarian losses and the direct and indirect costs borne by the industry. Project safety management in construction projects encompasses three major processes: safety planning, the execution of safety plans, and the administration and reporting of safety measures. Notwithstanding the human factor, legislation, non-compliance, penalties and accident related costs, the effective implementation of occupational health and safety is intended to result in the successful completion of a project within the project parameters of cost, time and quality (J. J. Smallwood, 2007).

Project health, safety, security, and environment management is added as a knowledge area in the Construction Extension to the PMBOK Guide (PMI, 2016). The purpose of health, safety, security, and environment management is to prevent accidents so as to avoid personal injury, fatalities, or property damage by project owner, sponsor or contractor in terms of determining and complying with the safety and environmental policies, objectives, and responsibilities (PMI, 2016).

2.3.12. Project Financial Management

Haupt & Padayachee (2016) proposed that the implementation of an effective financial management strategy is a key factor in the success of any construction business. Tengan et al. (2016) puts forth the proposition that the successful completion of a construction project is contingent upon a number of factors, including the level of financial resources available, the performance of the organizational structure, the implementation of appropriate financial management strategies, the projected completion time for the project, and the managerial input of the relevant personnel involved.

Bell (2003) defines financial management strategy as the capacity of corporate organizations to evolve from merely having the ability to attain a level of financial competence that may facilitate the delivery of their optimal performance.

According to the Project Management Institute (PMI, 2017), project financial management encompasses the comprehensive management, acquisition, and control of financial resources to support revenue generation. In the context of construction projects, financing can be approached from various perspectives.

From the perspective of the project owner, it is crucial to consider their interactions with other organizations involved in the project. The project owner could be from either the public or private sector, and construction projects can vary in size, including small-scale, medium-scale, large-scale, and megaprojects. Additionally, financing arrangements may be categorized as either long-term or short-term, which impacts the chosen financial solutions for the project (PMI, 2016).

According to the Construction Extension to the PMBOK Guide (PMI, 2016), project financial management involves the planning, monitoring, and controlling of the organization's financial resources. This area is directly associated with top management and is crucial for ensuring effective financial oversight throughout the project lifecycle.

2.4. Performance in Construction

Ogunlana & Toor (2010) have indicated that traditional performance criteria alone can no longer serve as the exclusive yardstick for gauging project success. This shift is attributed to changing user demands, evolving environmental regulations, and the shifting roles and functions of buildings. Scholars often draw a distinction between project management success and project success when endeavoring to measure success, as these two, while interconnected, can exhibit significant differences (Baccarini, 1999; Cooke-Davies, 2002; De Wit, 1988).

2.4.1. Project Performance

Traditionally, the construction industry has focused on project performance, with studies by Ward et al. (1991) and Mohsini & Davidson (1992) highlighting this emphasis. Performance assessment for both projects and contractors centered around achieving client objectives, such as cost, time, and quality (Mohsini & Davidson, 1992; J. Smallwood & Venter, 2001; Ward et al., 1991).

Although these three measures; cost, time, and quality provide an indication of project success, they do not offer a comprehensive view of overall project performance when considered in isolation. Moreover, these indicators typically reveal their impact only at the project's conclusion. Kagioglou et al. (2001) propose that these measures are lagging indicators rather than leading indicators of performance. International research supports this view, indicating that performance related to cost, quality, and schedule is influenced by additional factors such as health and safety, productivity, environmental performance, and employee satisfaction (J. Smallwood & Venter, 2001).

2.4.2. Project Management Performance

Performance in project management is defined by the achievement of successful project outcomes, which relies on team members consistently delivering high-quality work

and effectively applying their skills to complete project tasks such as procurement, communication, and integration (Abuazoom et al., 2017). This concept also underscores the process of generating positive outcomes and demonstrates how management decisions can influence performance (Lannon, 2019). Reich et al. (2014) describe performance as the accumulation of benefits resulting from project implementation.

Employee performance is further defined by how employees translate organizational goals into tangible results and align their interpersonal interactions with organizational standards (Osman et al., 2016). Organizational performance is comprised of four main elements: general, technical, administrative, and human (Ratnawat & Jha, 2014). The exchange of resources and knowledge, along with the benefits of knowledge integration and specialization, positively impacts innovation performance in inter-organizational collaboration. Consequently, improved innovation performance contributes to the overall performance of the organization (Cho et al., 2017).

Gaining a competitive advantage has become a central objective for organizations, prompting companies worldwide to undertake various initiatives to achieve and sustain a competitive edge within their industries (Kagioglou et al., 2001; R. S. Kaplan & Norton, 2009)

Given the impact of construction on the global economy, performance measurement in the context of construction is also critical. Therefore, effective project management is essential for higher construction performance (Demirkesen & Ozorhon, 2017b). In a similar study, Anantatmula (2015) revealed that in order to improve project performance, it is necessary to establish governing policies and procedures, an effective communication management plan, and a cooperative culture for the project. In addition, advances in knowledge are needed to push organizations to manage the performance of project teams optimally (W. H. Liu & Cross, 2016).

2.4.3. Performance Measurement

The process of performance measurement is the determination of how successful organizations or individuals have been in the achievement of their goals and strategies. It is a process of quantifying the results of a company's strategic and operational policies to monitor the qualitative signs of a company (Kagioglou et al., 2001). Thus as suggested by Bititci et al. (1997), Performance measurement systems are information systems central to performance management and are essential for performance management to work effectively.

Companies had a significant imperative to assess their standing within their respective industries, identify areas requiring improvement, and devise strategies for influencing the behavior of their subordinates, as highlighted by (Neely, 1999). The process of performance measurement serves as the means by which organizations and individuals gauge the extent to which they have successfully achieved their objectives and strategies. This entails quantifying the outcomes of organizational and operational strategies to effectively monitor the qualitative aspects of organizational performance, as proposed by (Kagioglou et al., 2001). Thus, it can be asserted, in alignment with the perspective of Bititci et al. (1997), that the performance measurement system functions as the core information system driving the performance management process and plays a critically vital role in ensuring the effective and efficient functioning of the performance management system.

In the period leading up to the 1980s, project performance was conventionally defined in terms of cost and time adherence and compliance with product specifications, as outlined by D. J. Bryde (2003). However, research conducted during the 1980s and 1990s aimed to investigate the dimensions of project success, leading to a consensus that project success is multifaceted, with diverse individuals measuring it in various ways and at different points in time, as evidenced by Ugwu & Haupt (2007).

Lynch & Cross (1992) developed the SMART model for strategic measurement analysis and reporting as part of the measurement process, while T. J. Brignall et al. (1991)

extended the nonfinancial perspective and proposed the division of performance criteria into determinants and outcomes. T. J. Brignall et al. (1991) extended the non-financial perspective to the service sector and proposed the classification of performance criteria into drivers and outcomes. Issues relating to the identification and use of project-related objectives within a project-owning client organization were considered by Ward et al. (1991). T. J. Brignall et al. (1991) distinguished between results and their determinants, while Azzone et al. (1991) emphasized the importance of time criteria in their matrix for time-based organizations.

Performance measurement systems rooted in financial metrics struggled to adapt to the industry's recent transformations, driven by emerging technologies and heightened competition, as noted by R. Kaplan & Norton, (1992). R. Kaplan & Norton (1992) introduced the concept of the "balanced scorecard" highlighting four perspectives for measurement. The balanced scorecard, as further elaborated in R. Kaplan & Norton (1996), emerged as a strategic performance management system. Cooper et al. (1992) similarly defined four perspectives for business measurement, while Adams & Roberts (1993) introduced the EP2M model, as outlined by Olve et al. (1999). All of these frameworks emphasized the translation of performance measurement from strategy.

Advances in performance measurement depend primarily on seven key factors identified by Neely (1999) as the changing nature of work, increased competition, specific improvement initiatives, national and international quality awards, changing organizational roles, changing external demands and the influence of information technology. Neely et al. (2001) also argue that the needs and contributions of stakeholders should have priority over strategies, processes and capabilities in the performance measurement process.

Similarly, in the context of project management, it becomes essential to gauge the maturity of project management implementation using a robust framework that centers on performance enhancement, as emphasized by Miklosik (2015).

Effective team evaluation, as emphasized by Marriage & Kinnear (2016), acts as a catalyst for improved performance by providing teams with reliable and timely feedback. Therefore, as emphasized by Montero et al. (2015), project management should prioritize the execution, monitoring and control of activities by employing valid metrics to ensure successful outcomes. Furthermore, according to Heinze & Heinze (2020), organizations should be prepared to employ performance metrics for project control systems to gather authentic information that is critical for decision-making at various levels of governance, including executives, board members, contextual leaders, and individuals.

2.4.4. Benchmarking

Camp (1989) authored the inaugural book on benchmarking, offering a defining description of the practice: "Benchmarking is the ongoing procedure of comparing products, services, and methods with the most formidable competitors or the companies acknowledged as leaders within the industry."

According to Bhutta & Huq (1999), performance benchmarking is outlined as a means of assessing a company's quality by comparing its performance metrics with those of other companies.

The CII has embraced a particular definition of benchmarking, as presented by Hudson (1997) and cited in El-Mashaleh et al. (2007): "Benchmarking is a systematic approach to assessing one's performance by comparing it to the outcomes achieved by acknowledged leaders, with the aim of identifying and implementing best practices that can lead to enhanced performance."

Types of benchmarking can be categorized in various ways, and one common classification is based on the benchmarking environment. Under this classification, benchmarking falls into three categories: internal, competitive, and functional. Internal benchmarking entails comparing the performance of similar business units within the same organization, such as different branches, geographically dispersed subsidiaries, and

divisions. Competitive benchmarking involves assessing an organization's products, services, and performance in direct comparison to its competitors within the same industry. Functional benchmarking, on the other hand, seeks to identify best practices from various types of organizations and then compares a company's performance to these best practices applied in different fields (Camp, 1989; Rankin et al., 2008; Watson, 2007).

Benchmarking can be categorized based on its application level into the following levels:

- Task level; involves specific activities related to a project, such as the placement of steel or concrete (Rankin et al., 2008).
- Project level; encompasses aspects related to the entire project, including factors like project cost, various phases within the project life cycle, design and construction timelines, cost and time predictability, health and safety considerations, and client satisfaction (Rankin et al., 2008).
- Organization level: This focuses on the broader performance of the company as a whole, including metrics like profitability, productivity, training programs, human resources management, and innovation capabilities (Rankin et al., 2008).
- Industry level: Here, the focus extends to the industry as a whole, assessing aspects like industry-wide productivity, innovation potential, overall image, and the management of human resources within the industry (Rankin et al., 2008).
- Economy level: At this level, benchmarking considers factors affecting the broader economy, such as international competitiveness, financial capacity, and overall productivity (Rankin et al., 2008).

Benchmarking stands as a crucial tool for continuous improvement, allowing companies to elevate their performance by discovering, adapting, and implementing best practices within a collaborative group of participating firms (Knuf, 2000; Smith, 1997).

While many perceive benchmarking as mere imitation, I. Thompson & Cox (1997) argue that it fosters innovation rather than replication. When utilized effectively, benchmarking becomes a potent instrument for enhancing productivity in the construction industry.

Sprow (1993) emphasizes that to succeed in benchmarking, it must be viewed as a process of improvement rather than an exposure of weaknesses. It's crucial to have a clear definition of company processes, strategic objectives, and a well-defined plan for what to benchmark and how to measure it. Furthermore, maintaining a customer-centric approach and understanding customer needs are fundamental prerequisites for successful benchmarking (Marosszeky & Karim, 1997).

The benchmarking process can also serve as a means to identify critical success factors or performance metrics for a company. It entails systematically and continuously measuring and comparing a company's business performance with industry leaders, with the aim of adopting the best practices for improvement (Poister, 2008).

Effective measurement requires an understanding of critical success factors and entails making comparisons. These comparisons can gauge progress towards specific goals, track performance trends over time, or assess one organization's performance relative to another's (Poister, 2008).

2.4.5. EFQM Excellence Model

The EFQM Excellence Model developed by the European Foundation for Quality Management is based on the philosophy of TQM. EFQM was established in 1988 by 14 leading European companies. The aim of the Foundation was to assist company

managements in adapting and implementing TQM principles and ensuring continuity in their implementation, thereby increasing the competitiveness of European Industry (KalDer, 2003).

The EFQM model is a performance measurement tool that identifies optimal strategies for enhancing organizational performance (Wongrassamee et al., 2003). In contrast to the traditional approaches to measurement processes, the EFQM model offers the possibility of transforming organizational strategies into business objectives (Kueng, 2000) and it enables organizations to assess the historical context, the present situation and future outlook simultaneously (Conti, 2007). Furthermore, the EFQM model emphasizes the concept of continuous development, which can be beneficial for organizations across a range of sectors. The model enables companies to identify and enhance their strengths in nine key areas, facilitating further growth and improvement (Hıdıroğlu, 2019).

The implementation of the EFQM Model represents a strategic decision that will not only enhance operational effectiveness but also reinforce the organization's market position as a leader in operational excellence, innovation and sustainable development (Martusewicz et al., 2024).

The EFQM Model in Figure 2.4 is structured around three principal domains (Direction, Execution, Results), seven key criteria (Purpose, Vision & Strategy; Organizational Culture & Leadership; Engaging Stakeholders; Creating Sustainable Value; Driving Performance & Transformation; Stakeholder Perceptions; Strategic & Operational Performances), and each criterion is further divided into criterion parts, resulting in a total of 32 criterion parts. Each criterion part contains a number of detailed guidance points that are worthy of consideration when managing an organization.



Figure 2.4. EFQM Model Structure (The EFQM Model 2025, 2024).

For over 35 years, EFQM has facilitated positive change, guiding over 50,000 organizations on their distinctive pathways. The latest iteration of the EFQM Model 2025 has been developed to place a significant emphasis on purpose, vision, strategy, organizational culture, leadership, stakeholder engagement, the achievement of meaningful and sustainable outcomes, and continuous improvement practices (The EFQM Model 2025, 2024)

The recently unveiled EFQM Model 2025, unveiled in Istanbul in June 2024, introduces substantial alterations to the existing model. These alterations place a significant emphasis on sustainability, innovation, and technology. The aforementioned changes are analyzed based on the following three questions: The three key questions that underpin the EFQM Model 2025 are: Why, How, and What. The necessity for improved alignment of organizations with contemporary challenges through flexibility, risk resilience, and innovation capabilities in a dynamic business environment, including alignment with the UN Sustainable Development Goals (SDGs), is clear. The model introduces an integrated approach to performance management and transformation, incorporating advanced technologies such as AI and data analytics (Martusewicz et al., 2024).

The evolution of the model incorporates several key elements, including the incorporation of RADAR logic, clarification of sustainable value, a focus on technology leadership, enhancements in leadership aspects, adaptation to changing work environments, segmentation of results, changes in the RADAR structure, and the introduction of a scoring system with different performance levels. Collectively, these elements provide a comprehensive framework for organizations to assess their performance, meet stakeholder expectations, plan for the future, and drive continuous improvement (The EFQM Model 2025, 2024).

The acronym RADAR is used by EFQM to describe the logic behind the diagnostic tool it has developed to assist organizations in:

- Effectively managing their current operational procedures,
- Identifying their current strengths and potential areas for improvement (The EFQM Model 2025, 2024).

By leveraging data-driven insights, an organization can:

- Guarantee the prompt, dependable, and precise generation of results, which should be classified in a manner that facilitates the acquisition of meaningful insights.
- Analyze data trends in order to provide effective direction for the organization.
- Establish ambitious targets that are aligned with the organization's overarching strategy.
- Conduct external comparisons in order to effectively position performance.
- Establish confidence in the ability to sustain results based on an understanding of cause-and-effect relationships, data analytics, and performance patterns.
- Develop and disseminate an effective communication strategy for the value creation process.
- Provide customers and stakeholders with the value they seek.
- The provision of a unified and coherent experience for all stakeholders must be defined and implemented.

- Effectively manage assets and resources.
- Data sets demonstrating stakeholder perceptions, strategic and operational performances, and results related to specific criteria be utilized.
- Apply the RADAR matrix charts for the structured performance evaluation.
- The necessary data should be identified and used to support transformation plans and manage performance effectively.
- Artificial intelligence, advanced analytics, and predictive models should be utilized for actionable insights.
- Data, statistical algorithms, and machine learning techniques should be utilized to predict future trends and outcomes.
- Evidence-based assessments, technology platforms, data analytics, and performance measurement tools should be utilized for informed decision-making and performance improvement. (The EFQM Model 2025, 2024).

2.4.6. Key Performance Indicators

The construction industry is known for its ever-evolving and challenging nature (Rehman et al., 2020). Despite significant technological advancements and innovation efforts to stay competitive, the construction sector grapples with persistent performance challenges such as project delays, cost overruns, and quality issues (A. Enshassi et al., 2012; Rathnayake & Ranasinghe, 2020). In the context of construction projects, KPIs have gained widespread adoption for evaluating performance, offering valuable insights into project quality and outcomes (Q. He et al., 2021).

KPIs are measures that are used to evaluate the performance of a variety of processes. These indicators are typically used to analyze an organization's performance against a specific set of performance measures. The main purpose of KPI is to implement the concept of benchmarking across different industries and business processes and products. Measuring the actual performance of various aspects of an organization and comparing these metrics with industry best practice is the basic concept behind the use of KPIs. KPIs are also used in

the management of projects in order to assess the actual performance in relation to the desired results (Demirkesen, 2016).

The Rethinking Construction report (Egan, 1998) directly informed the subsequent annual performance reporting for the construction sector in the UK. It was presented to the UK Deputy Prime Minister at the time, and its scope was to improve the quality and efficiency of UK construction. In response to the Egan Report, the UK Minister for Construction convened a Working Group on KPIs. Their (KPI, 2000) report outlined the purpose of the KPIs, which is to:

“...enable measurement of project and organizational performance throughout the construction industry. This information can then be used for benchmarking purposes, and will be a key component of any organization’s move towards achieving best practice.”

The Working Group report provided guidance on the calculation of indicator values. It was intended that the 12 headline indicators would be reported on an annual basis at the sector level;

- Time for construction
- Time predictability – design
- Time predictability – construction
- Cost for construction
- Cost predictability – design
- Cost predictability – construction
- Defects
- Client satisfaction – product
- Client satisfaction – services
- Profitability - company
- Productivity - company
- Reportable accidents

It can be observed that there has been no consistent improvement in performance across all KPIs, particularly when compared against the original targets proposed by Egan in the 1990s. (Brown et al., 2020).

The annual publication of performance data is now produced through a partnership between Constructing Excellence (which has been involved since 2003), Glenigan (which has been involved since 2009), and the Construction Industry Training Board (CITB) (which has been involved since 2014) (Brown et al., 2020).

The report has been endorsed by the UK Department of Business, Energy and Industrial Strategy. Its stated objective is to track trends and set benchmarks for performance in the construction sector. The report presents Key Performance Indicators (KPIs) under seven headings:

- Economic - All construction
- Respect for People – All construction
- Environment – All construction
- Economic – Housing (a smaller subset of all economic KPIs)
- Economic – Non-housing (a smaller subset of all economic KPIs)
- Construction consultant (a subset relating only to client satisfaction) (Brown et al., 2020).

The nature of the environmental KPIs reported has undergone a notable transformation over time. The following list presents the evolution of KPIs (and their associated measures) over time, with reference to available reporting. It should be noted that initial reporting from the early 2000s is not included in this analysis. Over the period spanning 2005 to 2018, KPIs have been grouped into 13 categories (Brown et al., 2020);

- Economic All Construction (2007-2018)
- Economic Housing (2007-2018)
- Economic non-Housing (2007-2018)

- Economic Housing R&M and Refurbishment (2005-2006)
- Economic KPIs - New Build Housing (2005-2006)
- Respect for People (2007-2018)
- Environment (2007-2018)
- Construction Consultants (2007-2018)
- M&E Contractors (2007-2011)
- Construction Products Industry (2007-2009)
- Financial (2005-2006)
- Client Satisfaction (2005-2006)
- Contractor Satisfaction (2006)

The alterations to the KPIs reflect an experimental and evaluative process concerning the feasibility of data collection and the relevance of the data to the industry. For instance, five environmental KPIs were removed in 2012 as part of a comprehensive review conducted by Glenigan for the 2012 report. This was done with the intention of creating KPIs that are more "quantitative" as described in the report (Folwell et al., 2012).

2.4.7. Balanced Score Cards

In the early 1990s, R. Kaplan & Norton (1992) introduced a pioneering approach to strategic management in response to the demand for new strategies and business models to measure and improve performance in the highly competitive business landscape. They named this innovative framework the BSC.

R. Kaplan & Norton (1992) originally conceived the BSC as an all-encompassing measurement system that incorporates strategic, operational, and financial metrics. The primary aim was to align corporate values with operational objectives, customer satisfaction, shareholder value, and expectations, along with the individual goals, skills, and aspirations of employees (R. Kaplan & Norton, 1996).

The foundational concepts of the BSC, as highlighted by Olve et al. (1999), are surprisingly straightforward:

- It provides a concise framework for conveying strategic objectives effectively.
- It elucidates the cause-and-effect connections among various factors, elucidating the strategic rationale guiding actions.
- It establishes a methodical approach for executing strategies, superseding traditional financial-centric planning and control methods.

The distinctive aspect of the BSC compared to traditional performance measurement approaches lies in its incorporation of a variety of "leading and lagging" indicators across four perspectives: customer perspective, internal business processes, learning, growth and financial. This approach assesses whether a business is progressing towards its strategic objectives (Olve et al., 1999).

The BSC emphasizes the importance of managing strategy by continuously measuring performance through performance indicators after iterative analysis of operations (Gaiss, 1998). In simpler terms, the leading indicators address issues that will ultimately influence financial performance but offer this information before those issues significantly impact results. Consequently, shortcomings and failures can be identified and addressed proactively before they affect the bottom line (Kagioglou et al., 2001). This is achieved by establishing goals for each perspective and developing corresponding measures or performance indicators, as illustrated in Figure 2.5.

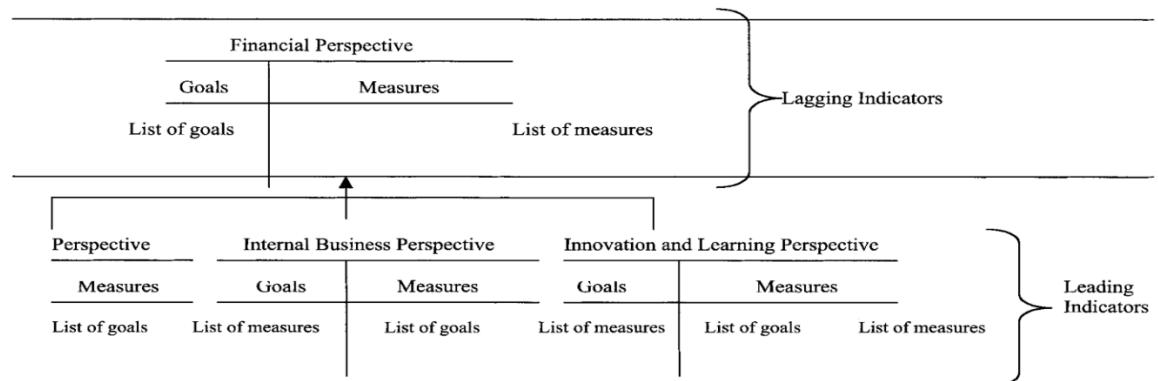


Figure 2.5. Lagging & Leading Indicators (Kagioglou et al., 2001).

Since its inception by R. Kaplan & Norton (1992), BSC has gained significant support from both academia and industry. However, it has also faced criticism for being overly simplistic (S. Brignall, 1992) and for not offering a comprehensive performance measurement system (Sinclair & Zairi, 1995).

Letza (1996) has identified several potential pitfalls that can occur when implementing a BSC, including measuring the wrong aspects even if they are measured correctly, assuming that some activities are unmeasurable, or assuming that professionals won't measure certain activities (rather than measuring all necessary activities). Additionally, conflicts between managers along functional lines can arise. Letza's (1996) case studies have highlighted that the BSC is a flexible framework, and the perspectives it comprises may vary for different businesses or within different business environments.

2.4.8. Integrated Performance Measurement

The effective measurement of performance in the construction industry is essential to address the needs and expectations of all stakeholders involved (Pillai et al., 2002). Evaluating stakeholder performance across different project phases is crucial to prevent conflicts, disputes, and blame games as projects progress towards completion. Figure 2.6 presents total number of KPIs tends to reduce over the years across all categories specific to the UK construction industry from various construction task forces (Mbugua et al., 1999).

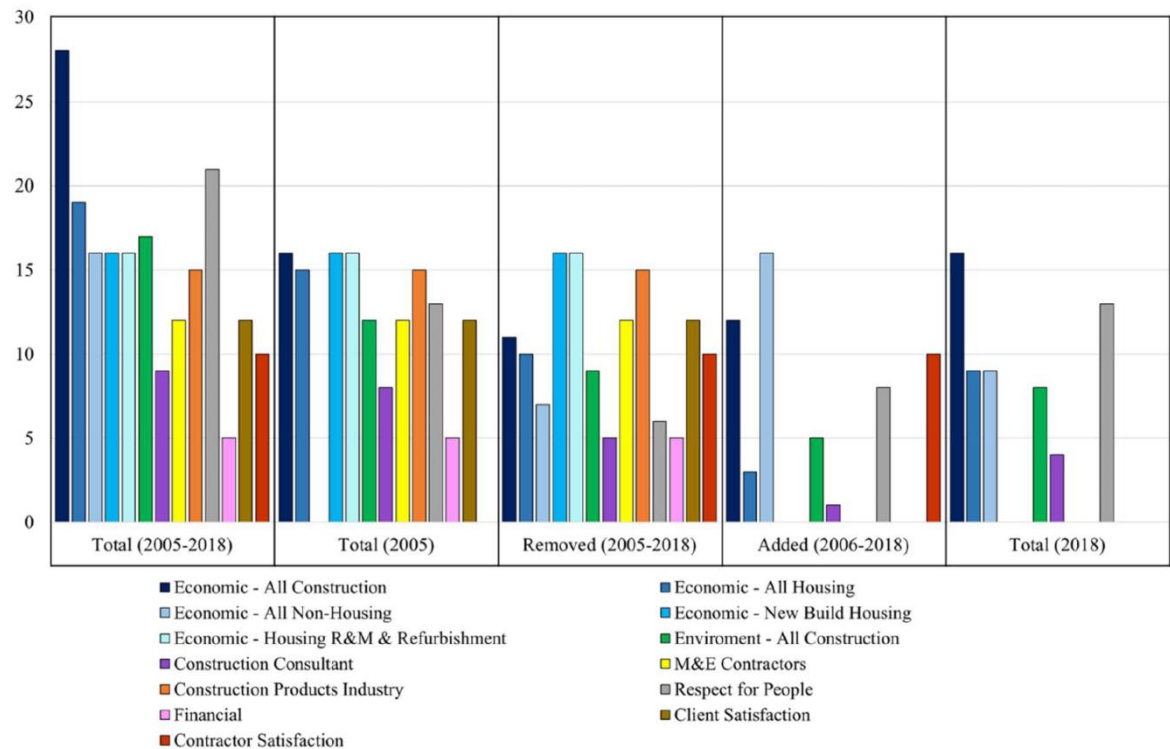


Figure 2.6. Changes of number of KPIs collected over the period 2005-2018 (Brown et al., 2020)

Performance in construction is essentially the individual contribution to project completion tasks (A. M. Liu & Walker, 1998). Therefore, evaluating and prioritizing the performance of each participant at every project stage is vital to gauge project success.

Mbugua et al. (1999) and Love and Holt (2000) distinguish between performance indicators, performance measures, and performance measurement. Performance indicators are the specific, measurable evidence required to show that planned efforts have successfully attained desired outcomes. When these indicators can be precisely and clearly quantified, they are termed measures. If achieving precise measurement is difficult, they are referred to as performance indicators. Performance measures, according to Sinclair & Zairi (1995), are numerical or quantitative indicators.

Performance measurement, on the other hand, is a methodical process used to assess inputs and outputs in manufacturing or construction activities. It functions as a tool for fostering continuous improvement (Mbugua et al., 1999; Sinclair & Zairi, 1995).

Cordero (1990) classifies performance measurement based on measurement method and area. Measurement methods encompass technical, commercial, and overall performance, while measurement areas include planning & design, marketing, manufacturing, etc., with overall performance measured at the firm or strategic business unit level. Cordero's (1990) model incorporates outputs (effectiveness) and resources (efficiency) measurement at different levels. However, it falls short of reflecting the interests of stakeholders and their economic and moral considerations. Construction organizations must understand their relations with customers, suppliers, employees, lenders, and the wider community for long-term competitiveness, as suggested by Love & Holt (2000). Hence, performance measurement should consider stakeholder interests both economically and morally.

In the literature, relatively few papers address the integration of performance measurement in construction projects. Researchers have tackled performance evaluation issues through various measurement systems, falling into three major categories: single-attribute measurement (e.g., labor productivity), multi-attribute measurement, which monitors multiple aspects of project effectiveness (Sinclair & Zairi, 1995), and measurement of organizational effectiveness (Dias Jr & Ioannou, 1996). According to Demirkesen & Ozorhon (2017a), their findings show that integration management greatly influences project management performance, suggesting that this relationship may be quite strong. It becomes crucial for project managers to skillfully synchronize processes and stakeholders, given the identified impact of integration management on project management performance. The use of IPDS, BIM tools, LPD, JIT delivery as well as ERP and agile management are notable strategies that tend to prevail during the construction phase (Demirkesen & Ozorhon, 2017a).

It involves effectively identifying, delimiting, integrating, consolidating and harmonizing the processes within the project management process groups, usually classified as initiate, plan, execute, monitor and control, and close. Project integration management

includes creating a project charter, developing project management plans, monitoring project activities, continuously monitoring and controlling project progress while implementing integrated adjustments, and finally closing project phases (Demirkesen & Ozorhon, 2017a).

ERP refers to a type of software that organizations use to manage day-to-day business activities such as accounting, procurement, project management, risk management and compliance, and supply chain operations. A complete ERP suite also includes enterprise performance management, software that helps plan, budget, predict, and report on an organization's financial results. ERP systems tie together a multitude of business processes, enable the flow of data between them and integrate all processes and data of an organization such as accounting-finance, maintenance-repair, project follow-up, investment, inventory control, material, human resources management by providing a single database and an integrated interface that enables effective and efficient use of resources in line with the strategies of the business (Abdinnour-Helm et al., 2003; Bingi et al., 1999; Gable et al., 1998; Klaus et al., 2000; Leuven et al., 2003; Shi & Halpin, 2003).

Figure 2.7, illustrates the project performance hierarchy, which serves as the fundamental structure underpinning the formal and quantified construction performance evaluation framework presented in this study. This research focuses on a specific phase of a project, namely the construction phase, and is tailored for lump-sum contract types. Nonetheless, the framework possesses a universal applicability, making it suitable for use in various project types and phases. The performance indicators depicted in the diagram pertain to efficiency across dimensions such as cost, time, billing or cash flow, profitability, safety, quality, team satisfaction, and client satisfaction (N. Nassar & AbouRizk, 2014).

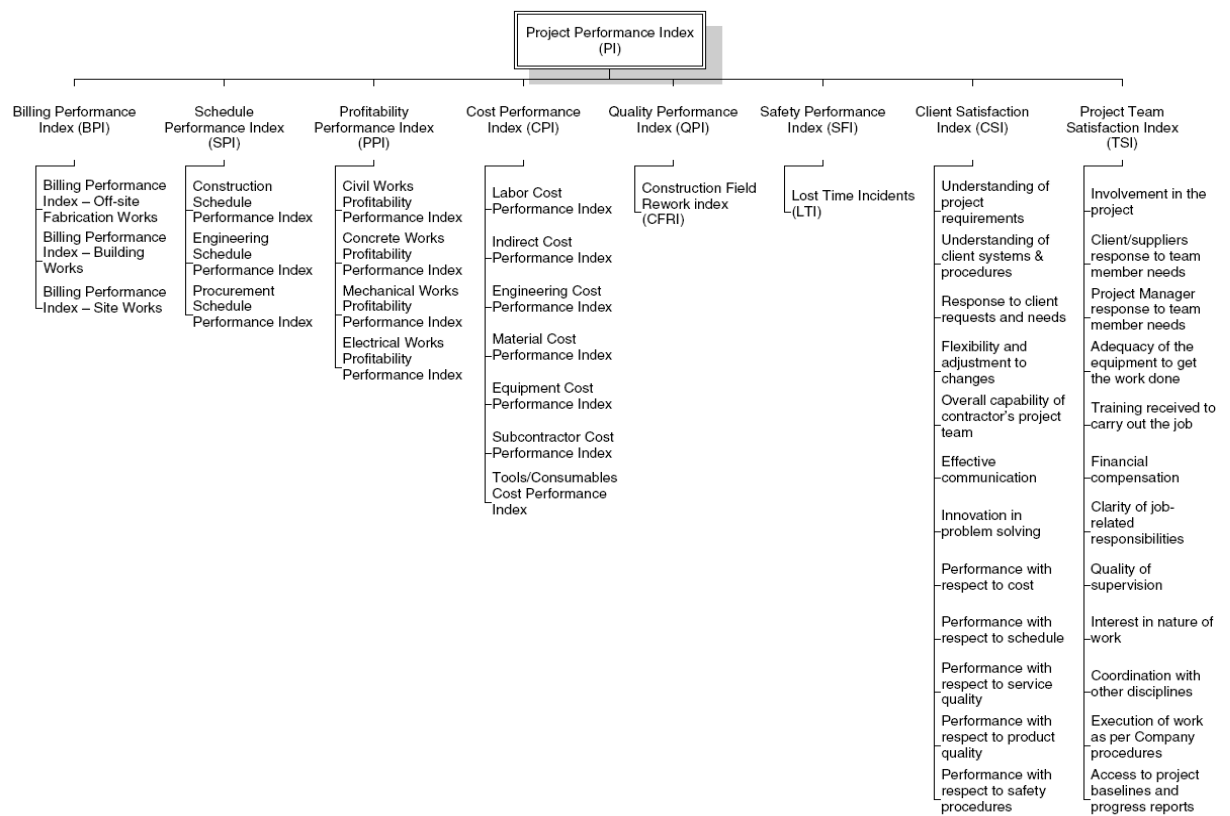


Figure 2.7. Hierarchy Design for the Project Performance Model (N. Nassar & AbouRizk, 2014).

All eight of these indicators, along with their respective sub-indicators, undergo quantitative assessment and are then transformed into a standardized scale. The specific descriptions of these indicators are detailed in Table 2.1 (N. Nassar & AbouRizk, 2014).

Table 2.1 Calculation of the Project Performance Indexes (N. Nassar & AbouRizk, 2014).

Index	Description
Cost performance index (CPI)	Cost efficiency of the project
Schedule performance index (SPI)	Schedule efficiency of the project
Billing performance index (BPI)	Efficiency of invoicing the client for earned work; determines cash flow
Profitability performance index (PPI)	Profitability of project to date
Safety performance index (SFI)	Safety of project to date
Quality performance index (QPI)	Consistency in application of project standards and procedures
Team satisfaction index (TSI)	Satisfaction of the project team
Client satisfaction index	Satisfaction of the client

The availability of quantified project indexes will enable the project manager to benchmark a project against the established company baselines and ultimately improve the probability of achieving the project goals (N. Nassar & AbouRizk, 2014).

2.5. Project Success

The concept of project success is delineated in the Canadian Oxford Dictionary (1998), where success is described as "the achievement of a specific objective, resulting in a favorable outcome."

American author Peter Drucker, efficiency is characterized as "doing things right" which implies optimizing output relative to the quantity of inputs or resources employed. In contrast, effectiveness pertains to "doing the right things" encompassing the achievement of a project's predefined goals and objectives. Drucker emphasizes the primacy of effectiveness over efficiency, a perspective supported by various sources. (Belout, 1998) posits that project success is intrinsically tied to both efficiency and effectiveness. In essence, it corresponds to the ability to concurrently achieve project goals and objectives while optimizing the allocation of resources and inputs. Efficiency and effectiveness are frequently regarded as interchangeable terms by numerous authors and practitioners, leading to a persistent source of confusion within the project management literature, as noted by (Belout, 1998).

Time, cost, and quality constitute the fundamental benchmarks for determining project success, and these parameters are consistently recognized and deliberated upon in virtually every article addressing the topic of project success. Prominent scholars such as Belassi & Tukel (1996), Hatash & Skitmore (1997), D. Walker (1996) and D. H. Walker (1995) have extensively examined and discussed these criteria in their respective works. Notably, Atkinson, (1999) coined the term "iron triangle" to specifically refer to these three criteria, highlighting their central role in project success evaluation.

In addition to the fundamental criteria, M. B. Pinto & Pinto (1991) advocate for the inclusion of measures related to project psychosocial outcomes, which pertain to the

satisfaction derived from interpersonal relationships within the project team. These subjective measures, such as the satisfaction levels of participants, are often referred to as "soft" measures. The incorporation of satisfaction as a metric for success is also suggested by (Wuellner, 1990).

Kometa et al. (1995) adopt a comprehensive approach for assessing project success, encompassing a range of criteria. These criteria include safety, cost-effectiveness (construction cost), operational and maintenance expenses, timeliness, and adaptability to users' needs.

Kumaraswamy & Thorpe (1996) take a holistic approach in their study of project success, incorporating a diverse array of criteria. These criteria encompass adherence to the budget and schedule, the quality of workmanship, satisfaction levels of both the client and project manager, technology transfer, environmental sustainability, and health and safety considerations.

Songer & Molenaar (1997) define a project as successful if it is completed within the allocated budget, adheres to the established schedule, aligns with user expectations, complies with specifications, achieves high-quality workmanship, and minimizes disruptions during construction.

Samset (1998) navigates through five different criteria for measuring project success, which include efficiency (linked to the iron triangle), effectiveness, societal impact of the project, alignment with real societal needs and priorities, and sustainability, which addresses the lasting impact of the project on the future. Pocock et al. (1996) further propose the inclusion of the absence of legal claims as an indicator of project success. Similarly, Shenhar & Dvir (2007) present an alternative set of five dimensions that characterize success:

- Project efficiency
- Impact on the customer
- Impact on the project team

- Business and direct success
- Preparedness for the future

Carvalho & Rabechini Junior (2015) introduce an additional dimension to the discourse on project success as sustainability.

Koops et al. (2017) highlight the diversity of perspectives among different project managers, particularly in the public project domain, on how project success should be evaluated. The concept of stakeholder perception has emerged as a pivotal determinant of project success, a point underscored by (Sebestyen, 2017).

Project success, therefore, emerges as a multidimensional construct, a viewpoint substantiated by the research of Carvalho & Rabechini Junior (2015), Samset (1998), and Shenhar & Dvir (2007). Additionally, various stakeholder groups bring their own unique perceptions of what constitutes project success into the discussion, a phenomenon elucidated by Chou & Yang (2012), Davis (2014), de Vrie (2009), Ogunlana & Toor (2010).

Construction projects involve a variety of project participants, with the key players being the client or project owner, the consultant, the subcontractors and the contractor. The actions of these key players substantially determine or shape the success of the project (Z. Jin et al., 2013).

Davis (2014) considers various key stakeholders, including senior management, the primary project team, and the groups of stakeholders who stand to benefit from the project, as central to the project's overall success. Meanwhile, P. Williams et al. (2015) adopt a multifaceted approach to assess project success. They gauge it by evaluating both customer satisfaction and the quality of the client relationship within the context of project management.

Project success serves as the bedrock for the effective management and oversight of ongoing projects, as well as for the strategic planning and direction of future endeavors, as

posited by Chovichien & Nguyen (2013). J. K. Pinto & Slevin (1988a) elucidate the advantages inherent in evaluating project success, a practice that extends beyond monitoring. Semantically, project success can only be quantified once the project reaches its completion (Han et al., 2012). In contrast, the evaluation of project performance occurs throughout the project's lifecycle (Han et al., 2012).

One classic approach to address the challenge of measuring project success is to propose a straightforward formula that is unambiguous, easy to apply, and agreeable to all parties involved, as advocated by Dvir et al. (2003) and J. K. Pinto & Slevin (1988b).

PSCs are employed as the yardsticks for measuring success, while CSFs play a complementary role in facilitating the attainment of success, as discussed by Collins & Baccarini (2004) and Frefer et al. (2018). It is imperative to clarify these two concepts, as discussions often blur the distinction between them or mistakenly treat them as interchangeable terms, a phenomenon underscored by Lim and Mohamed (1999).

2.5.1. Project Success Criteria

De Wit (1988) and Cooke-Davies (2002) refer to project success criteria as the standards by which the success or failure of a project will be assessed. Lim & Mohamed (1999) define a criterion as a principle or standard by which something can be evaluated or judged. According to Chan & Chan (2004), project success criteria are defined as a set of principles or standards that serve as benchmarks for achieving favorable outcomes within specified parameters.

Pheng & Chuan (2006) have emphasized that achieving cost, time, and quality objectives is usually linked to the success of project management, whereas project success is primarily concerned with the ultimate project goals. De Wit (1988) concludes that effective project management can indeed contribute to project success, but it may not always be sufficient to prevent project failure.

2.5.1.1. Time and Cost Criterion. Time can be assessed and quantified from various dimensions in the context of construction projects. Chan & Chan (2004) have explored this concept extensively. They have examined construction time in terms of its duration, the pace at which construction activities progress (speed of construction), and the extent to which projects deviate from initially established timeframes, often referred to as time overrun.

In the area of project scheduling and performance evaluation, Heravi & Ilbeigi (2012) have introduced the concept of the schedule performance index. This metric serves as a means to gauge the efficiency of a project's schedule management, providing valuable insights into how well a project adheres to its planned timeline.

Chan & Chan (2004) have argued that the notion of project cost should extend beyond the initial tender sum. Instead, it should encompass all expenses incurred due to variations and modifications during the construction phase, as well as costs arising from legal disputes such as litigation and arbitration. Cost measurement can take various forms, including unit cost and the percentage of net variation over the final cost, often referred to as cost overrun. To further assess the cost-efficiency of a project, Heravi & Ilbeigi (2012) have introduced the concept of CPI.

It is important to note that considerations related to time and cost are multifaceted and are perceived differently by various stakeholders involved in construction projects, including project owners, designers, and contractors. Certainty in project delivery time and the management of project costs are universally recognized as paramount success factors within the design/build project delivery system, as emphasized by Chan et al. (2002). These considerations underscore the significance of effectively managing both time and cost aspects to achieve successful project outcomes.

2.5.1.2. Quality Criterion. The concept of quality in the context of construction projects is well-defined as the extent to which the overall conditions facilitate the fulfillment of the project's established requirements concerning both materials and workmanship, as articulated by Bubshait & Almohawis (1994).

In the existing body of literature, it is evident that researchers have approached the assessment of quality from various perspectives. Some scholars, such as Atkinson (1999), Chan et al. (2002), Lim and Mohamed (1999), J. K. Pinto and Slevin (1988b), have chosen to regard quality as a singular, primary criterion. In contrast, others, including Al-Tmeemy et al. (2011), Chovichien and Nguyen (2013) and Elattar (2009), have delineated quality, technical performance, and functionality as distinct and separate criteria. Elattar (2009), in particular, distinguishes between quality and technical performance.

However, a common thread in the literature is the understanding that the quality of a project is predominantly defined by its adherence to technical specifications, as asserted by Khosravi & Afshari (2011). Prabhakar (2008) highlights the complex relationship between quality and technical performance, as well as the achievement of functional objectives.

Chan et al. (2002) emphasize the interdependence of quality, technical performance, and functionality, highlighting their significance to project stakeholders such as owners, designers, and contractors. Moreover, Chan & Chan (2004) elaborate on the measurement of quality, advocating for a subjective assessment employing a seven-point scale. Furthermore, he underlined project functionality as a critical success measure in the post-construction phase, when the project is finalized and delivered by means of its conformity to imposed technical specifications.

2.5.1.3. Health and Safety Criterion. The concept of health and safety within the context of construction projects can be precisely defined as the extent to which the overall conditions support the project's successful completion while minimizing the occurrence of significant accidents or injuries, as articulated by Bubshait and Almohawis (1994).

The issue of safety within construction has garnered longstanding attention, as evidenced by the works of Sanvido et al. (1992) and Parfitt and Sanvido (1994). In practice, it is customary for contractors to be bound by the requirement of developing a comprehensive health and safety plan to the satisfaction of the client before commencing construction operations, as emphasized by Mosey (1998). This precautionary measure reflects the industry's commitment to ensuring the welfare and protection of all stakeholders involved in construction endeavors.

Over time, this concept has been consistently employed without complexity in the field. Chan & Chan (2004), in their research, have chosen to embrace and adopt the definition presented by Bubshait and Almohawis (1994), which characterizes safety as the degree to which the overall conditions facilitate the project's successful completion while safeguarding against major accidents or injuries.

Building upon this foundation, Heravi and Ilbeigi (2012) have introduced a safety performance index that takes into account safety-related considerations when evaluating the ultimate outcomes of an executive project.

2.5.1.4. Client Satisfaction Criterion. In the field of project evaluation, different researchers have used different terminology to encapsulate the notion of satisfaction, reflecting the multifaceted nature of this concept. Takim and Adnan (2008) have used the term "client satisfaction" and elucidated it through several dimensions, including benefit to the end user, benefit to the client, project functionality, aesthetic value, client satisfaction with service, end user satisfaction with the product, the creation of a pleasant environment, and ease of maintenance.

Chovichien and Nguyen (2013) utilize the term "satisfaction" in a broad sense, while Chan & Chan (2004) and Elattar (2009) opt for more specific terms, referring to "participant satisfaction" and "user satisfaction" individually. In contrast, Al-Tmeemy et al. (2011), Heravi and Ilbeigi (2012), Khosravi and Afshari (2011), J. K. Pinto and Slevin (1988b) collectively employ the phrase "the client/customer satisfaction."

Heravi and Ilbeigi (2012) have taken a comprehensive approach by introducing the concept of a "client satisfaction index" which is derived from a questionnaire comprising 28 sub-factors. This index serves as a robust and detailed tool for assessing and quantifying client satisfaction. Conversely, Chan and Chan (2004) proposed a more streamlined method for measuring participant satisfaction, advocating for the utilization of a seven-point scale system.

Effective collaboration between designers and contractors is essential to meet the owner's requirements and achieve owner satisfaction, as articulated by Akintoye (1994). This collaboration helps maintain a cohesive and collaborative atmosphere within the project team.

The satisfaction of end-users can also be achieved by adhering to the principle of customer focus, as suggested by Testi et al. (1996). By prioritizing the needs and preferences of end-users, project stakeholders can enhance satisfaction levels and contribute to the overall success of the project.

2.5.1.5. Employee Satisfaction Criterion. Employees are a key group of stakeholders in construction projects. The presence and readiness of experienced professionals and a highly skilled workforce or staff constitute a crucial determinant of project success. This viewpoint is substantiated by research conducted by De Silva et al. (2008), Gunathilaka et al. (2013), Mitra and Wee Kwan Tan (2012).

Satisfaction is an attribute that is important in the context of project success, as noted by A. M. Liu and Walker (1998). In addition, Torbica and Stroh (2001) state that long-term project success depends on end-user satisfaction, suggesting that their satisfaction is a critical measure of project completion.

The satisfaction of project team members is another pivotal success criterion, as underlined by Songer and Molenaar (1997). They emphasize that maintaining team

satisfaction is essential for fostering cohesiveness and teamwork throughout the project's lifecycle.

Additionally, Serrador and Turner (2014) expand the purview of employee-related success factors to encompass team dynamics and morale, skill development, team member growth, and team member retention. Their research highlights the interplay between individual and team-level factors in shaping project success, and emphasizes the importance of fostering a positive and skilled workforce to achieve project goals.

2.5.1.6. Learning and Development Criterion. The processes of learning and exploitation can be precisely characterized as the systematic enhancement of actions and outcomes through the acquisition of improved knowledge and understanding (Fiol & Lyles, 1985).

Takim and Adnan (2008) offer an expansive perspective by incorporating elements such as the development of new knowledge and expertise, as well as the level of professional development, into their assessment of learning and exploitation within the context of project success.

In a similar vein, Han et al. (2012) broaden the scope by considering personnel training, the accumulation of experience, and knowledge gained, as well as improvements in management, as integral components of learning and exploitation that contribute to project success.

Shenhar et al. (2001) introduced an additional dimension to the measurement of project success by including the development of new technology as a criterion. This emphasizes the innovative aspect of learning and exploitation within the context of projects.

Furthermore, Serrador and Turner (2014) adopt the same measurement criterion, i.e., the development of new technology, in their investigation of the correlation between project efficiency, stakeholder satisfaction, and overall project success. This underlines the

overarching importance of fostering innovation and exploiting new knowledge and skills to achieve successful project outcomes.

2.5.1.7. Profitability Criterion. The concept of profitability performance within the context of construction projects can be defined as a measure of the project's current level of profitability. Heravi and Ilbeigi (2012) elucidated this notion as an indicator of how profitable the project has been up to the present moment.

A comprehensive evaluation model, consisting of project management and deliverables, is proposed by Heravi and Ilbeigi (2012) for the success of construction projects. This approach serves as a systematic means of evaluating a project's financial success. Takim and Adnan (2008) provide further insight into this criterion, highlighting that profitability serves as a metric for gauging the project's financial accomplishments. In line with this perspective, Parfitt and Sanvido (1994) emphasize that profitability measures the extent to which a project achieves financial success.

Norris (1990) defines profit as the surplus achieved when revenues exceed costs, with profitability quantified as the total net revenue over total costs. This financial perspective underlines the importance of managing costs and maximizing revenues to ensure project profitability.

It is noteworthy that profitability is typically assessed in the post-construction phase, once the final account has been settled, and both the paying and the paid parties can definitively ascertain the project's financial results, as highlighted by Chan et al. (2002).

Moreover, Han et al. (2012) introduce the concept of commercial success, and Chan and Chan (2004) equate this term with profitability. This underlines the integral link between commercial performance and financial success in construction projects.

2.5.1.8. Environment Performance Criterion. In the construction sector, Chan and Chan (2004) emphasize the significant role of environmental performance, highlighting its importance in the context of construction projects. They assert that the environmental performance of a given project can be effectively assessed by employing a scoring system, serving as an indicator to reflect the project's environmental impact and adherence to eco-friendly practices.

Building upon this notion, Heravi and Ilbeigi (2012) have introduced the concept of an environment performance index. This index is designed to measure the contractor's performance concerning environmental considerations throughout the project construction phase. It serves as a comprehensive tool for evaluating a project's environmental responsibility and the associated costs incurred due to a lack of adherence to environmental considerations during construction.

Recognizing the multifaceted nature of environmental issues, Mosey (1998) emphasizes the need for project stakeholders, including the owner, design team and contractor, to be equipped to assess the environmental impact on the surrounding environment. To facilitate this, Mosey (1998) suggests the appointment of an independent environmental consultant who can be responsible for preparing precontract designs and tender documentation and monitoring the works on-site. This approach ensures that environmental considerations are thoroughly integrated into the project's planning, execution, and monitoring phases, thereby contributing to improved environmental performance and sustainability.

2.5.1.9. Cash-flow Management Criterion. A consistent theme in numerous studies examining critical success factors in various contexts is the recognition of a specific factor as being of paramount importance. This factor has been identified as critical in a multitude of research works, including those conducted by Gudienė et al. (2013), Gunathilaka et al. (2013) and Kazaz et al. (2012).

Heravi and Ilbeigi (2012) contribute to this discourse by introducing the concept of a billing performance index. They underscore the significance of this index as a critical criterion for measuring the success of a project. This emphasis further reinforces the consensus within the academic community regarding the pivotal role of this factor in evaluating project success.

2.5.1.10. Technical Performance Criterion. In the context of design/build projects, a fundamental prerequisite for achieving success is the presence of a well-defined and clear project brief, as noted by Ndekugri and Turner (1994). This entails establishing a comprehensive understanding of the project's objectives, requirements, and expectations from the outset.

Songer and Molenaar (1997) introduce the concept of meeting specifications as a key success criterion for design/build projects. This criterion is consistent with the measurement of technical performance and emphasizes the importance of adhering to established specifications and requirements throughout the project lifecycle. By doing so, project stakeholders can contribute to the overall success of the design/build endeavor.

Furthermore, the project scope should also be meticulously and distinctly outlined, as emphasized by Molenaar and Songer (1998). A clearly defined scope is essential to ensure that the project stays on track and that success can be effectively pursued.

2.5.1.11. Productivity Criterion. Productivity is a universally recognized and fundamental success factor in project management. It is widely recognized as the primary driver of cost-effectiveness in projects, as highlighted by Tayler (1992). Essentially, productivity refers to the efficient utilization of resources to accomplish a specific task, and it is typically evaluated through a ranked assessment, as explained by Pocock et al. (1996).

In practice, productivity assessments often focus on the construction phase of a project, as this phase typically involves the majority of on-site work activities. The level of productivity achieved during this phase serves as a clear and tangible indicator of project

success. By optimizing resource allocation and task completion efficiency, project stakeholders can enhance productivity and, in turn, contribute to the overall cost-effectiveness and success of the project.

2.5.2. Critical Success Factors

J. K. Pinto and Covin (1989) have observed that the factors contributing to project success or failure often hinge on the existence or absence of CSFs. Furthermore, Belassi and Tukel (1996) assert that a crucial determinant of project success or failure lies in the existence of clusters of success factors and their intricate interactions. Milosevic and Patanakul (2005), adopted a project management perspective, defined CSFs as characteristics, conditions, or variables that possess the potential to exert a substantial impact on the overall success of a project, provided they are consistently sustained, properly maintained, and effectively managed.

Since the 1980s, there has been a heightened emphasis on the search for CSFs in the field of project management. Researchers in this domain have been driven by a fundamental question: "What are the critical factors that genuinely contribute to the successful outcome of projects?" This research, as articulated by Cooke-Davies (2002), underlines the ongoing quest to identify and understand the key determinants of project success.

The establishment of a scientific foundation for project success was pioneered by Slevin and Pinto (1986). They put forth a comprehensive framework comprising ten CSFs that play a pivotal role in achieving project success;

- Project Mission
- Top Management Support
- Project Schedules/Plan
- Client Consultation
- Personnel
- Technical Tasks

- Client Acceptance
- Monitoring and Feedback
- Troubleshooting
- Communication

Scholars like J. K. Pinto and Slevin (1988b) have gleaned numerous valuable insights from CSFs. However, this endeavor proves most fruitful when it encompasses both project success factors and success criteria. Consequently, it becomes imperative to elucidate the project success criteria, identify the project CSFs right from the project's initiation, and secure unanimous consensus among all stakeholders regarding their definition, as advocated by Wateridge (1995). Subsequently, J. K. Pinto and Slevin (1988a) expanded this list by incorporating four additional factors that are considered external to the project implementation process and thus lie outside the direct control of the project team. These factors are;

- Characteristics of the Project Team Leader
- Power and Politics
- Environmental Events
- Urgency

Numerous CSF lists and frameworks have been proposed by various authors, reflecting the different perspectives and contexts within the field of project management. In addition, some studies have explored the specific relationship between particular CSFs and project success, exemplified by research such as that conducted by Jugdev and Müller (2005). Together, these efforts contribute to a deeper understanding of the critical factors that drive project success and guide practitioners in their project management efforts.

Many elements play a crucial role in the success of projects. In the case of construction projects, their success is closely linked to the selection of contractors, as underlined by various academic sources (Banki et al., 2009; Ng et al., 2009; Palaneeswaran & Kumaraswamy, 2001; Yawei et al., 2005). The strategic selection of an appropriate

contractor not only ensures the overall quality of the project, but also provides opportunities for cost savings, as noted by Yawei et al. (2005). The main responsibilities of the main contractors, which have a significant impact on the success of the project, come into play once the project enters the construction or execution phase.

Numerous scholars have compiled comprehensive inventories of factors, occasionally linking them to particular problem domains and project activities. Furthermore, some researchers have accentuated the universality of these factors across diverse project categories, while others have introduced a paradigm shift by designating them as "Critical Failure Factors" as exemplified by Fortune and White (2006).

Fortune and White (2006) conducted an extensive and critical literature review concerning the concept of CSFs in project management. Their research encompassed an analysis of 63 publications dedicated to CSFs, drawing on a variety of databases and encompassing both empirical and theoretical studies on projects that both succeeded and failed. Through their rigorous review, Fortune and White (2006) compiled a list of twenty-seven critical factors, with top management support emerging as the most frequently cited, referenced in 39 sources (62%). In any organizational context, the primary responsibility of top management is to furnish the essential support and allocate necessary resources for project endeavors, a point underscored by Rauniar and Rawski (2012). Notably, a lack of active engagement from top management and insufficient organizational attention during the initial stages of a project have been associated with diminished project performance, as highlighted by Sosa et al. (2007).

Zwikaël (2008) proposed that the active engagement of executives can exert a substantial positive influence on project success. Nonetheless, the existing literature does not offer organizations a definitive catalog of practices that can enable or attain such effective top management support. Consequently, Zwikaël's (2008) research endeavors yielded the identification of a concise compilation of critical processes and best practices that hold the greatest potential for fostering effective top management support, ultimately enhancing project success.

As elucidated by de Vries (2009), a prevalent issue in many organizations is the occurrence of significant project delays attributable to political processes and conflicts. Consequently, possessing awareness of this potential scenario can empower top management to proactively steer clear of avoidable delays and mitigate adverse repercussions associated with the project.

Another consistently emphasized critical success factor highlighted in the literature pertains to the presence of a dedicated project manager, as underscored by Fortune and White, (2006), J. K. Pinto and Mantel (1990), J. K. Pinto and Slevin (1987). Archibald (2003), for instance, regards the project manager as the pivotal link responsible for the seamless integration of the entire project. Nguyen et al. (2004) identified a set of five critical success factors, within which the competence of the project manager and the availability of resources hold a prominent place. The leadership literature emphasizes the central role of the project manager in providing clear direction to the team, setting goals, providing motivational support and helping to resolve interpersonal and organizational challenges (Rauniar & Rawski, 2012). In alignment with this perspective, Qureshi et al. (2009) posited that project management leadership exerts a significant influence on project management performance. Thus, the project manager stands out as a CSF within a project, providing essential guidance, setting objectives, delivering motivational backing, and assisting in the resolution of interpersonal and organizational issues (Archibald, 2003; Rauniar & Rawski, 2012).

Several authors substantiate the importance of training and education in the field of project management, highlighting it as a critical factor. This view is supported by Cooke-Davies (2002), Dai and Wells (2004), Takey and de Carvalho (2015). Plaza and Rohlf (2008) go a step further, suggesting that the choice of training strategy has a significant impact on project cost performance. Similarly, Hong et al. (2011) highlight the impact of learning and knowledge sharing on project performance. McHugh and Hogan (2011) claim that training in international bodies of knowledge supports PM methodology, further highlighting the importance of training in this area.

2.6. Post Project Evaluation

The post-evaluation of a construction project involves a comprehensive, systematic, and objective analysis of various aspects, including the project's objectives, processes, benefits, functions, and overall impact, once the construction project has been completed. This analysis serves to determine whether the project has successfully achieved its intended goals, assess its overall feasibility and effectiveness, and evaluate the realization of its primary benefits. Through this evaluation process, it becomes possible to identify the reasons behind either the project's success or failure, gather valuable insights and lessons learned, and make recommendations for future project investment decisions. Furthermore, it allows for the timely provision of improved suggestions for addressing any issues related to project implementation and management, based on accurate and up-to-date information feedback. Ultimately, the post-evaluation process strengthens the governance and management of construction project investments, with the ultimate objective of enhancing economic benefits. The post-evaluation of a construction project can be categorized into four main components: process evaluation, benefit evaluation, impact evaluation, and sustainability evaluation (Lirong & Sifeng, 2008).

The assessment of construction projects stands as a pivotal tool employed to foster enhancements in performance and minimize setbacks such as delays, cost overruns, and quality deficiencies (A. A. Enshassi et al., 2014). According to Fan and Sun (2010), this evaluation process unfolds across distinct project stages, which can be delineated as follows: development assessment, implementation assessment, completion assessment, and suspension assessment. Notably, there exist three primary categories of project evaluation: pre-project evaluation, concurrent project evaluation, and post-project evaluation (A. A. Enshassi et al., 2014).

Y. He and Mi (2009) emphasized the challenges faced by evaluators in the process of selecting criteria and establishing performance indicators. This difficulty was acknowledged by Cao & Hoffman (2011), who concurred with the perspective of Li and Wang (2011). Li and Wang (2011) highlighted that certain organizations continued to rely solely on project

schedules as their primary performance measures and evaluation criteria. In contrast, some organizations had diversified their approach by also considering deviations from budgets.

In contemporary project management thinking, there exists a widespread belief in the value of post-project reviews (Anbari, 1985). Anbari (1985) asserts that "project evaluation should be integrated into various phases of the project life cycle". He goes on to elaborate, stating that during the project termination phase, it is essential to conduct a post-project evaluation to gauge the project's success in relation to its original and modified objectives. This evaluation should encompass an analysis of significant deviations, the extraction of lessons learned from the project, and recommendations aimed at supporting the future success of similar projects (Anbari, 1985).

Collier et al. (1996) have proposed a standardized process for conducting post-project reviews, outlining the activities, roles, and artifacts integral to this process. They emphasize the need for strong management commitment to mainstream such reviews as routine activities. According to their framework, the primary objective of a post-project review is to leverage the insights gained from project analysis to enhance future project management methods and practices. The tools employed in this process are geared toward proactive problem-solving.

Kuhn's (1970) framework of normal science paradigm applies to projects in the following manner:

- Projects are viewed as intricate puzzles that require solutions.
- The tools employed for finding these solutions are based on reasoned trial and error, grounded in established technical paradigms.
- It is believed that, with the application of these tools, the various components of the project will align and come together seamlessly.

On the other hand, Funtowicz and Ravetz's (1993) post-normal science paradigm is applied to projects as follows:

- Project objectives are characterized by their depth and breadth, often extending beyond conventional boundaries.
- Decision-making in project management is marked by ambiguity, continuity, and complexity.
- Projects are seen as unique entities, each presenting challenge for which no single individual possesses all the requisite expertise.

Charette (1996) stated that:

- A project is a distinct investment, with low opportunity costs, and is characterized by a clear beginning, duration, and end.
- Projects must adhere to criteria of feasibility, suitability, and acceptability.
- The time and resources required for a project can be accurately predicted.
- The contextual environment is well-understood and stable.
- All risks associated with the project, including worst-case scenarios, can be managed.
- Failure to meet a project's objectives is attributed to a lack of proper skills or their improper application, rather than the project being inherently infeasible, unsuitable, or unacceptable.

Charette (1996) posits that in the context of post-normal science, the implications for risk management on large-scale projects are as follows:

- Uncertainty shrouds the facts and information concerning the project.
- Project values and expectations are subject to ongoing disputes.
- Decision stakes are exceptionally high.
- The outcome of the project has far-reaching implications for a broad community of interest.

Charette (1996) suggests a new risk-taking ethic characterized by:

- Intelligent risk management as a cornerstone of successful project management.
- Viewing risks not as threats, but as opportunities from which to derive benefits.
- Embracing change as an inherent aspect of project dynamics.
- Mastery of project details as a means to mitigate associated risks.
- Recognizing that effective risk-taking and management require proactive leadership.

Busby (1999) expresses his aversion to the term "postmortem reviews" and looks at into the analysis of post-project reviews. He evaluates whether such reviews should be conducted and, if so, outlines how they can be improved to enhance their utility. He highlights several reasons for conducting post-project reviews:

- The notion that individuals do not always automatically learn from their professional experiences, necessitating structured learning exercises to derive meaningful and useful insights.
- The dispersion of project knowledge among various team members.
- The importance of disseminating project management experiences and lessons learned within an organization to prevent the repetition of mistakes.

However, Busby (1999) also acknowledges potential drawbacks to post-project reviews:

- They can be time-consuming.
- They may lead to embarrassment for project managers and team members.
- They have the potential to strain social and professional relationships.
- Some may resist the idea of conducting reviews, believing that professional experience alone suffices for acquiring project-related insights.

Busby (1999) describes two post-project review structures:

- Chronological reviews, where lessons learned are compiled for each phase of the project life cycle.
- Categorical reviews, where all lessons learned are compiled, categorized as positive or negative experiences, by all project team members.

In executing post-project reviews, Busby (1999) offers several key observations:

- These reviews are crucial and beneficial for staff members, project managers, and organizations.
- A thorough diagnosis of project shortcomings is highly recommended.
- Historical issues should be examined to distinguish between aspects unique to the completed project and systemic or structural issues affecting similar projects or the organization as a whole.
- Reviews should extend beyond project-specific details to encompass broader organizational and operational environment considerations.
- Specific problem categorizations, rather than generic headings like "communication blockages" are encouraged.
- Proper and timely planning of remedial actions, including assessing side effects and implementation logistics, is vital.
- The inclusion of external participants, including other project managers, can help disseminate review results throughout the organization.

Newell et al. (2006) address the practice of capturing lessons learned by project teams and storing them in a database for future reference.

The evaluation of construction projects is a multifaceted endeavor, with varying criteria and considerations that evolve depending on the project's specific context. Several key aspects have been identified in previous studies as critical for evaluating construction projects, and they are summarized as in table 2.2 below:

Table 2.2. Post-Evaluation Factors and Key References.

Evaluation	Definition	Key Reference
Time, Cost, and Quality	Time, cost, and quality are fundamental factors in evaluating construction projects	Wen-Zhhou and Jia, 2007
	These three elements are in constant tension and significantly influence project objectives	Xian, Lingling, and Ping, 2009
	Achieving peak performance in all three simultaneously can be challenging	Fan and Sun, 2010
	Cost evaluation involves comparing actual costs to planned costs and investigating any deviations	Mahamid and Bruland, 2012
	Delays and cost overruns are common challenges in the construction industry	Frimpong, Oluwoye, and Crawford, 2003
	Balancing cost-effectiveness with quality is crucial	Alzahrani and Emsley, 2013
	Quality defects may result from problems that affect compliance with specifications	Meng, 2012
Resource	Human resources play a pivotal role in project success	Alzahrani and Emsley, 2013
	Qualified and skilled staff are essential for successful project execution	Fan and Sun, 2010
	Human resource evaluation encompasses assessing staff requirements and tasks based on performance appraisals	Fan and Sun, 2010
	Linking performance measurement to incentives and disincentives is vital	Meng, 2012
	Models for evaluating human resource performance in projects have been developed	Cheng and Fan, 2010
Efficiency and Effectiveness	Evaluation may focus on efficiency (achieving maximum outputs with minimum inputs) and effectiveness (degree of project objective achievement)	Xu and Yeh, 2011
	These dimensions may not necessarily correlate with each other	
	They provide benchmarks for comparing project performance	
	Evaluation may focus on efficiency (achieving maximum outputs with minimum inputs) and effectiveness (degree of project objective achievement)	
Procurement	Procurement includes a range of processes such as acquisition, purchasing, logistics, monitoring, quality assurance, and contract administration	Alarcón, Rivas, and Serpell, 1999
	Procurement can be challenging due to schedule delays and issues with specified quality	
	Performance indicators can be used to evaluate the procurement process	
	Material procurement and price escalations can influence time and costs	Frimpong, Oluwoye, and Crawford, 2003
Environmental	Environmental protection is a growing concern in the construction industry	Alzahrani and Emsley, 2013

Table 2.2. Post-Evaluation Factors and Key References. (cont.)

Evaluation	Definition	Key Reference
Environmental	Failure to meet environmental obligations can lead to significant project delays and costs	Alzahrani and Emsley, 2013
	Environmental evaluation assesses site conditions, environmental impact, and protective measures	Fan and Sun, 2010
Risk	Risks are integral to post-project evaluations and offer insights into project management processes	Altug, 2002
	Post-project evaluations contribute to building a knowledge database of risks for future projects (Altug, 2002).	
	Defining responsibilities in contracts and equitable risk allocation is essential	Meng, 2012
Safety	Safety performance in the construction industry is a significant concern	Li and Li, 2009
	Thorough safety evaluations are essential for the successful management of safety on construction sites	
	Factors influencing safety management include roles, organization, management, technology, and industrial relationships	
Owner Satisfaction	Owner satisfaction is a critical component of the evaluation system	Li and Xiong, 2011
	Owners typically prioritize on-time, on-budget project completion while meeting quality and safety requirements	Wen-zhhou and Jia, 2007; Fan and Sun, 2010; Mahamid and Bruland, 2012

These factors collectively contribute to a comprehensive evaluation of construction projects. It is important to note that the specific criteria and considerations may vary from one project to another and depend on the project's unique characteristics and objectives.

3. RESEARCH METHODOLOGY

This thesis employs a structured research methodology comprising three primary steps.

- Literature Review and Conceptual Framework Development:

The first step of this research involves conducting a comprehensive literature review, complemented by an examination of the Project Management Body of Knowledge Guide (PMI, 2017). This process aims to identify the core components within project management knowledge areas and ascertain the determinants that influence project performance. The findings from this step will be used to construct the foundational conceptual framework for the study.

- Case Study Investigation

The second phase of this research centers around an in-depth analysis of an EPCM project. This specific project was selected because it successfully implemented project management knowledge areas and achieved a favorable outcome. Moreover, research specifically focusing on Engineering, Procurement, and Construction Management (EPCM) projects remains relatively limited, emphasizing the need to address this gap in the literature. By scrutinizing this real-world case study, we aim to gain practical insights into the effective application of project management practices that lead to project success.

- In-depth Interviews with Key Personnel

In the third phase of this research, we conducted comprehensive face-to-face interviews with key individuals who played pivotal roles in the selected project from the case study. These participants were specifically chosen from among Senior Managers within

the involved company, holding titles such as Project Manager, Planning Manager, Program Director and Quality Manager.

The interview questions were thoughtfully designed and tailored to construction professionals, with the following objectives in mind:

- Assessing Awareness and Knowledge: Assess the level of awareness and understanding of Project Management Methodologies and Standards among these key personnel.
- Investigating Project Management Knowledge Areas: Explore the practical application of Project Management Knowledge Areas within the context of the case study project.
- Evaluating Project Management Success: The interviews explored the level of success achieved in implementing the Project Management Knowledge Areas within the case study project.
- Analyzing Project Management Criteria: Examination the impact of Project Management Criteria on the overall success of the project.

Through these in-depth interviews, I aimed to gather valuable insights from experienced construction professionals, shedding light on the critical factors influencing project success.

Finally, the contribution and effect of the use of Project Management on the success of the project included in the case study was examined and interpreted.

3.1. Project Management Performance Conceptual Framework

The factors influencing project management performance, along with the metrics used to suggest and establish the concept of project management performance from various viewpoints are differentiated. Within this framework, the processes anticipated to have direct

affect to project management performance are categorized within their respective project management knowledge areas by referencing the PMBOK Guide (PMI, 2017).

Processes that are considered to be project-specific and not implemented in the EPCM project selected as a case study are not included in the framework. On the other hand, the processes that were not defined as processes in the Construction Extension to the PMBOK (PMI, 2016) but were implemented in the EPCM project selected as a case study were included in the scope of this framework. The processes included in the first part of this description are indicated in italic font and those included in the second description are underlined.

Table 3.1. Conceptual Framework for Construction Project Performance.

Project Life Cycle	Planning & Design (Starting the Project)	Construction Organizing & Preparing ----- Carrying Out the Work			Turnover & Start-up (Ending the Project)
 Process Groups  Knowledge Area	Initiating	Planning	Executing	Controlling	Closure
Integration Management	- Project Stakeholders - Enterprise Environmental Factor Considerations - <i>Project Service Provider Engagement</i>	- Planning Inputs - Value Engineering - <i>Intermittent Contract Closures and Commissioning</i> - Project Strategy	- Work Performance and Inspection - Value Engineering in Executing - Construction Administration - <i>Initiate and Manage Partnering</i> - Change Order Management	- Technology Integration - <i>Integrated Change Control</i> - <i>Sources of Problems with Project Changes</i>	- <i>Delayed Project Closure</i> - Closeout Documents - Project Punch List - Beneficial Occupancy and Substantial Completion - Close Contracts - Final Project Report and Lessons Learned
Scope Management		- Define Scope - Create WBS		- Scope Validation/Verification - Scope Creep and Change Management	
Schedule Management		- Define Activities - Sequence Activities - Estimate Activity Resources - Estimate Activity Durations - Activity Weightage Definition - Develop Schedule - Progress Curves Development and Update		- Progress Curve Updates - Schedule Impacts - Progress and Performance Reviews	
Cost Management		- Estimating Costs and Techniques - Bill of Materials - Allowances, Contingency, and Management Reserve - Escalation, Inflation, and Currency Exchange - Metrics - Determine Budget		- Actual Cost - Earned Value Management - Progress and Performance Reviews - Forecasting or Estimate at Completion - <u>Trend Management</u>	
Quality Management		- Contract Requirements - Project Stakeholder Requirements	- Quality Audits - Quality Management Reviews	- Quality Control	

Table 3.1. Conceptual Framework for Construction Project Performance. (cont.)

Project Life Cycle	Planning & Design (Starting the Project)	Construction Organizing & Preparing ----- Carrying Out the Work			Turnover & Start-up (Ending the Project)
 Process Groups  Knowledge Area	Initiating	Planning	Executing	Controlling	Closure
Quality Management		- Quality Policy - Quality Assurance Measurements - Quality Checklist - Project Requirements Review - Quality Management Plan			
Resources Management		- Organizational Planning	- <i>General Resources</i> - <i>Human Resources</i>	- Resource productivity & consumption	- <i>General Resources</i> - <i>Human Resources</i>
Communications Management		- Communications Management Plan - Project Documentation Assessment - Communications Skills - Corporate Communication and Social Responsibility - Communication Flow for Construction Change Orders, Requests for Information (RFIs), Instructions, and Variation Requests - Daily Report - Information and Communication Technology (ICT), Project Management Information System (PMIS)	- <i>Managing Conflict</i> - <i>Managing Meetings</i> - <i>Project Documentation and Information Distribution</i>	- Performance and Progress Reports - <i>Contractor Performance Evaluation (CPE)</i>	
Risk Management		- <i>Bidding and Contract Documents</i> - Organizational Methods - Budgeting - Project Risk Management	- <u>Determination of Responses to Risks</u> - <u>Assessment of Risks</u>	- Risk Management Monitoring and Controlling	

Table 3.1. Conceptual Framework for Construction Project Performance. (cont.)

Project Life Cycle	Planning & Design (Starting the Project)	Construction Organizing & Preparing ----- Carrying Out the Work			Turnover & Start-up (Ending the Project)
 Process Groups  Knowledge Area	Initiating	Planning	Executing	Controlling	Closure
Risk Management		- Risk Identification in Construction Projects - Qualitative Risk Analysis - Quantitative Risk Analysis - Insurance			
Procurement Management		- <i>Procurement Management Plan</i> - <i>Enterprise Environmental Factors</i> - <i>Supply Chain Management</i> - <i>Project Scope Statement</i> - <i>The WBS in Procurement</i> - <i>Make-or-Buy Analyses</i> - <i>Project Delivery Methods</i> - <i>Construction Contracts</i> - <i>Procurement Planning Outputs</i>	- Procurement Solicitation - Contract Statement of Work - Procurement Documents - <i>Prequalification of Service Providers</i> - <i>Nongovernment Organizations (NGO) Solicitation of Seller Responses</i> - <i>Public and Government Solicitations</i> - Evaluation and Selection of Sellers - <i>Single-Source Procurement</i>	- Contract Management and Contract Administration - <i>Work Performance Reporting</i> - <i>Approved Change Requests</i> - <i>Buyer-Conducted Performance Review</i> - <i>Inspections and Audits</i> - <i>Progress Payment System</i> - <i>Claims Administration</i> - <i>Records Management Systems</i> - <i>Project and Contract Documentation</i> - <i>Project Management Plan Updates</i>	- Punch List - Administrative Closeout
Stakeholder Management	- <u>Interaction of Project Stakeholders</u>	- <u>Division of Responsibility Matrix</u>	- <u>Creation and Maintenance of Stakeholder Relationships</u>	- <u>Monitoring & Controlling of Key Stakeholders' Engagement</u>	
Health, Safety, Security, and Environmental Management		- Contract Requirements & Owner/sponsor-enforced regulations - <i>Safety and Environmental Policy</i> - <i>Safety Metrics</i>	- <u>Project HSSE Management Plan</u>	- Project HSSE Management Plan - <i>Key Performance Indicators</i> - <i>Heinrich's Accident Triangle</i> - <i>Accident Investigation</i> - <i>Defect Repair Review</i>	

Table 3.1. Conceptual Framework for Construction Project Performance. (cont.)

Project Life Cycle	Planning & Design (Starting the Project)	Construction Organizing & Preparing ----- Carrying Out the Work			Turnover & Start-up (Ending the Project)
 Process Groups  Knowledge Area	Initiating	Planning	Executing	Controlling	Closure
Health, Safety, Security, and Environmental Management		- Site Neighborhood Safety and Environmental Characteristics and Constraints - Trials and Simulations - Cost of Safety (COS) and Cost of Environment (COE) - Process Mapping - Flowcharting - Project Safety and Environmental Requirements Review - Project HSSE Management Plan - Safety and Environmental Zoning and Signage - Safety and Environmental Training and induction Requirements - Traffic Management Plan - Emergency Response Plan - Permit to Work Management Plan - Waste Management Plan - Safety and Environmental Programs			
Financial Management		- Sources of Funds for Construction Projects - Short-Term Financial Fluctuations - Economic Environment		- Project Accounting Systems - Financial Internal and External Audits - Cash Flow Analysis - Financial Reports - Professional Expertise - Ex-Post Evaluations	

Table 3.1. Conceptual Framework for Construction Project Performance. (cont.)

Project Life Cycle	Planning & Design (Starting the Project)	Construction Organizing & Preparing ----- Carrying Out the Work			Turnover & Start-up (Ending the Project)
 Process Groups  Knowledge Area	Initiating	Planning	Executing	Controlling	Closure
Financial Management		- Analytical Techniques, Feasibility Study, and Sensitivity Analysis - Construction Project Finance and Corporate Finance - Legal Entity - Contract Requirements - Financial Impact Risk Factors - Tax Planning - <u>Banking</u> - <u>Payroll</u> - <u>Audit Plan</u>			

3.2. Case Study

3.2.1. Selection of the Case

The research scope involves the application of Project Management knowledge areas to an international airport project, with multiple contractors, suppliers, and institutions, managed by an international company under an EPCM contract. In the EPCM model, the contractor does not undertake building or construction directly; rather, they develop the design and manage the construction process on behalf of the owner. This arrangement positions the EPCM contractor as the owner's agent, establishing direct contractual relationships between the owner and suppliers/construction contractors.

The primary liabilities of the EPCM contractor encompass breach or negligence in several aspects: performance of design work, preparation of budget cost estimates, estimation of work duration, managing, supervising, and coordinating construction contractors' scopes, and coordinating design and construction between contractors.

EPCM contracts necessitate the EPCM contractor to manage relations and work with all project stakeholders, allowing the owner to retain full control over the project life cycle while managing the EPCM scope from start to finish. Consequently, such projects offer an opportunity to evaluate all twelve knowledge areas as specified by PMI.

In this context, an EPCM project is chosen. This setup enables the project owner to maintain complete control while the engineering, procurement, and construction scopes are managed comprehensively by the EPCM contractor. Essentially, EPCM contractors handle all stages of engineering, procurement, and construction, including planning, technical requirements, coordination of contractors and suppliers, and serve as a single point of contact for the client.

Furthermore, the selection of this EPCM project as a single case study is warranted by the presence of nineteen Major Erection Contracts, which include a combination of re-measure, fixed-price, and lump-sum turn-key contracts. This diversity allows for the

examination of various construction works and work packages within the scope of design, project management, and construction management services.

3.2.2. Definition of a Case Study

Case study is a methodological approach that involves an in-depth examination of a limited system using multiple data collection to collect systematic information about how that system functions and works (Chmiliar, 2010). Merriam and Tisdell (2015) defines case study as an in-depth description and examination of a limited system. On the other hand, according to Creswell et al. (2007), case study is a qualitative research approach in which the researcher examines one or several situations limited in time in depth with data collection tools including multiple sources (observations, interviews, audiovisuals, documents, reports) and defines situations and themes related to the situation.

Hancock and Algozzine (2006) define case studies as deeply grounded studies that try to describe the events occurring in their natural conditions in a rich way by using various data collection tools under time and space constraints.

According to Gerring (2006), case study is the in-depth study of a single situation in order to explain more situations. Gerring (2006) calls the case study including more than one case a multiple case study. Since the number of cases is high in such studies, it is difficult to study these cases in depth. At this point, the sample of cases becomes the focus of the study instead of single cases. Gerring (2006) also calls this type of study a cross-case study and explains the difference between a case study and a cross-case study by the number of cases they include and how in-depth these cases are studied. While the in-depth study of one or a few situations corresponds to a case study, the less in-depth study of many situations is a cross-case study. In cross-case studies, the large number of cases and the large sample size cause these studies to be conducted quantitatively. Therefore, quantitative data analyses are also conducted in case studies. According to Gerring (2006), all empirical studies are either case studies or cross-case studies.

3.2.3. Case Study as a Research Method

As there are differences in its nomenclature, there is not a complete consensus on what it is and the process of its application. Therefore, in order to understand what a case study is, it is first necessary to define the situation. Gerring (2006) defines the situation as a phenomenon observed at a single point in time or at a single point in time. Miles and Huberman (1994) state that a situation is a phenomenon that always occurs in a limited context.

Unlike experimental studies, case studies do not make comparisons, but try to explore. Instead of testing hypothesis or proving relationships, the researcher tries to define categories of events and behaviors (Hancock & Algozzine, 2006). The use of case studies in explaining, defining and exploring events that involve interventions that cannot be explained by experimental or screening methods in real life and are assumed to have causal links between them distinguishes it from other studies (Yin, 2009).

Case study is a method in which a single situation or event is examined in-depth longitudinally, data are collected systematically and what happens in the real environment is examined. With the results obtained, it reveals why the event occurred in that way and what should be focused on in future studies (Davey, 2019).

Yin (2009) defines case study as;

- focusing on "how" and "why" questions in the research,
- the researcher has little or no control over the events,
- when you study the event or phenomenon within its natural life framework,
- defines it as a research method used when the link between the event and real life is not clear enough.

Yin (2009) developed a table that explicitly shows relevant situations for different research methods. According to the table, there are three conditions consisting of the type of

research question asked, the degree of control the researcher has over actual events, and the degree of focus on contemporary as opposed to past events. These three conditions and their relationship with five different research strategies: experiments, surveys, archival analysis, histories and case studies, can be seen in the table 3.2 below.

Table 3.2. Relevant Situations for Different Research Methods (Yin, 2009).

Strategy	Research Question	Control of Events	Focus on Contemporary Events
Experiment	How, Why	Yes	Yes
Survey	Who, What, Where, How Many, How Much	No	Yes
Archive	Who, What, Where, How Many, How Much	No	Yes/No
Analysis	Who, What, Where, How Many, How Much	No	Yes/No
History	How, Why	No	No
Case Study	How, Why	No	Yes

Although there is some overlap between the techniques of case study and history, the strength of the case study lies in the wide range of evidence, such as documents, interviews and observations (Yin, 2009).

Yin (2009) argues that because the case study method has distinct advantages as a research strategy, it has been adopted in certain cases where 'a how or why has been asked about a set of current events over which the researcher has little or no control.

Since this research seeks to answer the questions of how and why, case studies are the appropriate research strategy to be implemented in this thesis. It aims to explain what is decided by finding out why it happened. This research leads the researcher to case studies because there is no control of events in this research. Throughout the research process, the focus has been on contemporary events.

3.2.4. Data Sources

In the case study methodology, there are two main information resources namely; primary information and secondary information. Primary information contains any documents about the subject such as reports, forms and letters. Archives like project drawings and name lists are also can be good examples of primary information. Moreover, interviews made with project personnel or clients can be count as secondary information which provides direct observations about the subject. Data sources within case study method are defined by Yin (2009) as;

- In the case study research method, the interview is the first source of data that can be used. It is considered to be a qualitative form of data. The investigator needs to organize and then analyze the data collected. Open interviews, semi-structured interviews and structured interviews are the three types of this source. The advantage of interviewing is to ask questions which lead to causal actions and references. The disadvantage of interviews is that poorly worded questions can distort data and the interviewer gets the data he wants.
- Documentation can be in the form of charts, reports, documents, contracts, memos, etc. As this source is rarely created for the sake of a case study, the data can give the researcher a better overview of the situation in the case. However, among many other documents, it may be difficult to find the relevant reports and references.
- Direct observation relies on the researcher being someone outside the case organization who can observe what is happening in the case from the outside. The researcher's judgement will be crucial in the choice of what is necessary for the continuation of the study. However, this can lead to the data collected being biased due to subjective judgement. In addition, the characteristics of participant observation are similar to those of direct observation. They are informative about interpersonal behavior, but can be biased by the researcher's manipulation of events.

Please see the table 3.3 below for the primary information collected from the project evaluated under the case study;

Table 3.3. Collected Primary Information.

Knowledge Area	Data	Description/Function
Integration Management	Project Contract General Conditions Project Charter Project Execution Plan Monthly Progress Report	Defines the fundamental contractual obligations, rights, and responsibilities of all parties involved, establishing the legal framework under which the project will be executed. Serves as the foundation document, integrating objectives, stakeholders, and high-level scope, cost, and timeline expectations. Project's scope, objectives, schedules, resources, and methods, providing a structured roadmap for successful project delivery. Sections included are Executive Summary, Health Safety and Environment, Design, Construction, Commissioning & Operational Readiness, Contract, Project Management & Support and Schedule Status.
Scope Management	Project Scope Statement Work Breakdown Structure (WBS) Change Requests and Logs Project Charter Contractual Scope Clauses Progress Reports with Scope Updates Punch List/Deficiency Reports	Detailed description of the project's deliverables, boundaries, and objectives. Hierarchical decomposition of the project scope into manageable components. Records of scope changes, their evaluation, and approval/rejection status. High-level overview of the project, including its purpose, objectives, and scope. Sections of the contract that specify project deliverables and exclusions. Monthly or periodic updates focusing on progress against the defined scope. Final scope-related issues identified and resolved before project handover.
Schedule Management	Project Schedule (Baseline Schedule) Schedule Management Plan Activity List	The approved timeline detailing project activities, milestones, dependencies, and deadlines. A document outlining how the project schedule will be developed, monitored, and controlled. Detailed breakdown of all project activities, including descriptions, durations, and sequencing.
Schedule Management	Critical Path Analysis Reports Lookahead Schedules Progress Monitoring Reports Schedule Risk Analysis Time Impact Analysis Change Logs for Schedule Adjustments	Documentation identifying the sequence of critical tasks and their impact on the project timeline. Short-term schedules focusing on immediate project phases Periodic reports comparing actual progress against the baseline schedule, identifying variances. Analysis of potential risks impacting the schedule, including contingency and mitigation strategies. Evaluating the effect of changes or delays on the project schedule. Records of approved schedule changes and their impact on the baseline.

Table 3.3. Collected Primary Information. (cont.)

Knowledge Area	Data	Description/Function
Cost Management	Project Contract and Cost-Related Clauses Cost Management Plan Cost Baseline Bill of Quantities (BoQs) Cost Estimates Earned Value Management (EVM) Reports Interim Payment Certificates Change Orders and Cost Impact Logs Risk Contingency Cost Logs Cash Flow Forecasts Delay and Disruption Cost Analysis Cost Closeout Reports	Contract Price Schedule: Detailed breakdown of the contract price, including fixed costs, unit rates, and payment terms. Cost Escalation/Adjustment Clauses: Provisions for adjustments due to inflation or material price changes. Provisional Sums and Contingencies: Budget allocations for undefined or uncertain scope. A document describing how project costs will be planned, structured, monitored, and controlled. The approved budget, including all planned expenditures and reserves, serving as a reference for cost performance measurement. A detailed document listing materials, labor, and resources with corresponding quantities and costs. Preliminary Cost Estimates: Early-stage estimates based on conceptual designs. Detailed Cost Estimates: Accurate projections based on finalized designs and specifications. Metrics such as Cost Performance Index (CPI) and Cost Variance (CV) to evaluate cost efficiency and identify deviations. Requests and approvals for periodic payments based on work progress. Records of approved changes to the scope, schedule, or resources and their associated cost impacts. Documentation of allocated contingencies and their utilization for identified risks. Projections of cash inflows and outflows aligned with project milestones and schedules. Reports quantifying the financial impact of delays, disruptions, or claims. Final reconciliations summarizing actual costs incurred versus the budget.
Quality Management	Project Contract and Quality-Related Clauses	Technical Specifications: Detailed requirements for materials, workmanship, and standards to be adhered to.
Quality Management	Quality Management Plan Inspection and Test Plans (ITPs) Non-Conformance Reports (NCRs) Third-Party Certification Reports Quality Metrics and Key Performance Indicators (KPIs) Lessons Learned and Continuous Improvement Reports Handover and Closeout Documentation	A document defining how quality standards will be planned, assured, and controlled during the project lifecycle. Detailed schedules and protocols for inspections and tests to verify compliance with quality standards. Records of deviations from specified standards, root cause analyses, and corrective actions taken. Independent assessments verifying compliance with industry or contractual quality standards. Data on defect rates, rework percentages, and compliance with quality benchmarks. Documentation of quality issues encountered and actions taken to improve processes in future projects. Evidence of quality adherence during the final stages of the project, including signed-off inspection records.

Table 3.3. Collected Primary Information. (cont.)

Knowledge Area	Data	Description/Function
Resource Management	Project Contract and Resource-Related Clauses Resource Management Plan Organizational Charts Resource Allocation Schedules Resource Utilization Reports Productivity Reports Time Sheets and Work Logs Training and Competency Records	Resource Allocation Clauses: Provisions for the use of labor, materials, and equipment. A document describing how human, material, and equipment resources will be planned, acquired, allocated, and monitored. Visual representation of the project team structure, roles, and reporting lines. Labor Allocation Plans: Detailed schedules of workforce distribution over time. Equipment Utilization Plans: Allocation and usage schedules for machinery and tools. Reports tracking actual resource usage against planned allocations. Metrics on workforce and equipment performance, such as output per labor hour or machine hour. Records of labor hours worked, categorized by activity or project phase. Documentation of training sessions, certifications, and competency levels of project personnel.
Communication Management	Project Contract and Communication-Related Clauses Communication Management Plan Meeting Agendas and Minutes Progress Reports	Clauses specifying communication responsibilities, formats, and reporting requirements. How project information will be collected, shared, and managed throughout the project lifecycle. Documentation of project discussions and agreements. Records of ongoing project discussions, decisions, and action items. On-site updates summarizing work completed and issues encountered on weekly/monthly.
Communication Management	Correspondence Logs	Records of all official communications, such as emails, letters, and memos between stakeholders.
Risk Management	Project Contract and Risk-Related Clauses Risk Management Plan Risk Register Qualitative Risk Analysis Reports Quantitative Risk Analysis Reports Risk Response Plans Contingency and Reserve Plans Insurance Policies and Claims Documentation Crisis Management Plans	Risk Allocation Clauses: Provisions specifying which party is responsible for specific risks. A document outlining the processes for identifying, analyzing, responding to, monitoring, and controlling project risks. A comprehensive list of identified risks, including their descriptions, likelihood, impact, and assigned owners. Assessments prioritizing risks based on their likelihood and potential impact on the project. Analytical data on risks, including probabilistic models, Monte Carlo simulations, or sensitivity analyses. Detailed strategies for mitigating, avoiding, transferring, or accepting identified risks. Documentation of allocated reserves for addressing potential risks and unexpected events. Records of project-specific insurance coverage, claims made, and their resolutions. Detailed protocols for managing major risk events or emergencies that threaten the project.

Table 3.3. Collected Primary Information. (cont.)

Knowledge Area	Data	Description/Function
Procurement Management	Contract Procurement-Related Clauses Bid and Tender Documents Procurement Management Plan Vendor Prequalification Records Bid Evaluation and Selection Reports Purchase Orders and Agreements Material Delivery Schedules	Detailed clauses governing procurement processes, responsibilities, and payment terms. Invitation to tender, request for proposals (RFP), and request for quotations (RFQ). A document describing how procurement activities will be planned, conducted, and controlled throughout the project lifecycle. Documentation of criteria and evaluations for selecting potential vendors or suppliers. Records of bids received, evaluation criteria, and final selection decisions. Documents specifying the materials, services, quantities, and costs agreed upon with vendors. Timelines and records of materials or equipment deliveries to ensure alignment with the project schedule.
Stakeholder Management	Project Contract and Stakeholder-Related Clauses Stakeholder Management Plan Stakeholder Register Conflict Resolution Records	Stakeholder Obligations and Rights: Clauses defining responsibilities and rights of project stakeholders. A document detailing strategies and approaches for identifying, engaging, and managing stakeholders throughout the project lifecycle. A comprehensive list of stakeholders, including their roles, interests, influence, expectations, and communication preferences. Documentation of disputes or conflicts involving stakeholders and how they were resolved.
Stakeholder Management	Stakeholder Engagement Activities Approval and Acceptance Forms Stakeholder Satisfaction Surveys	Workshops for engagement events conducted for stakeholders. Signed documentation from stakeholders confirming acceptance of deliverables or project phases. Records of surveys conducted to measure stakeholder satisfaction and areas for improvement.
Health, Safety, Security, and Environmental Management	Project Contract and HSSE-Related Clauses HSSE Management Plan Safety Data Sheets Incident and Accident Reports Training Records Permit-to-Work (PTW) System Documentation Health Monitoring and Medical Records Security Plans and Logs Waste Management and Disposal Records	Provisions detailing health, safety, security, and environmental responsibilities of the parties. A comprehensive document outlining strategies, policies, and procedures for managing health, safety, security, and environmental risks. Documentation for hazardous materials used in the project, including handling and emergency procedures. Records of workplace accidents, near-misses, injuries, and corrective actions taken. HSSE Training Logs: Documentation of safety, environmental, and security training sessions Work Permits: Approvals for high-risk activities, such as confined space entry or hot works. Records of health checks conducted for workers, including fitness assessments. Access Control Logs: Documentation of personnel and vehicle entry and exit. Documentation of waste types, quantities, and disposal methods to ensure environmental compliance.

Table 3.3. Collected Primary Information. (cont.)

Knowledge Area	Data	Description/Function
Financial Management	Project Contract and Financial Clauses	Contract Payment Terms: Details of payment schedules, milestones, and methods. Advance Payment Clauses: Provisions for upfront payments and their recovery mechanisms. Retention Money Clauses: Conditions regarding withheld payments to ensure quality and compliance. Escalation Clauses: Provisions for adjustments in costs due to inflation or market fluctuations.
	Financial Management Plan	A document describing how project finances, including budgets, expenditures, and cash flows, will be planned and controlled.
	Invoice Records	Documentation of invoices submitted for work completed, materials supplied, or services rendered.
	Interim Payment Certificates	Periodic approvals for payments based on progress.
	Taxation and Regulatory Compliance Documents	Records of taxes paid, permits acquired, and compliance with financial regulations.

3.2.5. Case Study Form

The interviews were conducted on one-to-one basis via the questions raised in a way that the discussions would pursue on an open-ended format. The interviews were conducted in English language. Due to confidentiality purposes the names of the interviewed persons remained confidential.

The focus of the in-depth interviews was on the use of project management practices in the construction sector and the contribution to the management and success of the project.

Questions on the profile of the interviewees make up the first part of the interviews. In this section, the participants were asked about their overall work experience, the sector in which they work, their role in the projects, the total number of projects in which they have been involved and the types of projects in which they have been involved.

Following this introduction session, Respondents were asked to comment on project management standards, knowledge areas and techniques and the contribution they make to project success. They were also asked for their views on the criteria that have an impact on

the success of construction projects, on the basis of their experience through different sets of questions.

3.4.6. Interviewees' Profiles

For the selection of the key personnel to participate in the interview, the main profiles of the participants were analyzed and care was taken to ensure that all of them were working in managerial positions in the project examined in the case study. In this respect, as you can see in the table 3.4 below, it is seen that the participants are suitable for the interview related to the thesis research topic. In addition, it has been assumed that the selected managers are people who can use PMO standards in their professional business life and get results due to their job position, duties and responsibilities.

Table 3.4. Interviewees' Profiles.

Interviewees	Age	Level of Education	Position at the Project	Experience	Knowledge about the PMP Standards	Having the PMP Certificate
No. 1	55	Civil Engineering (B.S) Master of Business Administration (M.S)	Project Manager	31	Yes	Yes
No. 2	47	Industrial Engineering (B.S)	Planning Manager	24	Yes	No
No. 3	64	Civil Engineering (B.S & M.S)	Program Director	40	Yes	Yes
No. 4	50	Electrical Engineering (B.S) Computer and Control Engineering (M.S)	Quality Manager	27	Yes	No

3.4.6.1. Interviewee No. 1 - Project Manager. Interviewee No. 1 has established a dynamic career characterized by expertise in project management, architectural design, and construction management, spanning multiple sectors and roles.

Commencing as a Project Manager in the Construction Sector, he oversees intricate airport construction initiatives, skillfully leading cross-functional teams with his supervisory acumen. This pivotal role finds him based in Dubai, United Arab Emirates.

Before that, Interviewee No. 1 excelled as a Project Manager in the Architectural and Construction Sector. In Athens, Greece, he demonstrated outstanding leadership and team coordination.

Transitioning to the Infrastructure Sector as a Senior Architect, he managed the compliance program for regional airports' European Union Aviation Safety Agency Certification. His coordination skills and environmental compliance expertise yielded noteworthy results.

Within the Construction Sector, Interviewee No. 1 held the position of Construction Manager. Overseeing a substantial project, he managed infrastructure, finishes, fit-outs, and subcontractors, showcasing his adeptness in meetings, budget management, and stakeholder relations.

As a Lead Architect / Sr. Project Engineer in the Construction Sector, he orchestrated seamless user experiences and coordinated disciplines to ensure architectural integrity.

In the Construction Sector as a Coordinator/Senior Architect Engineer, he played a vital role in shaping a construction project through design management, procurement oversight, and collaboration with subcontractors.

Interviewee No. 1's contributions as an Architect in the Construction Sector highlighted his attention to detail and alignment with client expectations.

Earlier in his journey, he served as an Estimator Engineer in the Construction Sector, meticulously managing costs and crafting persuasive tender estimates for substantial projects.

Throughout his journey, Interviewee No. 1 consistently showcased strong supervisory skills, cross-functional team leadership, and an unwavering commitment to achieving successful project outcomes.

3.4.6.2. Interviewee No. 2 - Planning Manager. Interviewee No. 2 has forged a notable career path characterized by his prowess in planning, scheduling, and project control across diverse roles and locations.

Currently serving as a Senior Planning Director, he orchestrates on-site planning activities, showcasing his commitment to effective project timelines.

Previously, he held the role of Planning Director, followed by an Associate Director Planning position. These roles underscore his strategic planning capabilities.

Transitioning to a role as an Associate Director, he showcased his planning and scheduling expertise.

In the dynamic landscape of project management, Interviewee No. 2 spent significant time in roles spanning project control and scheduling. He also served as a Lead Scheduler Main Terminal Complex, where he honed his scheduling and planning skills.

His journey also included impactful roles as a Performance Manager in Reading, United Kingdom. Additionally, as a Lead Planner, he managed interfaces, mitigated plans, and offered change management recommendations.

Commencing as a Scheduling Engineer, he contributed to Fuel System contract planning. During his tenure as a Planning and Scheduling Engineer, he exhibited comprehensive expertise, incorporating physical progress into schedules and establishing structured databases for precise data reporting.

Throughout his career, Interviewee No. 2 consistently showcased his planning, scheduling, and project control prowess, significantly impacting project success.

3.4.6.3. Interviewee No. 3 - Program Director. Interviewee No. 3 has established a remarkable career marked by significant contributions to the field of project management, particularly in the aviation sector.

His current role as a Principal showcases his dedication to on-site project leadership, consistently delivering outstanding outcomes.

Previously serving as an Executive Director, Package Delivery and Vice President Program Director Aviation, he has demonstrated strategic leadership in driving aviation projects, contributing to innovation and effectiveness.

In his capacity as Program Director, he oversaw notable achievements such as the development of multimodal interchange transport hubs and international airport programs. These projects encompassed terminal complexes, runways, air traffic control systems, and utility infrastructure.

His tenure as vice president was marked by expanding global aviation business and managing high-profile projects in the aviation sector.

With extensive experience at a prominent corporation, he held the role of Director General and Project Control Manager, showcasing his adeptness in complex project management.

He spearheaded diverse projects in the civil infrastructure sector, consistently demonstrating his ability to ensure successful project outcomes through effective resource management and timely delivery.

Interviewee No 3's career highlights his influential contributions to aviation and project management, serving as a beacon of expertise and leadership.

3.4.6.4. Interviewee No. 4 - Quality Coordinator. Throughout his journey, he has held pivotal roles that have contributed significantly to his expertise and growth. His latest role as Vice President and Quality Coordinator for Airport Engineering involves overseeing the coordination of design elements for airport engineering projects. His meticulous attention to detail ensures seamless integration and successful outcomes.

Previously, as an Airport Projects Quality Group Manager, he exhibited adept leadership in supervising a team responsible for executing a range of airport projects.

He has also made substantial contributions to the energy sector, functioning as a Quality Manager for a power plant project which was built in EPC basis.

In various capacities, including Commissioning Manager and Deputy Operation Manager, he showcased his ability to manage operations and orchestrate critical commissioning activities.

Additionally, he played a vital role in an international joint venture company, holding positions such as Deputy Construction Manager, Electrical and Instrumentation Site Superintendent, Instrumentation Superintendent, and Electrical Superintendent. These roles underscore his hands-on experience in various projects, from expansion initiatives to infrastructure development.

His dedication to learning, excellence, and impactful project management has marked his journey. His achievements stand as a testament to his commitment, and his ongoing contributions to future projects are eagerly anticipated.

3.4.7. Post Project Appraisal

The name of the contractor along with the selected EPCM project are kept confidential due to non-disclosure agreement requirements.

While writing the post project report of the project in the selected Case Study, a flow based on the knowledge areas in PMBOK Guide (PMI, 2017) was provided.

An international company performed EPCM services for the design and construction of an international airport project in the country. The client was acting on behalf of the government of the country. The site was on the south side of the city. The project schedule duration was 60 months, which included design, construction, and operational testing.

The prime contract provided for a fixed scope of services with defined deliverables. Project funding was provided entirely by the government. The project being crucial for the country's economic development involved several stakeholders. Project owner also involved project management consultant, airport designer, airport operator, lending banks and their engineers, fuel and water suppliers, local communities, and various experts from the national and international authorities. Thus, the complexity in this project was due to the geopolitical significance of project, the involvement of multiple project stakeholders, the challenging contractual clauses, and the scope interfaces.

The project objectives were clearly stated in the project management plan at the beginning phase of the project, and the project processes were managed, controlled and monitored to realize these objectives throughout the project period.

3.4.7.1. Integration Management. The EPCM contractor had created a project initiation document that covered business needs, current customer needs and the new project to be created, service and deliverables as part of the integration management. The project management plan was created and documented the actions required to define, prepare, integrate and co-ordinate all supporting plans. The company had also analyzed the background of the project by carrying out project management disciplines before starting the work. The project management overview and analysis were also done to identify the main challenges of the project. The EPCM contractor had assigned a project manager who was responsible for managing and overseeing the project integration management tasks;

- Set up a supervisory organization including monitoring systems (refer to figure 3.1) to ensure fast and efficient management of activities, timely completion of works and efficient use of financial resources.
- Set up a benchmarking system as a basis for performance monitoring.

- Project Controls
- Health, Safety and Environmental Precautions
- Contractor Coordination and Supervision

3.4.7.2. Scope Management. The contract, along with its appendices and applicable standards, helps establish the definition of each stakeholder's interest, their power to influence project outcomes, and consequently their role in communication. Design, project management, and construction management services were provided for the project. One complexity in the project was the distribution of scope among the contractors, which requires continuous follow-up and agreement on interfacing between both contractors. The scope interfacing issue list was submitted to the owner and EPCM contractor to inform them about possible discrepancies and risks that could lead to project changes. The scope of the airport project included a new international airport, partially built on an existing site and partially on reclaimed land. Key airport facilities comprised:

- Repair and construction of sea defenses and landfill for the airport site
- Passenger terminal designed to accommodate over 10 million annual passengers
- Runways including full lighting, signage, instrument landing systems
- Cargo terminal
- Aircraft maintenance base
- Special occasion terminal
- Aircraft parking aprons at various locations
- Control tower
- Two airport fire stations
- Airport operations facilities
- Airline support facilities
- Airport road system
- Utility distribution network
- Other utility facilities
- Aeronautical equipment

The scope of services was fully described in the EPCM contract signed and sealed with the owner. A brief description of the scope management was embracing the following:

- Project Management Services

Project Controls Management: EPCM contractor employed monitoring and control systems that it had developed on infrastructure projects via WBS, including major international airport and aviation projects. The following process groups were utilized under the respective knowledge areas;

- Time Control
- Cost and Financial Control
- Document Control
- Reporting

- Design Services

EPCM contractor's scope of services relating to the design of buildings and infrastructure included:

- Soil Investigation Activities
- Environmental Assessment Statement Report
- Site Mobilization
- Buildings
- Infrastructure
- Field Engineering Services

- Supervision of Construction

- Preconstruction Activities
- Contract administration and Completion

3.4.7.3. Schedule Management. The EPCM contractor developed the schedule management and prepared the schedule management plan within the project management framework. The construction activities were described and their duration was determined. The estimated sources of activities were developed in the time schedule.

The EPCM contractor prepared Gantt charts to determine the start and completion dates of the project and used CPM and PERT techniques for time planning. The duration of work was determined and tracked in accordance with the following schedules techniques;

- Schedule Hierarchy

The schedule control framework used a schedule hierarchy to provide the project team and owner with valuable project plans and a wealth of additional information to monitor schedule progress, status, changes and impacts, allowing for proactive schedule control. These schedule reporting requirements and definitions were followed by all subcontractors and contractors. Primavera project planner was used for all level 3 scheduling to facilitate schedule integration activities.

- Milestone Summary Schedule

This schedule identified project milestones, summary engineering, procurement, construction, and startup activities, and the project critical path. This schedule provided an overview of activity status and was used to communicate project status to management. From this schedule, the schedule risk analysis was developed.

Reports:

- Milestone Summary Schedule
- Schedule Risk Management Table

- Project Summary Schedule – Level 2

This schedule provided additional detail over the milestone summary schedule for the project team management. Included were activities for all facilities and all major

equipment. It was updated monthly and backed up by a Level 2 logic network using primavera project planner.

Reports:

- Project Facility and Major Equipment Summary Schedule
- System Turnover Plan to Operations

- Detailed Logic Network – Level 3

The detailed logic network used the critical path method precedence diagramming method to integrate engineering, procurement, construction, startup, and owner activities. Each subcontractor performing work on the project prepared a time schedule by utilizing primavera project planner software. Overall coordination and integration of all subcontractors' schedules were under the responsibility of EPCM contractor. A logic interface list was prepared by the contractor's lead planning and scheduling engineer that summarized the logic interfaces identified by the project performing organizations along with the required and promised dates as agreed upon by the receiving and providing organizations.

- Detailed Schedules – Level 4

An engineering progress and performance reporting system tracked the status of deliverables and calculated planned and actual progress based on earned value methods for engineering performed by the EPCM contractor and subcontractors. Schedule performance and cost performance were calculated. subcontractor proposed a methodology to prepare and track procurement and construction progress in accordance with their standard procedures as modified for the project.

Reports:

- Progress and Performance Report
- Progress S-Curves
- Schedules

3.4.7.4. Cost Management. The cost control system allowed specific modules to be selected to facilitate effective control of specific elements of the project. It integrated and focused on specific contractual commitments and budgets, allocated and planned budget requirements, monitored and identified variances to these plans, assessed projected outcomes of actual performance against plans, and enabled development of prompt remedial actions to ensure delivery. The elements of the system included:

- Budget Control

The project team reviewed the conceptual cost estimate prepared as part of project master plan and recast it as the project budget. The automated system for capital cost control was selected once the capabilities of the expedition system were determined. Project cost budget control submodule was used. It was expected that the first entries in the capital budget control system were made after completion of the conceptual design estimate.

- Change Order Control

The contracts manager through the prime contract administrator had primary responsibility for the identification of the change notice using the trend program. The contracts manager through the prime contract administrator had responsibility for notification and processing of contract change orders. The lead cost engineer priced all change orders, and the lead planning & scheduling engineer provided the schedule impact analysis.

- Trend Program

The primary responsibility for identifying, tracking, resolving and reporting cost and schedule trends was held by the lead cost engineer. However, emphasis was placed on common ownership of the budget by the entire project team, joint responsibility for the profitability of the project, and the need for proactive involvement in the entire trend program. Of particular importance was the need to identify potential trends early so there was time to take mitigating or corrective action.

In accordance with contractual requirements, the project scope, total installed cost and overall project schedule were reassessed on a quarterly basis. Forecasting included a reassessment of risk, an expected range of accuracy, a recommended contingency and a resulting probability of overrun. The forecasts have been compared with the previous forecast and with the trend value.

Reports:

- Trend Report including Summary and Register
- Forecasting

3.4.7.5. Quality Management. The project quality management system was developed and followed meticulously. This system facilitates transparency and builds trust among stakeholders, ensuring that the project outcomes will fulfill the defined objectives. The project quality system was based on the EPCM contractor's quality and environmental management system, certified to meet ISO 9001 and ISO 14001 requirements.

The project quality management was comprising in all phases of the project, including design, procurement, construction, commissioning and handover. EPCM contractor's headquarter management supervision visits took place every six months throughout the project duration.

Coordinating the development of the project management system to meet the execution strategy contained in the project execution plan and the requirements of the contract was the main QA activity in the early stages of the project. A project quality plan identifying the procedures to be used by each project function to cover their aspects of the work was developed by the project QA manager. All project management system documents (manuals, plans, procedures, instructions, etc.) were subject to QA approval before being released.

The project quality plan was generated and addressed the entire work scope activities of the project as defined in the contract. Therefore, this plan, containing all detailed tasks,

responsibilities, procedures and deliverables, was the priority document for the project, issued under the authority of the project manager.

The subcontractors involved in the project were expected to utilize their own quality management systems, however each were checked by the EPCM contractor's project quality management to ensure that the requirements of ISO 9001 and ISO 14001 were met along with the project specific requirements.

Regular audits were the main quality management activity throughout the project. A coordinated audit plan had been initiated early in the project and a number of audits had been carried out in key areas during the early stages of the project. The audits were based on a number of factors, including risk, and covered both quality and environmental aspects.

Subcontractors, including design subcontractors, were audited by the quality management team to assure compliance with contractual quality requirements. Generally, these external audits concentrated on the internal management system audit/review capabilities of those being audited. Only if these revealed deficiencies were additional audits of work processes imposed. Internal audits of the project team at all locations were also carried out to determine the suitability of project-specific procedures and compliance with contractual and company requirements.

3.4.7.6. Resources Management. The EPCM contractor carried out a resource estimate and identified the resources required. The company prepared a resource management plan that included the people, materials and infrastructure (materials, equipment, facilities, services, information technology, information and documents, funds) required to carry out the project activities. The project organization was defined and the project team developed. Due to the very large scale of the project, several highly experienced experts worked on the project.

EPCM contractor assigned a project manager who was responsible for managing and overseeing all obligations under the three phases of work described below. Project core teams are identified and their participants were nominated from all key stakeholders. For

example, the core team for project time schedule, civil, architectural, mechanical, electrical, and construction established.

The company provided all the necessary experience, expertise and backstopping skills to meet the expectations of the client and the beneficiary. The organizational structure of the project is shown in Figure 3.2. separate staffing plans were prepared as a basis for the costs associated with each phase of work. The project manager resided in the project site at the earliest practical convenience to optimize the effectiveness of their interface with the owner. A prime contract administrator was assigned to the project upon award to implement the tools and systems necessary to effectively manage the contracts for each phase of work.

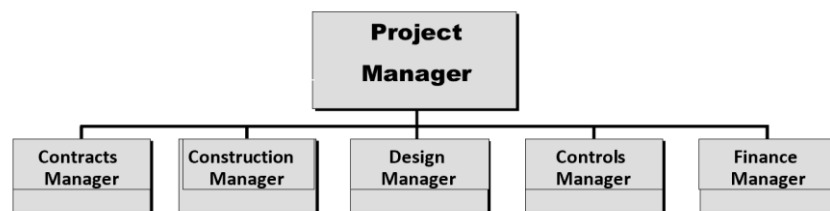


Figure 3.2. High Level Organization Chart.

- Contract & Procurement Organization

The contracting plan involved the tendering and administration of nineteen (19) major erection subcontracts for the entire scope of the project. These major erection contracts were a combination of re-measure, fixed-price, and lump-sum turn-key (design & build) contracts. The contractor's scope of supply included the procurement of all equipment and materials for each major erection contract. All major erection contracts were tendered, formulated and administered by the project contracts group. These included common minimum acceptance criteria for the key project performance elements of safety, quality, sustainable development and cost and schedule control.

- Construction Management Organization

Construction management staffing has been developed based upon similar experience on previous airport projects, in conjunction with the principles critical to successful achievement under the contracted cost and schedule constraints. The most important principle requiring focus will be interaction with the design group, as over half of the works performed on the project require construction contractor design refinement. This must in turn be verified with respect to all project design parameters. Additionally, the multitude of interfaces between subcontractors and activity disciplines will require management vigilance to ensure acceptable construction quality is achieved within schedule timeframes. Ideally several members of the EPCM contractor's design team, assigned to on-site support, should be transitioned to the construction management team to monitor the construction. A resident engineer of the EPCM contractor has been appointed as the main person responsible for the supervision and management of each of the contracts.

- Design Services Organization

The EPCM contractor managed the entire design scope, integrated airport-wide concept designs, and self-performed Packages D and E. Packages A, B, C, and F were subcontracted. Each package or sub-package had been competitively bid out to at least three firms.

- Project Control's Organization

The focus of project control for the project is mainly the control of cost, schedule and lump sum budget of the EPCM contractor for engineering and management services.

The project controls philosophy is to provide the information to the project team as necessary to monitor and control the project's execution. Therefore, individuals in the project take ownership of the schedule and cost their area of responsibility. To accept the respective people to take responsibility, key documents are reviewed and signed off reciprocally.

- Financial Management Organization

The finance and accounting manager's organization, working in concert with the project controls group will develop a project business management approach to project execution, internal control of cost commitments, budgets, forecasts, etc. Integration of the financial systems with the systems and work processes of other functional groups will deliver the required results to the project.

The EPCM contractor's project books will be maintained in EPCM contractor's satellite office outside of the country. However, the finance and accounting functions were performed by project accounting staff assigned to EPCM contractor's office in the country.

3.4.7.7. Communications Management. This major project necessitated scheduled communication routines for all key stakeholders. Due to the project's complexity, these communication requirements were explicitly included in the contractual agreement. The contract detailed "what is to be done" and "why it is to be done." During the planning phase, the communication tools and practices, which outline "how to be done" and "when to be done," were agreed upon.

In this sense, project communications management aims to ensure timely and appropriate generation, collection, distribution, storage retrieval, and ultimate disposition of project information. Since high number of different key stakeholders involves in construction projects and they need timely and accurate communication, project communication management plays a key role in successful project completion. Therefore, regular meetings with various stakeholders, daily, bi-weekly, monthly progress reports, official letters & notifications, e-mails, and presentations were the main communication instruments of the project. Periodic inspections and site meetings were also held between the company's team and the contractor, during which the contractor presented progress over the previous week and proposed works for execution in the following week. These meetings were the vehicle for identifying any delays in the overall schedule and for reviewing the measures that the contractor proposed for overcoming these delays.

The communication matrix, developed during the project planning phase, provides the foundation for agreeing on communication routines between project stakeholders. Many routines in this matrix are linked to contractual requirements. Consequently, the objective for each communication routine is defined. Additionally, the medium of each routine, its frequency, and the audience/participants to be invited are specified. The communication routine owner is designated, along with the deliverables to be furnished. It is important to note that although this communication matrix was developed during the planning phase, new communication routines are added as work progresses and certain risks materialize. The EPCM contractor maintained the confidentiality of the client's information pertaining to their works or activities. No information was disclosed to third parties without the written consent of the client.

This management group involves identifying external and community risks and developing mitigation strategies. It must manage external issues and maintain effective communication with staff and project stakeholders that could affect the project schedule and budget. Therefore, the software and hardware infrastructure team implemented EPCM contractor's system as in figure 3.3 below to accomplish the required communication management tasks to ensure the success of the project.

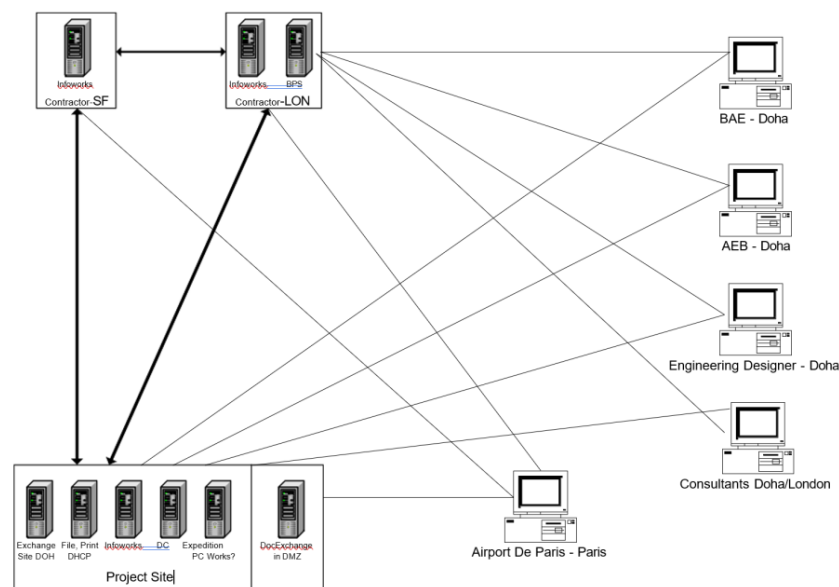


Figure 3.3. Data Flow Schematic.

3.4.7.8. Risk Management. Risk management was one of the key components of project management and ensures that undesirable situations that may occur during the project are minimized or their consequences are mitigated. The primary approach to this subject management was that although we cannot predict the future, we can anticipate uncertainties in the project and minimize the effects of these uncertainties by creating a simple and effective risk management plan. The management of uncertainty was an intrinsic aspect of this project. Although a comprehensive risk register was developed at the outset of the project, it was unavoidable that some risks had not been anticipated. Therefore, the focus of risk management was on assessing significant risks and implementing appropriate risk responses.

Risk management should be a continuous process to support the development and implementation of the organizational strategy. It should address all risks associated with activities in a systematic manner. When it comes to risk management, the first thing that comes to mind is generally negative risks. However, the modern risk approach requires that positive risks, in other words opportunities, should also be recognized and managed.

Risks are discussed in both official and unofficial meetings. A formal risk management plan is deemed unnecessary due to the project's limited scope. Financial risk is addressed in the early phases of the project, but in the later phases, it is recorded in the minutes that everyone should "stay within the budget." The project generated a risk management plan. This plan describes how risk management to be structured and realized in the project to cover the following aspects;

- Identification of risks

Risks in the project were started to be identified from the first step of the project and new risks and / or transforming risks were identified throughout the project. Below were the potential risks identified at the commencement of the project;

- Delays in construction,
- Delays in finding suitable subcontractor for the execution of works as per the schedule,
- Shortages in the key construction commodities in their supply,
- External factors through the stakeholders,
- Potential issues with the environmental aspects,
- Changes in law,
- Political risk,
- Warranties,
- Liability and indemnifications set out in the contract.

- Assessment of risks

It is neither necessary nor possible to consider all risks in risk assessment. Otherwise, hundreds of risks and their follow-up will lead to both time and labor losses. Which risks to be followed and evaluated had been handled with risk assessment / risk analysis methods. The situation identified in the project was the result of risk analysis run within the framework of the risk management plan and to eliminate the risk.

It is very important to sort all risks in order of importance. As not all risks have the same order of importance and cannot be evaluated equally. Some risks have more impact than others. Therefore, it is necessary to spend more time/effort on risks that will cause large losses of earnings. For all these, project's risk management team make a risk assessment via the probability of the event causing the risk (prediction) and the effect of the event causing the risk (evaluation) and create a risk management plan according to the results.

Qualitative risk analyses were also used when there is no reliable and sufficient quantitative data. For qualitative risk assessment, instead of numerical values, qualitative impact values such as very low, low, low, medium, high, very high indication factors were used.

- Determination of responses to risks / creation of action plans

Implementing a risk response plan was the precaution to the project to enable preventing emerging threats and minimize their negative impact. The following risk responses were implemented;

- Avoidance: Avoiding the risk that may arise by making changes in the project plan. In short, it is to look for other ways to realize the work.
- Transferring: Transferring the risk to another organization or individual. In this practice, the risk will not actually be eliminated, only the responsibility of the risk will be assumed by someone else.
- Mitigation: The most comprehensive category of responses is the one created to minimize risks. It is the work of creating a risk response plan by taking additional measures to reduce the impact or probability of realization of these risks after the risks that may be encountered are identified.
- Acceptance: The last reaction is to accept the risk. Trying to take precautions against all identified risks may increase the project budget considerably. In this case, the project parties monitor such risks throughout the project and activate other response plans when the probability of affecting the project increases.

- Controlling and Reporting the Risks

After determining the appropriate risk responses for each identified risk, action plans were made and put into practice. Of course, as in every action plan, a responsible person is determined for all actions and the final state of the risk is monitored within the time plan.

A very important step of the Risk Management Plan was the reporting of all these risks for the follow-up and awareness of all stakeholders and management. In all review meetings and even in the main project team evaluations, the top 5 risks and the action plan of these risks were circulated with the whole team. The change and results of these risks over time were also shared with the team to follow up.

The risk management plan defines how and how often risk management processes will be performed and determines risk management activities. It also contains the methodology with approaches, tools and data sources used to implement risk management.

3.4.7.9. Procurement Management. The company employed the project procurement management approach and successfully completed the nineteen (19) Major Erection Contracts which were a combination of re-measure, fixed price and lump-sum turn-key (design & build) contracts as noted in Table 3.5 below:

Table 3.5. Contractors' Packages for the Overall Scope of Works.

Area	Package No.	Scope
Area 1 Airfield	Package No. 1	Site development, construction facilities, site infrastructure.
	Package No. 2	Site Reclamation, Retention Pond
	Package No. 3	East Runway/Taxiway System, Isolation Pod, North Retention Pond
	Package No. 4	West Runway/Taxiway System
	Package No. 5	
Area 2 Airside Support Facilities	Package No. 6	Sea Rescue Stations, Main Fire Station, Fire Training
	Package No. 7	Cargo Terminal, Cargo Agents/Mail Terminal, Courier Terminal
	Package No. 8	Fuel Farm
Area 2 Airside Support Facilities	Package No. 9	Maintenance, Catering, Airport, Administration, Facility Maintenance, Medical Center, Airline Operations, Airline Engineering, Meteorological Complex, Transmitter Station
	Package No. 10	Air Traffic Control Tower, Radar
	Package No. 11	General Aviation Building, Aircraft Maintenance
	Package No. 12	Airside Roads, Lighting and Signage
Area 3 Terminal	Package No. 13	Passenger Terminal Complex, Central Plant, Remote Aircraft Parking
	Package No. 19	Passenger Terminal Foundations
	Package No. 14	Special Occasion Terminal Complex
Area 4 Landside Support Facilities	Package No. 15	Apron Fuel System, Main Electrical Substation, Solid Waste Plant, Wastewater Treatment Plant

Table 3.5. Contractors' Packages for the Overall Scope of Works. (cont.)

Area 4 Landside Support Facilities	Package No. 16	Landside Roads, Lighting and Signage
	Package No. 17	Landscaping and Irrigation
	Package No. 18	Landside Buildings
	Package No. 19	Furnish Project Concrete and Asphalt

- Pre-qualification: The contracts department, in conjunction with engineering, construction, and input from the client, developed a recommended slate of bidders. Package-specific prequalification questionnaires were developed, including selection criteria based on contractors' regional and/or country experience and demonstrated ability to execute projects of similar size and complexity. Pre-qualification evaluation criteria based on a weighted matrix approach were prepared and submitted to the client for approval prior to receiving the pre-qualification submittals. Formal prequalification visits and interviews were, if necessary, conducted jointly by contracts, engineering, and construction to verify and validate the proposed contractors' ability to successfully execute the Works.
- Tender package preparation:
 - Request for tender letter
 - Instructions to tenderers
 - Information for tenderers
 - Form of proposal
 - General conditions
 - Special conditions
 - Pricing and payment
 - Scope of work
 - Drawings and data
- Pre-Tender Meeting and Site Visit: A pre-tender meeting for each tender package was held after issuance of the tender documents to the pre-qualified contractors. The purpose of the meeting was to address any clarification questions the tenderers may

have and to ensure that they fully understood the tender documents. A visit to the work site was also organized at the conclusion of the pre-tender meeting.

- Tender Clarification: The contracts manager was the only point of contact for all communications during the tender period. There were no verbal communications allowed, and Tenderers were required to submit any clarification questions they may have in writing. Depending on the nature of the questions, input from the affected disciplines was solicited, and written responses were issued by contracts to all tenderers.
- Tender Opening and Evaluation: Tender selection and evaluation criteria were prepared and submitted to the client for approval prior to the tender due date. A budget estimate was prepared by project controls and included in a sealed envelope to be opened only at tender opening. Tenders were submitted in sealed envelopes marked “technical” and “commercial”. Tender opening was public, and all tender prices were read aloud and recorded in the tender opening form. Any tender received after bid opening was also rejected and returned to the tenderer unopened. A tender evaluation team was selected with members from the participating disciplines, and the contracts representative led the team. Tenders were evaluated based on the pre-approved technical and commercial criteria. Only the technical envelopes were released to engineering to perform the technical evaluation, scoring, and ranking. This was followed by a commercial evaluation to identify the lowest evaluated tenderer. In the event clarifications were required with the lowest evaluated tenderer, meetings were held to resolve any outstanding issues. All such meetings were documented in meeting minutes and kept on file in contracts.
- Recommendation for award: A contracts representative led the effort in preparing a Recommendation for award for submittal to the Client. The following input by discipline was included in the Recommendation:

- Technical analysis
- Constructability, construction approach, method statement, equipment and workforce
- Schedule
- Safety and environment

Once owner approval was obtained, the selected tender was called in for further negotiations and/or clarifications and conforming the Contract.

- Re-award/construction kick-off meeting: A pre-award kick-off meeting was held with the successful subcontractor, attended by representatives from the various disciplines, to explain to the sub-contractor issues such as insurance, safety, invoicing, correspondence and messaging, site regulations, etc. The subcontractor was then invited to attend the kick-off meeting at the end of the construction period.
- Construction contract administration: Administration of contracts was based on the EPCM contractor's corporate standard "blue book" and "brown book" processes and any requirements included in the main contract.
- Backcharge notices: Backcharge notices were used if a subcontractor failed to fully comply with the terms of its contract and was identified as responsible for damage to another subcontractor's work. If the subcontractor refused or, through its actions, showed an unwillingness to perform the corrective work after written or verbal notification, a formal claim letter was prepared by the construction division representative and provided to the contract's division for recording, issuance to the contractor, distribution and filing.
- Contract Closeout: Closeout planning commenced at the outset and was confirmed at least 30 days prior to scheduled completion and was carried out in conjunction with field engineering and construction's punch list and turnover procedures. The contract administrator managed the closeout paperwork and liaised closely with field

engineering and construction. Retention and final progress payments were not released until closeout was complete.

3.4.7.10. Stakeholder Management. It is inherent to construction work that requests for information and further instructions on details are made with some regularity. Therefore, the EPCM contractor established a transparent and systematic protocol for site communications. This protocol included procedures for requesting further information from contractors and specified the format for responses. Additionally, it delineated the levels of authority required at different communication levels. With this achievement, the EPCM contractor ensured that the client and other relevant parties were kept informed about progress and any issues that arose on site. This was achieved through regular briefings and the implementation of a monthly reporting system.

The EPCM contractor identified the external and community tasks facing the project and developed division of responsibility matrix. By this way, it managed external issues and maintained effective communication with staff and project stakeholders that could have affected the project schedule and budget.

In order to overcome the consequences of the risks, the following consultations had been performed via the respective groups of the project;

- Country's local officials and other key stakeholders to identify potential issues, concerns and anticipations,
- Local residents and affected owners on the construction area,
- Maintaining balance between national interests of the country and its residents throughout the development and construction of the project,
- Approaching and establishing transparent and timely communications with all stakeholders.

The goal was to stakeholders' expectations, and establish and maintain a positive reputation for the EPCM contractor in the country.

3.4.7.11. Health, Safety, Security, and Environmental Management. The EPCM contractor believed that all accidents are preventable. Demonstration of EPCM contractor's dedication to this aspect to customer as safety excellence was also another point of interest to the project. In this sense, the objectives set out in the health, safety, social and environmental management plan were as follow;

- Elimination of all injuries and illnesses,
- Treating safety as an equal value to the other target business units of the project,
- Dedication, awareness and assignment of ownership of HSE programs,
- Directing and controlling subcontractors to stick with the safety commitment,
- Necessary training to be provided to the project employees and subcontractors to get them understand how behavior-based safety contributed to accident prevention and to use these skills to improve safety in the workplace,
- Generating the project HSE plan with regards to the commitments made by the project and setting down the framework for the stringent implementation of it.

3.4.7.12. Financial Management. The business management group provided finance and administration support for the project. The finance and accounting manager's organization, working in concert with the project controls group, developed a project business management approach to project execution, internal control of cost commitments, budgets, forecasts, etc. Integration of the financial systems with the systems and work processes of other functional groups delivered the required results to the project.

A set of project books was established for project in which all project payments to vendors and sub-contractors were recorded. All disbursements to vendors and sub-contractors were approved by the project director and made from the project's bank account. Finance and accounting in the country provided the following services in a timely manner:

- Finance and accounting management
- Accounts payable
- Accounts receivable

- Banking
- Legal entity
- Treasury functions
- Payroll
- In country statutory/tax reporting
- Monthly client reporting
- Project accounting

The finance and accounting team, working closely with the project leadership team, supported the implementation of the project execution plan with particular attention being paid to the following activities:

- Finance and Accounting Functions: The finance and accounting operations provided project controls with current project expenditure data, using the Oracle general ledger application and internal reports available from the centralized corporate reporting system. The finance department's duties will include, in addition to those mentioned above:
 - Preparing EPCM contractor invoices and cash requests for submittal to project's steering committee on an assigned schedule.
 - Processing travel and other project expense reports.
 - Maintaining time and attendance records for all EPCM contractor's staff in order to trend and track non-manual job hours.
 - Banking and cash management following established corporate procedures for forecasting, administering and accounting for project funds.
- Asset Register: Assets were defined in line with project steering committee's procedures and requirements, with the data being compliant with project steering committee's selected system. EPCM contractor compiled the data and assisted in populating Project's asset register, with respect to office equipment, IT hardware, leasehold improvements, and small tools purchased during the project. The method

for project capitalization was agreed with project's steering committee. This was done in consultation with project controls.

- Banking: Bank guarantees, performance bonds, and retentions for the supply of equipment and services negotiated with suppliers were managed by the project finance team in accordance with commercial terms of those supply agreements.
- Payroll: EPCM contractor's staff were expected to work the hours necessary to perform their job, irrespective of additional variances to the standard workweek. Overtime beyond the approved extended workweek was paid for special events that had been planned and for which prior approval had been obtained.
- Taxation: A successful outcome of the project required that all tax exemptions were realized. Purchase orders and contracts were structured in such a manner to ensure that there were no unnecessary tax exposures. EPCM contractor's procurement organization worked closely with project's steering committee to ensure that the appropriate wording was included in purchase orders and contracts.
- Audit Plan: Project's steering committee periodically audited the project's activities. These activities were not limited to accounting and finance but covered all functional areas. These audits were undertaken by an off-project team from project steering committee's internal audit department or by the secondment of an employee.

4. RESEARCH FINDINGS

The research was conducted as qualitative analysis, and the experiences and opinions of the participants were analyzed in detail.

The interview questions were thoughtfully designed and tailored to construction professionals, with the following objectives in mind:

- Assessing Awareness and Knowledge: Assess the level of awareness and understanding of Project Management Methodologies and Standards among these key personnel.
- Investigating Project Management Knowledge Areas: Explore the practical application of Project Management Knowledge Areas within the context of the case study project.
- Evaluating Project Management Success: The interviews explored the degree of success achieved in implementing the Project Management Knowledge Areas within the case study project.
- Analyzing Project Management Criteria: Examination the impact of Project Management Criteria on the overall success of the project.

Assessments of each of the project implementation practices is obtained by using percentages of frequency distribution and responses of respondents under each knowledge areas per the project's processes as presented under the research framework section and results are discussed in the following sections.

4.1. Integration Management

Within the success goals of the project, it is very important for the key managers of the project to feel the senior management support behind them in order to be able to execute

the project. In this respect, the employees in the project want to see and feel a strong senior management behind them in the struggle in the field.

“During the project execution, I noted that they felt this power many times in the steering committee meetings we held with the employer, because it is considered to be very important for the employer to see this power as a component of the project and to treat the managers who manage the work with respect.”

“Well, there was a lot of emphasis on senior management, we were all of a sudden thrown into a spotlight, you were the spotlight, you were in a very, very visible environment in terms of senior management, so you got a lot of you got a lot of high-level help.”

“The support from the senior management is good as far as you can get the priority on the job”

When the project reaches the planning stage, the execution strategy of the project is determined and an execution plan is written. Within this execution plan, it is aimed to achieve the targeted goals at the end of the project by shaping the relationships between the knowledge areas that I have researched in this thesis. The execution plan can be described as a handbook that determines the communication and methods of the project with the stakeholders and the actions to be taken by the Contractor while performing the work and in accordance with all contractual specifications. Accordingly, we can see this execution plan as a project manual that includes the components specified by process groups in the conceptual framework.

“If we consider the project as a work to be performed by an orchestra, the project manager is the conductor of this orchestra and the notes to be played are the works defined under knowledge areas.”

The practice of good project integration management is essential to avoid liability through appropriate coordination of project activities, and to ensure that projects are

completed smoothly, without delay and with high quality. In the present study, the positive outcome of project integration management is indicative of the fact that the development of a project management plan, such as management of project work, monitoring and control of activities, and a plan to hold the different parts of the project together and integrate them into one, was attempted at a satisfactory level. However, there were cases where project integration management was not practiced and there were fragments of activities which led to a lack of synchronization between the different parts of the project, which in turn affected the time and cost management of the project.

The project schedule had undergone multiple changes and revisions and the initial schedule also termed as “Contractual Schedule”, which was developed to fulfill the contractual requirements.

It was emphasized that there is high importance of having an Enterprise Resource Planning (ERP) system capable of linking the project management phases specified in the standards and providing usable data reporting.

“Although data could be recorded, accessing, collecting, reporting and gaining a clear understanding of the situation could be difficult or even impossible without an appropriate ERP system. Of the project issues most difficult to manage, senior respondents considered integration issues to be the most challenging, followed by communication and people issues”

4.2. Scope Management

At the initial stage of the project, more information about the project is acquired from the sponsor and the business development team of the organization. Discussions with the key stakeholders to understand the reasons for undertaking this project and to understand the business needs and expected outcomes of the project. It is obvious that since the construction projects are goal-oriented and the scope is clearly defined through a contract, project charter, project management plan, etc. A project can only be completed when all the requirements in a contract have been met.

"Scope is really important and if you are in control of your inputs, you have a better chance of being in control of your outputs."

As the project evaluated under the case study was carried out for an external client, there must already be an agreement/contract in place between the client and our organization. The contract/agreement is the source that provides information about the customer's expected objectives. From the contract one can understand the scope of the project and other constraints such as time and cost that are agreed.

"The project team should also clearly understand the objectives and goals of the project. They need to reach a formal understanding with the sponsor and other key stakeholders about the project requirements, objectives and end goals to be achieved."

It was observed that the performance of project in terms of scope management was average; the gaps noticed in terms of scope management were mainly due to factors such as design changes increasing the scope of work, tight schedule and procurement difficulties. In addition, change management and its inadequate planning and execution had an impact on project duration and cost overruns.

"Although the project management is aware of the key milestones, the rest of the staff were not aware of them as they tended to concentrate only on their scope of work"

"They also monitored and controlled project work effectively, identified, assessed and managed change throughout the project lifecycle, and completed all activities for the formal closure of the project. Those who failed either did not complete these processes in a timely manner, or completed some but not all of them, resulting in a lack of focus in managing their client's project."

The project manager felt that he is unable to clearly define, understand, and control the scope to the whole team for several reasons: therefore, his team members did not get enough

detail from their client, the project managers had no fallback plans and had failed to clearly state project objectives to their team members.

"Present a clear vision and focus and give the team a real objective, let them know where it is, let them know what it is, let them see what it is and let them contribute towards that vision."

The project reports reveal that all requirements are documented to the extent possible by the project team and that technical requirements are collected and quantified using standard forms. A company-wide classification system is used to record deliverables, in line with the project's WBS.

"Lack of focus on what is important is why some packages' schedules are falling late and overspent."

During the execution of the project, some managers allowed their team members a lot of freedom, but quickly found out that they were becoming victims of scope creep. These managers suggested that although this freedom helped keep their team members working and interested in the project, they needed to limit the amount of freedom and hold team members accountable for the tasks assigned to them by the project manager.

"Internally, we had to re-focus and re-target our team, so we had to change people's attitudes, give them clearer goals and get them to achieve them. As soon as you get people to understand what they have to do and to do it, then you start to see the project moving forward and people start to see the light."

4.3. Schedule Management

During the planning phase, the project team used tools such as cause-and-effect, flowchart, control chart, Pareto, histogram, control chart and distribution chart to help make decisions.

“Well-planned projects, delivered to the desired level of quality, resulted in increased productivity, reduced costs, increased stakeholder satisfaction and improved profitability.”

“WBSs are arguably the most valuable tools available, and together with the project scope and requirements, they provide the basis for task identification at all project / schedule stages, and for planning and assigning resources that encompass all the other core project management issues.”

Delivering a project on time was a challenge and usually took more time than originally planned. The duration of the project was usually not properly planned and the duration is extended due to lack of follow-up of project activities and poor scheduling. Strict monitoring and control systems and appropriate use of human resources, together with improved communication between different parts of the project team, can improve the challenge of project time management.

“Schedules are reviewed and approved by all project team members, suppliers and customers.”

“Management portfolio and business unit strategic decisions are based on efficiency and effectiveness metrics.”

“A typical day starts with tracking where we are today compared to the actual plan[...] having an overview of the whole project and then meeting my project controls team followed by a daily progress meeting with the project manager for updating him with the status report. My job is also to analyze the risks and raise an alarm if there are any issues that can affect the critical path or near critical path.”

If the project is going behind schedule, then the corrective action will be something that can help speed up the remaining work so that we can make up the schedule variance. If, after conducting a root cause analysis, the team realizes that the schedule variance has occurred because of a lack of clear management direction to the team, then the preventive

action will be to provide clear direction and information to each team member for their respective work so that similar variances will not occur in the future.

“The biggest issue to arise with respect to schedule management was difficulty finding a uniform time for weekly team meetings and occasional client meetings to track down the schedule analysis.”

Project schedule variance means that some of the tasks on the critical path have variances. Some of the critical tasks are behind schedule. If the variance requires intervention, the team will identify means to accelerate the remaining project work. Priority must be given to accelerating the work on the critical path without unduly neglecting the non-critical tasks.

“Planning, scheduling and control was important to track down the activity’s importance. The activities on the critical path are the ones that the majority of the focus to be kept on.”

4.4. Cost Management

Earned value management is a technique which is used for numerically calculating the schedule and cost variance in a project. It is used for calculating the schedule and cost performance index of the project. This is also used for creating new cost and performance forecast for the project. This technique is used in the project for the quantification of planned value of work at different points in project schedule, earned value of work and actual cost of work completed.

“Earned value management is simple, yet a very practical and effective technique for ascertaining the variances and performances of the project numerically so that the team can make meaningful forecast and also identify appropriate corrective actions for managing the variances.”

The interviews revealed that the cost schedule is frequently misread or misunderstood by the clients, and that the clients is unlikely to listen to expert advice in this area. When the client hasn't decided on the project's requirements or design, predicting a price and timetable for the project is exceedingly difficult. It takes time to develop a cost schedule, and the expenses are usually stated as a range of uncertainty.

“A cost overrun due to an unplanned elongation of project duration resulted in as a consequence of changes or delays in Owner’s requirement. This case resulted in rise in cost of individual items and problem of cash management. The good performance of project cost management coupled with a poor project time management led to project delay or failure and waste of resources.”

4.5. Quality Management

During quality management planning, the team decides the relevant standards and processes to be followed during product development including the reviews, testing etc. The management will have to ensure that the team actually follows the chosen processes and standards for development. The management also plans for regular quality audits for ensuring process compliance. Complying to the processes and standards ensures the team ends up developing the desired product without any defect. This method of ensuring quality through adherence to standards is known as quality assurance.

“Compromised quality of project was a result of multiple factors having an independent and interacting influence. It might be the poor project time management in combination with rising prices of materials as project duration gets elongated that played the major roles in poor practice of project quality management.”

Quality process is well documented with respect to the organizational standard. Management involved in quality oversight for the project. Basic organizational project quality policy has been adopted. Management encouraged quality policy application on large to have visibility.

Quality management has to ensure quality reviews at supplier's premises and construction site also. If the material or service is not acceptable, change is requested through quality management.

"I work as [...] quality reviews and I am generally engaged in one project at a time. My job involves reviewing the supply quality as well as the field quality technically [...] visit a site for reviewing the quality. [...] I have to also make sure that all the concerned departments such as construction, logistics and procurement are informed regarding the recent development."

Quality management team, composed of certified and experienced professionals from various fields, including engineers. These team members were well versed in working in different environments and possessed the necessary knowledge and experience to meet the standards imposed through the respective contract specifications.

"Quality management was of paramount importance to the success of the project and he were keen to emphasize their commitment to the delivery of high-quality work on their projects by maintaining the strict adherence to documented QC/QA procedures and guidelines."

The process of establishing project standards in the preliminary design phase and their subsequent integration into the design and contract processes. It is important to control the quality of work during construction, as even minor errors, if overlooked, could lead to significant problems in the future.

" Quality should be a focus from the beginning of the project through to final completion."

4.6. Resource Management

Appropriate human resource management in project has been observed having a positive link with project duration. A sufficient number of human resources with proper training and motivation contributed to the success of project management performance.

The fundamental principle that underpins this field, emphasizing that it was not merely about cost-cutting but, more importantly, about selecting managers who possessed in-depth knowledge, extensive experience, and the requisite qualifications.

“Building an experienced and skilled management team and workforce was the cornerstone of success in the project”

A project manager held a role similar to that of a cruise ship captain, ensuring a smooth journey through a set of responsibilities that encompassed formulating strategies, task delegation, ongoing progress monitoring, fostering coordination among team members, and promoting collaboration.

“as a project manager, one should consider it their duty to oversee the development, implementation, launch, or even the comprehensive overhaul of an organization's existing strategies. To achieve these goals, one needed to continually refine leadership abilities, coordination skills, and motivational techniques. “

“The people management is very vital. If you don't give a proper direction and training to your human resources, you cannot get the desired result.”

Resource planning process documented to match project requirements to schedule. Resource forecasts used for project planning and prioritization. Project team performance measured and integrated with career development. Resources selected based on training and prior experience.

“HR management is one of the main aspects I would say for getting the work done by the team. I sit with my team very often, spend time with them. The focus is on the employees’ performance enhancement, learning and self-development.”

Resource management is important for a project management’s success.

“If you have the right and motivated resources for the right job half of your work is done and this is why senior managers focus a lot on the wellbeing of employees. A happy employee will perform better and also keep the client happy.”

“The resource commitment process certainly offers some challenges. The important thing is that the skill set of those people need to match the requirement role, thus leading to inefficiency.”

4.7. Communication Management

Project communication management is vital for coordinating the various teams and put the different pieces of a project together to achieve project goals. The poorly practiced communication management could have been due to irregular and unplanned communication, unscheduled meetings and lack of devotion for work. This poor communication management in turn would result in gaps between the various teams leading to an uncoordinated activity resulting in poor time and quality management.

“As most of the work is done on ERP systems effective communication is very important. I have to communicate with lot a of people on the ground to understand the actual status of the project who are from various backgrounds.”

The project team members have good writing and speaking skills to communicate effectively during collecting the data as well as during collating and sharing the communication by report. At certain instances a presentation to higher management is compulsory regarding the progress.

A problem between the team members is most likely to arise when the team members accepts attendance to meetings, but do not show up, because they do not understand the importance of their attendance, which leads to the meeting not taking place.

“The biggest issue which I think stands out across the board is simple communication. Communication in my opinion is the biggest factor that will impact your project, absolute key is to get that right.”

“The clarity of communication and the clarity of goals, making sure that everybody understands at higher level and detailed level of what they need to do.”

4.8. Risk Management

The project was susceptible to various problems and risks. The risks that project was exposed to were mainly ambiguities in the definition of deliverables, inadequate prioritization of project' packages, insufficient allocation of funds and resources, conflicts and unavailability of division of responsibilities between the project's packages, changes in laws and regulations, complex schedule and cost forecast plans.

“project management plays an important role in reducing the chances of such undesirable events through appropriate action.”

It is important to categorize the risks that arise during projects and allocating responsibilities to executives, project leaders and project teams according to the authority they have to deal with them.

"Risks are ranked according to their significance, taking into account both the probability of occurrence and the impact on the project.”

Inappropriate risk management, have consequences such extension of project duration, and cost overrun. Risk management processes are utilized and metrics are used to support

risk decisions at the project and the program levels. On the other hand, the involvement of Owner to the risk management process could not have been achieved at the required level.

Management consistently involved with risks on large, visible projects. This would enable the project to be able to properly prepared and respond to the risks that appeared throughout the project.

“Management is actively engaged in organization-wide risk management. Risk systems are fully integrated with time, cost, and resource systems.”

“You should be able to manage your risk and take acceptance for risk. Something we are not good at in the company. Manage your risk but be prepared to take an acceptable level of risk.”

“Yes, the project I have been on either did a risk assessment at the front end, the majority of the projects don’t do risk assessment at the front end, the risk is acknowledged and known at the business end who are making decisions to where to go for it and I suspect its more Owner based driven than others.”

4.9. Procurement Management

Procurement management was a continuous process that begins with the initiation of a project and continues until the project’s completion. Procurement management in the project involves acquiring suppliers’ goods and services to complete work on projects.

“Procurement management becomes critical when there are multiple suppliers working on a project. The issues reported are related to timely deliveries and also to the conformity of the parts delivered.”

The changes requested by the Owner created lengthy purchase requests and processing time have impact the project to an increase in cost. These changes had negative impact to

the procurement management plan. Regardless, the average project procurement management in the project, however, is an encouraging performance as it greatly impacts the successful completion of a project positively.

“As a project manager, you can either stick your head in the sand and say “This type of project is not for me” or you can consciously respond to the challenge. In fact, if you want to remain a project manager, you ultimately won’t have a choice as project management to involve the procurement challenges and manage the completion of the contracted work.”

4.10. Stakeholder Management

Project was motivated to be undertaken to fulfil stakeholder expectations and needs. Hence knowing them and engaging them through the project right from initiation will be critical for project success.

Project stakeholder management is practiced at an average level as that of the overall project practice implying that a good communication with stakeholders by recognizing their expectations and dealing with issues of conflict of interests. Presence of gaps in communication and a defined stakeholder’s responsibility might have contributed to the reduced level of stakeholder’s management practice.

“I would need to start identifying all the stakeholders of the project, both within our organization and from the client side.”

There are mainly two documents, the Project Charter and the Stakeholder Register, are produced during project initiation. Project Charter is initiated by the sponsor to officially appoint the project manager and also to establish the agreed project goals and objectives. The detailed project requirements are collected from the various stakeholders involved in the project. There is a necessity to understand the expectations stakeholders who later on will benefit from the project.

Stakeholder Register is prepared to capture the detailed list of all project stakeholders with all relevant information about the stakeholders.

The project management was aware the importance to ensure that stakeholders are being constantly and closely managed.

“My main role is to keep the employee happy. So, I keep a close eye on the employee satisfaction survey and as per the results strategize and make organizational announcements in the form of writing and speaking in different forums.”

The project management planned weekly communication with stakeholders with the agenda prepared for each such communication. Face-to-face meetings, telephonic conversations were treated the best as the Client was reluctant to e-mails. However, sharing important project information such as a schedule, project documents and all kind of approvals was done using formal written communication.

“When I came in PM years ago, it was very much PM Triangle, that was like the core of PM, but I think there is more and more recognition that stakeholder management is more and in fact you look at project to be successful its more important to have stakeholder management skills than the triangle.”

4.11. Health, Safety, Security, and Environmental Management

Interviewees’ common perspective on Health, Safety, Security, and Environmental management revolved around measurement and comparison, asserting that these principles were foundational to effective management. They emphasized the importance of considering both human and environmental factors when managing projects and advocated for a clear distinction between the production and construction sectors in terms of management practices.

It could also be noted that HSE training procedures were largely centralized. Given that project sites were spread over a vast area and were logistically challenging, the existing safety training procedures were not serving the remote sites adequately. Moreover, the safety training was being provided in English to the supervisory level and no measures were being taken to ensure that it is properly communicated to the site workers and subcontractors. Another important observation in HSE management on the case study project was that although recorded incidences were generally low, there were indications that data collection and preventative action were lacking. In summary, the overall safety culture in the organization was weak and lacked companywide cohesion.

4.12. Financial Management

For the successful completion of construction projects, the project participants were paid on time. Participants with different financial capacities belonging to different organizations depend on contractual relations per contract packages. Achieving the financial goals established for the project value are fundamental responsibilities of the managers, which require an understanding of common goals.

“Financial management is a strategic and well-coordinated process focused on value creation and cash flow maximization. Project management achieve these goals by communicating business plans to interdisciplinary teams, motivating them to achieve the objectives defined therein, and making data driven decisions.”

Keeping accurate records goes beyond the organization and also impacts the stakeholders. Therefore, the financial Management would focus on maintaining accuracy in all records. Part of the way the respective department achieved this is to leverage technology that ensures accuracy and detailed record-keeping.

“When we do projected budget and so on, we carry figures up a little and see and then as we go along with the monthly management accounts, we compare as to what we have

projected and see where we are going with that, if we are meeting those targets, if we need to do extra work in certain areas.”

4.13. Knowledge Areas' Impact on Project Management Performance

The tables 4.1 and 4.2 below reveal the results of the Interviewees' grading for the knowledge areas. Each interviewee was asked key questions associated with the conceptual framework according to the project phases and the answers and scores were noted. Afterwards, a joint session was organized with the interviewees on these scores and the general performances of the knowledge areas were determined by evaluating the common consensus.

Table 4.1 Ratings from the Interviewees for the Knowledge Areas.

Knowledge Areas	Importance Factor (0-100)	Importance Factor (0-1) /100 (A)	Performance Factor (0-100) (B)	General Performance (A) x (B)
	1= least important 100: most important		1= least important 100: most important	
Integration Management	90	8.9%	80	7.09
Scope Management	92	9.1%	72	6.52
Schedule Management	89	8.8%	98	8.58
Cost Management	98	9.6%	95	9.16
Quality Management	99	9.7%	90	8.77
Resource Management	74	7.3%	88	6.41
Communication Management	81	8.0%	83	6.62
Risk Management	85	8.4%	69	5.77
Procurement Management	65	6.4%	75	4.80
Stakeholder Management	84	8.3%	68	5.62
Health, Safety, Security, and Environmental Management	81	8.0%	90	7.18
Financial Management	78	7.7%	81	6.22
Overall	1016			82.74

Table 4.1 presents the distribution of ratings for the individual knowledge areas based on the success level of interviewees of the survey. While calculating the project impact values by looking at the performance of the knowledge areas in Table 4.1 individually within the project, the importance factors of these knowledge areas, which were evaluated based on the interviews, were taken into consideration. According to the table prepared with this smart method, the overall project performance scored 82.74 points out of 100. Moreover, it is observed that cost, schedule and quality management are the top three knowledge areas that they perform during the project execution. However, stakeholder, procurement and risk management are rated as the lowest three performing knowledge areas within the scope of the selected case study EPCM project.

In order to compare the interview results with the performance values followed according to the knowledge areas in the project, the target and actual Project's Performance Metrics table was obtained during the post project appraisal and is presented below in table 4.2.

Table 4.2 Project's Performance Metrics.

Significance	Knowledge Area	Objective	Performance Indicator	Calculation Method	Data Resources	Achieved Value	Target Value
Tertiary	Integration Management	Continual Improvement	Number of Best Practices	Total Number of Approved Best Practices / Total Number of Staff)	Best Practice Log	1	2
Tertiary	Integration Management	Continual Improvement	Number of Lessons Learned	Total Number of Approved Lessons Learned / Total Number of Staff)	Lessons Learned Log	1	2
Tertiary	Integration Management	Continual Improvement	Shared Lessons Learned Ratio	(Total Number of Lessons Learned shared with Corporate Office for institutionalization / Total Number of Approved Lessons Learned) x 100	Lessons Learned Log	90%	100%
Critical	Integration Management	Client/Field/Eng. Team	PF>1	Engineering Efficiency	e-mails	93%	100%
Critical	Integration Management	Client/Field/Eng. Team	On time Responses	Response Time to RFI	e-mails	5.00	3.00
Critical	Integration Management	Client/Field/Eng. Team	On time Responses	Response Time to FCR	e-mails	6.00	3.00
Critical	Scope Management	Supplier Sustainability Audits	Performed Supplier Sustainability Audits per year to suppliers/subcontractors of products and services important to nuclear safety	Number of performed audits / Total number of suppliers and subcontractors providing services/products ITNS	Audit Reports	>80%	>75%
Critical	Schedule Management	Project progress tracking	Progress vs. Planned Comparison	Actual progress completion/ Planned progress completion for construction x 100	Project Schedule	93%	98%
Critical	Schedule Management	SPF>1	Schedule Performance Factor	Overall manual person-hours earned/burned x 100	Monthly Quality Reports	80%	90%
Critical	Schedule Management	Zero defects	Time spent for rectifying defects (for remedial works, including rework and repair)	Total spent person-hours to rectify defects in the reported month / Total spent person-hours for scheduled works in the reported month x 100	QURR Reports	0.26%	0.2%

Table 4.2 Project's Performance Metrics. (cont.)

Significance	Knowledge Area	Objective	Performance Indicator	Calculation Method	Data Resources	Achieved Value	Target Value
Critical	Schedule Management	On Schedule	Progress vs. Planned	Actual Project Progress completion/ Planned Progress completion for overall project x 100	Monthly Progress Report's average	90%	100%
Important	Schedule Management	Planning & Scheduling Performance	Planning Performance due to Revisions	Number of Project Baseline Schedule Revisions	Schedules	3	0
Critical	Schedule Management	PF>1	Overall Project Planning Efficiency	Earned Project person-hours/ Burned Project person-hours x 100	Schedule Resource Reports	90%	100%
Tertiary	Schedule Management	Resource Planning and Tracking	Actual to Planned Personnel Number Ratio	(Total actual number of personnel at site /total number of personnel baselines planned at site) x 100	Weekly Progress Reports	>100%, <130%	100%
Important	Schedule Management	On time (Right First Time)	Deviation status from Detailed Project Schedule & Project Execution Plan	Number of activities on critical path (CP) where progress falls behind the schedule/ Total number of activities on CP	Schedules	5%	0%
Critical	Cost Management	On budget (No deviation)	Cost Optimization	Actual Project Cost /Project Baseline Budget x 100	Cost & Commitment Reports	115%	100%
Tertiary	Quality Management	Transfer the Know-How to QMS	Improvement via Lessons Learned	Number of Lessons Learned causing revision in any QMS document / Total number of Lessons Learned x 100	Lessons Learned Documents	55%	50%
Critical	Quality Management	No Major Findings	Major Findings on Internal/External Audits	Number of Open Major Findings	Audit Reports and CAR Plans	1	0
Critical	Quality Management	On time close out of Audit Findings	Number of closed out findings on time	Number of audit findings closed out within the given initial deadline / Total number of closed out audit findings x 100	CAR Plans	92%	90%
Critical	Quality Management	On time closing out Audit Findings	Number of overdue audit findings	Number of overdue audit findings / number of open findings x 100	CAR Plans	5%	5%

Table 4.2 Project's Performance Metrics. (cont.)

Significance	Knowledge Area	Objective	Performance Indicator	Calculation Method	Data Resources	Achieved Value	Target Value
Important	Quality Management	Tracking average training person hours	Training availability (Average training person-hours) for Non-Manual (except HSE trainings)	Total non-manual training person-hours achieved in the reported month (except HSE trainings) / Total non-manual person-hours in the reported month (except HSE) x 100	Monthly Quality Report	0.4%	0.35%
Important	Quality Management	Pre-Job Quality Briefings Tracking	Number of Pre-Job Quality Briefings	Total Unique Pre-Job Quality Briefings Done/Total Unique Site Activities as per Project Schedule x 100	Briefing Log	90%	90%
Tertiary	Quality Management	Quality Walkdown Tracking	Number of Walkdowns Conducted	Total number of walkdown conducted in a month	Walkdown Report	2	2
Important	Quality Management	Compliance to Corporate Procedure List	Ratio of Issued Procedures	Total Procedure issued/Total planned Procedures due to Corporate Procedure List	Procedure Lists	100%	100%
Important	Quality Management	Subcontractor (2nd Party) Audit Tracking	Number of Subcontractor Audits	Audits Conducted at Subcontractor Companies/Total Subcontractor Number	Audit Records	0.9	1
Important	Quality Management	Internal Audit Tracking	Number of Internal Audits	Internal Audits Performed/Number of Departments in the Project	Audit Records	1	1
Tertiary	Quality Management	Continual Improvement	Root Cause Analysis	Number of Root Cause Analysis done for Nonconformities /Total Number of Nonconformities	Nonconformity Reports	100%	100%
Critical	Quality Management	The existence of ITP Tracking	Number of prepared ITP	Total actual ITP prepared/Total planned ITP per Baseline Schedule Activities	Project Baseline Schedule	0.9	1
Critical	Quality Management	Close-out time of NCR's Related to ITNS items	Timely closeout of NCR's Related to ITNS items	Total number of days taken to closeout ITNS related NCR's / Total number of ITNS related NCR's	NCR Log / Dashboard	8	7

Table 4.2 Project's Performance Metrics. (cont.)

Significance	Knowledge Area	Objective	Performance Indicator	Calculation Method	Data Resources	Achieved Value	Target Value
Critical	Quality Management	Developing Lessons Learned	Developing Lessons Learned on Repetitive Incidents	Developed lessons learned x 5 / Total number of repeating or similar incidents	Lessons Learned Log	1	1
Important	Quality Management	IR (Inspection Request) Tracking	Average Completion Duration of Inspections	Total (Inspection Completion Date- Inspection Planned Date) / Total Inspection Number per month	Inspection Log	2 days	1 days
Critical	Quality Management	Zero rework	NCR rework value ratio	Total monetary value of rework and repair in the reported month / monthly progress payment x 100	NCR Log	0.65%	0.5%
Critical	Quality Management	Welding Performance	Welding repair rate	Total rejected welding dia-inch / Cumulative welded dia inch x 100	Welding Log	2%	2%
Important	Quality Management	Work quality performance	Site QC Inspections Ratio	Number of Approved Site QC Inspections (Code A and B) / Number of Total Inspections x 100	QC Inspections Log	85%	90%
Critical	Quality Management	NCR close out on time	Average duration for closing out NCRs	$\sum$ (Date NCR closed out- Date NCR raised)/ Total number of closed NCRs	NCR Log	13	14 days
Critical	Quality Management	NCR tracking and closing	Closed NCR Ratio	Total number of NCRs closed / total number of NCRs raised x 100	NCR Log	94%	90%
Important	Quality Management	Punch Items Tracking and Closing	Closing out Punch Items	Total number of Punch Items closed / total number of Punch Items raised x 100	Punch Items Log	85%	90%
Important	Quality Management	Full compliant test results	Failed site tests results ratio	Total number of laboratory tests failed / Total number of laboratory tests conducted x 100	Laboratory Test Results	3%	2%
Critical	Resource Management	Engaged Employees	Employee Engagement Survey	Employee Engagement Survey Report Result	Survey Reports	90%	90%

Table 4.2 Project's Performance Metrics. (cont.)

Significance	Knowledge Area	Objective	Performance Indicator	Calculation Method	Data Resources	Achieved Value	Target Value
Critical	Resource Management	Assign Right Staff	Staff Turnover rate (excl. de-staffing due to work completion)	$\frac{[\text{Number of staff resigned and/or dismissed} / \text{Total number of staffs}] \times 100}{}$	HR Reports	2%	3%
Critical	Resource Management	Avoid unnecessary recruitment	Indirect personnel efficiency	Indirect person-hours/ Total person-hours	HR Reports	0.27	0.25
Important	Resource Management	Equipment Availability	Equipment Availability	Equipment Availability Calculation in equipment management system	Machinery Equipment Management System	95%	100%
Important	Resource Management	Work with maintained machinery and equipment	Periodic Maintenance	Percentage of overdue periodic maintenance activities	Machinery Equipment Management System	3%	0%
Critical	Resource Management	To improve safety	Lifting Equipment's Certificates	$\frac{\text{Total number of Lifting Equipment's Certificates} / \text{Total number of Lifting Equipment} \times 100}{}$	Machinery Equipment Management System	100%	100%
Critical	Resource Management	To improve safety	3rd Party Inspections on lifting Equipment	$\frac{\text{Total number of 3rd Party Inspections conducted on Lifting Equipment} / \text{Total number of Lifting Equipment} \times 100}{}$	Machinery Equipment Management System	100%	100%
Important	Communication Management	Executive Reports Tracking	Timely preparation of daily / monthly executive reports	Weekly control of email notifications sent to senior management	Document Management System Daily Notifications	4	0
Important	Communication Management	Contractual Compliance	Open Letter Ratio	$\frac{\text{Number of Open Letters} / \text{Total Number of Letters Received and Response Required}}{}$	Letters Log	97%	100%
Important	Communication Management	Contractual Compliance	Average duration for responding Letters	$\frac{\sum (\text{Date Letter responded} - \text{Date Letter received}) / \text{Total number of responded Letters}}{}$	Letters Log	12 days	14 days
Important	Communications Management	Zero Late Documents	Late Documents to Total Documents Ratio	$\frac{\text{Total Number of Late Documents} / \text{Total Number of Documents in MDR} \times 100}{}$	Master Document Register	2%	0%

Table 4.2 Project's Performance Metrics. (cont.)

Significance	Knowledge Area	Objective	Performance Indicator	Calculation Method	Data Resources	Achieved Value	Target Value
Important	Communications Management	Valid version of documents	Ratio of old revision documents to all documents at site	Number of old revision documents found at site during DCC walkdown/Total Number of documents controlled during DCC walkdown x 100	DCC Walkdown Reports	0%	0%
Important	Communications Management	Timely distribution of incoming documents	Time between receiving and distribution	Average hour between receiving and distribution of incoming documents	DCC Records	3	4
Important	Communications Management	# of Documents without files	Documents that do not contain files should be detected and fixed monthly	The number of documents found on site during the DCC Review should be consistent with the target value.	w/o File Document Report	3	4
Important	Communications Management	Create document reports	Integrating the reporting processes of the Departments with the Document Management Reports Module	The number of total project reports during the DCC Review should be consistent with the target value.	Generated Project Reports	3	5
Important	Communications Management	Minimum unavailability	Unplanned Server shut down - unavailability	Unplanned un-availability, crash, shut-down of each server (hrs.) / Total available hours in the Month x 100	IT Support System	0.20%	0.25%
Important	Communications Management	Server backup operation	successful backup	Number of days successfully backed up/30 x 100	IT Support System	90%	87%
Important	Communications Management	Information Security	Unauthorized Access	Number of unauthorized access incidents	IT Support System	1	0
Important	Communications Management	Information Security	Security Incidents	Number of security incidents	IT Support System	0	0

Table 4.2 Project's Performance Metrics. (cont.)

Significance	Knowledge Area	Objective	Performance Indicator	Calculation Method	Data Resources	Achieved Value	Target Value
Critical	Risk Management	Risk Control	Mitigated Risk Ratio	Number of Mitigated (Accepted, Transferred, Shared, Reduced, Avoided) Risks/ Number of determined project Risks x 100	Risk Analysis Document	90%	100%
Critical	Procurement Management	RFQ Success	Number of bidders on the RFQ	–	Procurement System	2.8	3
Critical	Procurement Management	Manual Tender	Manual Tender to Total PO Ratio	Manual Tender Amount/Total Purchase Order Amount	Procurement System	30.75%	20%
Important	Procurement Management	Increase the organizational knowledge	Performance evaluations of vendors	(Number of evaluated vendors/Total number of project vendors) x 100	Vendor Network	90%	100%
Important	Procurement Management	On Budget	Purchase Orders Budget Ratio	Total actual budget of Purchase Orders/ Total planned budget of Purchase Orders x 100	Procurement and Financial Systems	110%	100%
Tertiary	Stakeholder Management	Continual Improvement	Shared Best Practices Ratio	(Total Number of Best Practices shared with Corporate Office for Institutionalization / Total Number of Approved Best Practices) x 100	Best Practice Log	90%	100%
Critical	Health, Safety, Security, and Environmental Management	Zero Accident	Fatal Accident	Number of Accidents Resulting in Death	HSE Database	0%	0%
Critical	Health, Safety, Security, and Environmental Management	Zero Accident	Lost Time Accident Frequency Rate	Number of Lost Time Accidents x 200.000 / Total Man Hours	HSE Database	1%	5%

Table 4.2 Project's Performance Metrics. (cont.)

Significance	Knowledge Area	Objective	Performance Indicator	Calculation Method	Data Resources	Achieved Value	Target Value
Critical	Health, Safety, Security, and Environmental Management	Zero Accident	Frequency Rate of Near Misses	Number of Near Missed Cases x 200,000 / Total Man Hours	HSE Database	2%	TBD
Critical	Health, Safety, Security, and Environmental Management	Timely closure of findings	Proactive (Preventive) Activity Closure Rate	Related after the non-conformities detected preventive actions within the specified period Completion rate	HSE Database	96%	>95%
Critical	Health, Safety, Security, and Environmental Management	Awareness through training	Training hours	Total Training Man Hours / Total Man Hours	HSE Database	2%	1%
Important	Financial Management	Progress Performance	Overall Project Progress Success due to Progress Payments	Actual Monthly Progress Payment/ Planned (Claimed) Monthly Progress Payment x 100	Financial Reports	90%	100%

4.14. Project Management Performance

The interviewees were asked to reflect back and highlight based on their experience the project success criteria for a desired project management performance. They were asked to focus on the areas of the key project management processes, and report the ones required for the successful outcome of the project. Accordingly, figure 4.1 presents the distribution for the components of project success criteria. According to this figure, it is seen that project is considered to be more successful when achieving the criteria's set for "Time and Cost", "Quality", "Client Satisfaction".

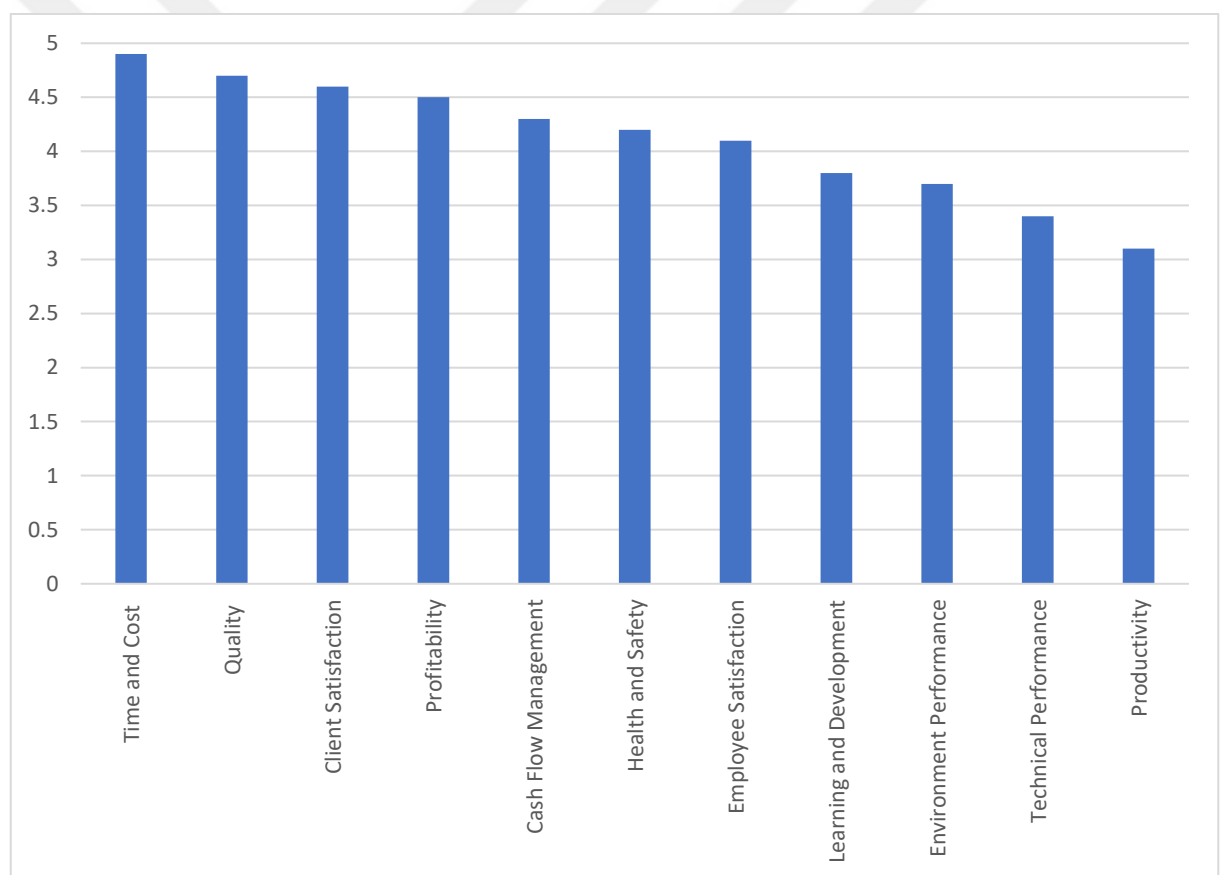


Figure 4.1. Component's Distribution Per Project Management Performance.

Figure 4.2 below represents arithmetical average of ranks which were assigned to each of critical success factor by interviewees. The scale from 1 to 5 refers to the following grades: 1 – not at all important, 2 – unimportant, 3 – neutral, 4 – important, and 5 – very important.

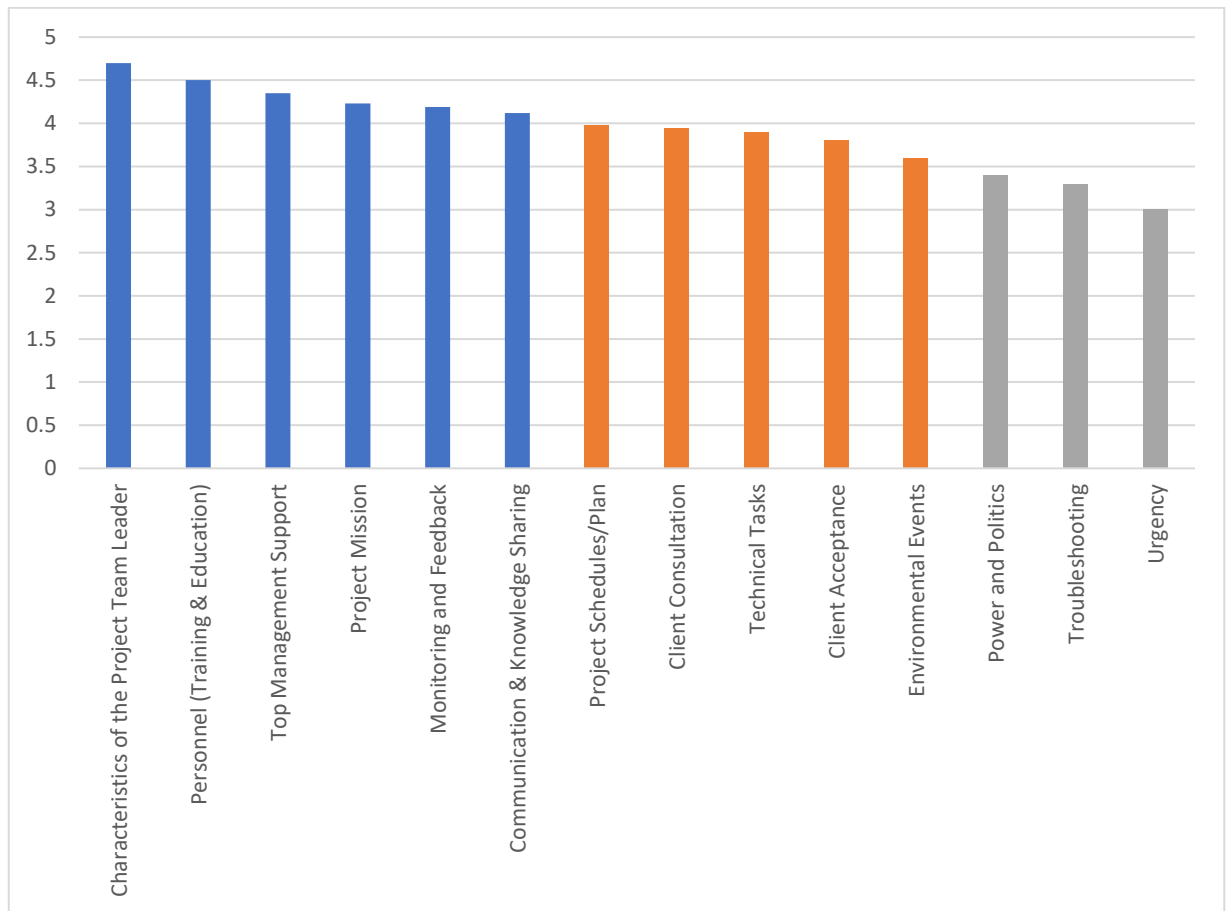


Figure 4.2. Success Factors Evaluated by Interviewees.

As could be seen from the chart above the majority of factors leading project to successful outcome were characterized as ‘important’ with blue colored bars in the above Figure 4.2. Some of them receive similar ranks and therefore it seems complex to define differences between such factors and explain them. Therefore, minimum and maximum values on a rank scale offer more interest for discussion. Explicit Lessons Learned by Knowledge Areas from the Case Study Project are in the table 4.3 below;

Table 4.3. Lessons Learned Summary per Knowledge Area.

Knowledge Area	Lessons Learned Description
Integration Management	It is important to focus on project integration ‘early and often’ throughout the project
	Transition through all other knowledge areas would have been smoother had they grasped the importance of integration management earlier in the project lifecycle.
	Early and continuous engagement with stakeholders is key to successful integration.
	Encouraging cross-functional teamwork enhances integration and helps identify potential issues before they impact the project.
Scope Management	Defining scope is critical – must be able to define ‘what’s in and ‘what’s out’
	Ambiguities in the scope definition often lead to misunderstandings, rework, and scope creep, which negatively impact the project timeline and budget.
	Periodic reviews of the project scope throughout the project lifecycle ensure that the project remains aligned with its goals.
	Engaging all stakeholders in scope verification ensures that the project’s objectives and deliverables are understood and agreed upon by all parties.
Schedule Management	Coordinating team member meeting times to allow enough time for planning and control.
	Ensuring detailed and realistic schedule planning from the outset helps in identifying potential risks and allows for better resource allocation
	Consistent schedule monitoring is necessary to identify deviations early and to implement corrective actions.
	It is essential to involve all key stakeholders during the planning phase to get a holistic view of project timelines.
Cost Management	Quarterly forecasting is to be supported by monthly cost reports for controlling
	Incorporating historical data, risk factors, and market conditions into the estimation process ensures that budgets are more reliable and achievable.
	Continuous monitoring and regular cost reporting throughout the project lifecycle help in identifying potential cost overruns early. This allows for timely corrective actions, such as reallocation of resources or reforecasting to keep the project on track.
	Including contingencies in the budget to account for unforeseen costs proved essential.
Quality Management	Establishing detailed quality criteria ensures clarity and alignment among all stakeholders.
	Regular audits, reviews, and adherence to quality plans ensure that processes are aligned with the project’s quality goals and prevent non-compliance.
	Providing continuous training and maintaining quality awareness across all project phases helps maintain consistent output and reduce the risk of defects.
	Clear communication of quality objectives to all team members and stakeholders helps maintain focus on quality throughout the project.
Resource Management	Misallocation or underestimation of resource needs, including manpower, equipment, and materials, often leads to delays and budget overruns.
	Early identification of resource requirements ensures smoother project execution.
	Proper allocation of resources, based on skillsets and availability, is essential to maintaining productivity.
	Regular monitoring and adjusting of resource usage are crucial to ensuring resources are not over- or under-utilized.
	Ensuring that team members are equipped with multiple skills helps mitigate resource shortages or shifts in project demands without significantly affecting progress

Table 4.3. Lessons Learned Summary per Knowledge Area. (cont.)

Knowledge Area	Lessons Learned Description
Communication Management	Defining communication channels, frequencies, and responsibilities early on minimizes confusion and promotes transparency.
	Ensuring that communication is not just one-directional allows team members to raise concerns early, reducing the risk of misalignment.
	Keeping a record of important communications, such as decisions, changes, and agreements, helps avoid disputes and confusion.
	Holding regular status meetings and updates, both formal and informal, promotes proactive issue resolution and keeps all team members aligned.
Risk Management	Creating and Maintaining a Risk register, that includes human resource, technology and quality risks is essential, and must be started early.
	Engaging key stakeholders and subject matter experts early in the process ensures a more comprehensive identification of potential risks, including technical, financial, and environmental risks.
	Developing detailed response strategies (avoidance, mitigation, transfer, acceptance) for the most significant risks helps ensure readiness.
	Regular risk reviews help detect emerging risks early and allow for timely adjustments in response strategies.
Procurement Management	The suppliers which are identified and aligned along with the project scope shall be prequalified in terms of their adaptation capability to the local norms and standards.
	Drafting clear and detailed contracts, including performance expectations, delivery timelines, and penalty clauses for non-compliance, is essential.
	Maintaining regular communication with suppliers and monitoring their performance throughout the project helps ensure adherence to terms.
	Developing a well-defined procurement plan early in the project is critical.
Stakeholder Management	Stakeholder Register and Stakeholder Strategy must be integrated with the risk register plan and to be followed up by higher management closely.
	Identifying key stakeholders early in the project lifecycle is critical to understanding their interests, expectations, and influence.
	Establishing transparent and consistent communication channels with stakeholders ensures that they are well-informed about project progress, risks, and changes.
	Developing strategies to manage differing expectations through negotiation and compromise helps avoid disruptions and ensures that the project remains on track.
HSSE Management	Implementation of a comprehensive HSSE management as well as an emergency management system that has been certified by successive audits conducted by independent external experts is the way to constantly improve safety and further develop safety-related measures.
Financial Management	One of the most important financial management skills for project closure and evaluation is budget reconciliation which helps the project management to assess the financial performance and efficiency of the project, and to report it to the stakeholders.
	Implementing regular financial reporting processes helps keep stakeholders informed and facilitates timely corrective actions when needed.
	Ensuring proper cash flow management is crucial for maintaining project momentum.
	Keeping stakeholders informed of financial challenges and strategies allows for better alignment and support throughout the project.

5. DISCUSSIONS

The utilization of face-to-face interviews proved immensely valuable in my research, facilitating the swift acquisition of feedback from project professionals. This method enabled direct solicitation of their insights and opinions regarding the factors explored within the context of this thesis.

5.1. Integration Management

Considering the importance factor in Table 4.1 as 8.9%, one should recommend that for enhanced project management performance, projects must not oversee the process integration. The literature also supports this idea as the integration management is the most important knowledge area, which provide platform for processes, and activities that integrate, coordinate the various elements of project management in one chain (Dias, 2004). The importance of integration in project management is well-documented in the literature. As per previous research by (Halfawy & Froese, 2007; Ozorhon et al., 2014; Tatum, 1990), integration in achieving project success has a very critical role.

Although the details of integration management were identified early and issues were addressed on time, Owner's request of changes caused delays in the Case study project. Due to this impact, the performance factor of this knowledge area is rated as 80 in the Table 4.1. The overall performance of this knowledge area to the project management is rated as 7.09 as per the Table 4.1.

Iceland, as an island nation, is naturally prone to various hazards, including volcanic eruptions, snow avalanches, and landslides. Reconstruction projects rely heavily on contingency planning due to immediate construction needs following disasters. Key stakeholders in these projects include the local government, insurance bodies, Iceland Catastrophe Insurance, funding organizations, and contract repair entities. Historically, these stakeholders have not coordinated effectively, leading to delays and political challenges during recovery phases. To address these issues, significant improvements have been implemented, such as mandatory documentation in response planning, clear identification of

disaster types, streamlined project manager appointment processes, and timely consultation with financing bodies (Meredith & Mantel, 2012). This reveals the fact that effective integration management throughout the processes is emphasized as crucial and cannot be overlooked.

The sponsor is responsible for multiple activities spanning the entire process of projects and the continuous monitoring of benefit realization, and it is the responsibility of the project manager to handle these demands (D. Bryde, 2008; Hall et al., 2003; Kliem & Ludin, 1992; Morris & Hough, 1987; Turner, 2009). Accordingly, the EPCM contractor in the case study had assigned a Project Manager at the within the initiation process who was responsible for managing and overseeing all obligations, he had limited control to the stakeholders' acting and thinking which resulted decrease in the project integration. The case is also revealing the importance of having the alignment with the stakeholders at the initiation phase of the project as indicated in the table of conceptual framework. Mitropoulos and Tatum (2000) indicated that the degree of integration affects project performance.

Moreover, the lifetime of the project, the project manager is responsible for managing the project network and measuring the actual cost, time and quality discrepancies from the plan (Blackburn, 2002). When we evaluated the case study project, it was observed that it had well established tracking system to report on projects challenges promptly, whether actual or potential. Moreover, the project control plans were well documented and communicated within the project organization. However, the project schedule had undergone multiple changes and revisions and the initial schedule, which was developed to fulfill the contractual requirements. Considering the conceptual framework, although the planning inputs (Planning), work performance inspection (Executing) and technology integration (Controlling) were well managed, the Project could not have achieved a high project management performance as described the reasons with the Project Owner above.

Furthermore, during the planning and execution stages, actual progress is documented and measured against the planned metrics. This is supported with the fact from the literature that the project may not be entirely carried out along with plans and expectations due to

numerous unpredictable factors. Therefore, management should continuously and consistently be advised whether progress is advancing and that accurate assessment of the effect of each site occurrence on available resources and potential activities of each project is made (Ahuja & Thiruvengadam, 2004). As the EPCM project is comprising sub-packages of contracts, the integration management involves coordinating all sub-project's scopes and a holistic approach is required to manage sub-packages' scope of the EPCM project with their interdependencies.

When we look at the closure process group, a lesson learned log is well documented which is aligned with the conceptual framework. This log defines the lessons to be learned and carried as knowledge with the corrective actions by means of defining the coordination between required process and actions. Previous studies also reported that high performance in the realization of integration management functions such as process integration, knowledge integration, and supply chain integration are keys to achieve project success (Ernst et al., 2010; Heising, 2012; Kleinschmidt et al., 2007).

The transient nature of construction projects, which often span various durations and require diverse resources, poses a significant challenge for construction enterprises aiming to balance production capacity with fluctuating workloads (Shi & Halpin, 2003). In this context, the implementation of an ERP system to the EPCM case study project offered a strategic advantage by optimizing the use of organizational resources, thereby enhancing profitability and maintaining a competitive edge in the market. First, it facilitated more efficient integration of key business processes, thereby reducing duplication of efforts across departments. By centralizing data and streamlining workflows, the system enhanced real-time information sharing, which in turn supported more effective decision-making at both managerial and operational levels. Furthermore, the project's adoption of ERP appeared to positively influence overall resource utilization, as it offered greater visibility into resource allocation and enabled the organization to respond more swiftly to changing demands. Notably, these improvements contributed to increased stakeholder satisfaction, exemplified by reduced processing times and better alignment of departmental objectives.

Under the light of above, this study reveals that there is a strong link between project integration management with both stakeholder management and project scope management.

This study offers strategic recommendations for construction practitioners to enhance integration management. These include practical tools and strategies that can be implemented at various stages of the project to ensure seamless integration.

5.2. Scope Management

Considering the importance factor in Table 4.1 as 9.1%, it could be stated that scope management is an important factor for the success in project management. The literature is also aligned as according to (Fageha & Aibinu, 2013), project scope management has a direct impact on the project outcome.

The performance factor of this knowledge area is rated as 72 in the Table 4.1. Considering the general performance of this knowledge area to the project management is rated as 6.52 as per the Table 4.1.

During the planning process group, the project had well practices preliminary management practices, leadership and key personnel, however the project's delays were inevitable as the project bid did not adequately evaluate the scope and risk associated with this kind of project and client. The literature supports this idea as the priorities of the involved parties will have to be addressed (Haferkorn, 2018). Moreover, managing the scope of construction work within a project contract is crucial, as it directly impacts both the implementation process and the final outcomes of the construction efforts. Therefore, every aspect of the construction process must be meticulously defined, including assigning responsibilities for each task. This detailed planning is essential because any additional work items that arise during construction can lead to delays in project completion (Susila & Handoyo, 2015). The process of defining the scope was also highlighted in the planning process groups of the conceptual framework.

In this regard, the initial planning and proposal development phase are vital and its purpose is to study and evaluate the requirements of the proponent to further assess viability, understand the scope of work, translate technical specifications, understand the risks involved, and plan and prepare the proposal accordingly (Fox, 2005). Moreover, another literature study running the scope management analysis of construction work for mix-used building projects in the city of Jakarta focuses on the importance of detailed planning in construction projects and the methods used to analyze the scope of work found that; the process of planning and controlling the management of the scope of construction work involves identifying the type and activity of work items and dividing the scope of work according to the sequence and implementation procedures in accordance with the construction work contract agreement. (Hidayat & Simanjuntak, 2023). Therefore, it could be said that a successful scope management could be achieved when it is managed well along with risk management and schedule management.

During the controlling process group, the project had well established systems and tools for tracking down the project scope, interfaces between the sub-packages and requirements. Accordingly, the project manager and team should correctly interpret the project's outcomes, evaluate the customer's expectations and determine the scope of the work precisely (Sindi, 2018). However, it is interesting that the performance of the scope management did not achieve a high score in opposite to the anticipations. This may be because of the delays and inefficient delivery as the scope changes requested by the Owner of the project which may cause conflicts in the technical specifications of the sub-packages due to interfaces between respective sub-packages' scopes. This can happen for a wide range of reasons such as weak initial requirements analysis, inability to say no to a client, no structured change evaluation and approval processes that give the project participants the feeling that a minor change is not important (Turk, 2010).

The conceptual framework is also indicating the necessity of "Scope Creep and Change Management" process during the controlling process group of the project scope management.

The above proves that effective management of risk, schedule and stakeholder is needed to enhance project scope management performance.

5.3. Schedule Management

Considering the importance factor in Table 4.1 as 8.8%, it could be stated that schedule management is an important factor for the success in project management. Researchers have previously indicated that effective project time management contributes to the enhanced project performance (Gayatri & Saurabh, 2013; Ngacho & Das, 2014).

The performance factor of this knowledge area is rated as 98 in the Table 4.1. General performance of this knowledge area to the project management is rated as 8.58 as per the Table 4.1.

During the planning process group, the construction work planning was well connected from the overall project plans and sub-packages' schedules. Therefore, the changes in the plans due to whatever the reason is often changed along with resource requirements. The impact of time management on performance was significant, this also implies that schedule management is important for a better performance. This is supported by the previous studies as the critical role of project schedule in achieving higher performance in schedule management practices was highlighted in most of the research studies (Berssaneti & Carvalho, 2015; Farzad Moosavi & Moselhi, 2014). AlNasser and Aulin (2015) indicated that an incorporation of detailed project scope during front-end planning significantly contributes for project success. Furthermore, the conceptual framework has many processes underlined to be followed for an adequate project schedule management which could also be defined as the steps of a schedule formation.

The case study selected an EPCM contractor with a well-established track record of executing projects globally with variety of stakeholders. The execution of the project started smoothly but soon after it followed several delays and disruptions. The delays in the project were caused by many reasons including the complexity of interfaces between several

contractors who were working for the sub-packages and inadequate management practices in managing the client. Meeting project schedule is being challenged due to a number of factors such as project schedule reliability (Gannon et al., 2012). Therefore, as indicated in the conceptual framework, updates for progress and setting up review meetings are necessary to manage control of the planned work.

The EPCM project's schedule was developed for contractual reasons to reflect realistic planning in support of project execution. The planning forecasts being dictated by the proponent made the overall execution plan unrealistic, and hence did not reflect actual work conditions and available resources which decreased the performance points of the schedule management along with the integration management. This led to increase in stress as well as frustration in the project manager as well as his team members. In this sense proper estimation of resources and activity durations are to be ensured during the planning process group as indicated in the conceptual framework.

It is hard to anticipate the choices and priorities of project owner; therefore, this factor could be evaluated as a risk. Therefore, providing management reserve (such as providing an allowable buffer time) helps to manage prominent risks and uncertainties (Russell et al., 2013). Therefore, reference to the conceptual framework, the proper sequencing of the activities is noted to be performed under the planning process group.

Under the light of above, one could say that risk management, stakeholder management and integration management has direct relation with schedule management to achieve high performing project management.

5.4. Cost Management

Considering the importance factor in Table 4.1 as 9.6%, it could be stated that cost management is one of the most important factors for the success in project management. Researchers have previously indicated that improved and more advanced project management increase cost-effectiveness contributing to more budget savings in projects (Yazici, 2009). Cost management skills have demonstrated to be one of the main project

management competencies to empower the project to achieve more favorable outcomes (Attakora-Amaniampong, 2016).

The performance factor of this knowledge area is rated as 95 in the Table 4.1. The general performance of this knowledge area to the project management is rated as 9.16 as per the Table 4.1.

During the planning process group, parallel to the project framework, EPCM contractor prepared for full control over the project which allows leveraging the control towards reducing the overall cost of the project through efficient design, intelligent procurement, and interface controlling of the sub-packages' construction by working on the bill of quantities, budget forecasting, change order control and trend program. The literature supports this preparation by stating that budget determination is one of the most important steps of cost management to achieve higher success rate (Kim et al., 2012; Xu et al., 2012). Furthermore, several researches underlined the importance of performing well in cost control and cost performance to experience enhanced performance in the projects (Khodakarami & Abdi, 2014; Xu et al., 2012; Yildiz et al., 2014). Ultimately, good cost management will help to maximize a company's profit. Hence, such a system should have the support of upper-level management but should also seek to involve employees across all company positions (Huang & Zhang, 2013).

During the controlling process group, as per the interviews and the reports from the post project evaluation report, the project is aligned with the frame work. One could say that this the reason of achieving high performance in cost management. Although schedule delay is one of the main causes of project cost increases. By increasing the schedule efficiencies to mitigate the delay was is an effective measure to reduce the level of deficit by not compromising from quality. Therefore, the project management has worked on the earned value management by controlling the correct and well-suited resources to the activities. Furthermore, potential cost savings were investigated by means of communicating with the stakeholders' expectations. This is a high indication of relation between cost management and schedule management, quality management, stakeholder management.

5.5. Quality Management

Considering the importance factor in Table 4.1 as 9.7%, it could be stated that quality management is an important factor for the success in project management. This is supported by the literature by incompetent management of the quality resulting in defects that are required to be addressed and redone can negatively impact construction projects' progress and success (Love et al., 2002).

The performance factor of this knowledge area is rated as 90 in the Table 4.1. Considering the general performance of this knowledge area to the project management is rated as 8.77 as per the Table 4.1.

As per the conceptual frame works, quality management comprises elements under planning, executing and controlling process groups. During the post project evaluation, it was recognized that the quality management plan which is generated during the planning process group as per contract, stakeholder and contractor quality policy does contain the elements listed under the respective process groups of the conceptual framework. In this respect, quality plan is prepared via scope management and stakeholder management. It is communicated with the sub-packages' contractors via procurement management. The quality requirements are feeding the complexity of the activities' sequence with the resource requirements. Therefore, it can be said that quality management is one of the knowledge areas which has interactions with several knowledge areas as scope management, schedule management, cost management, human resources management, communication management, procurement management, stakeholder management. This is also supported by the literature as Tommelein et al. (2003) identified that quality management in the EPC project is a key factor in the overall project success. The necessity for careful consideration of "quality standardization" and "quality assurance and control" to experience higher success rates was previously underlined in several studies (de Sousa Jabbour et al., 2014; Flyvbjerg, 2014; Wanberg et al., 2013). To achieve the desired level of excellence, it is necessary to plan for quality in a project, ensure that quality policies have been adequately implemented in the project and, finally, monitor and assess the performance of specific project

deliverables and management processes (Ab Malik et al., 2019; Lu et al., 2019; Nastase, 2013; PMI, 2017).

Although QA/QC procedures on the project were adequate and met the requirements set by the client. However, it was observed that QA/QC procedures were not integrated with contractors which are constructing the sub-packages, for better performance. Therefore, during the initiation process, quality management would better be involved defining the requirements of pre-qualification and selection of subcontractors. As a result, one could say that the QA/QC plans and procedures would be followed adequately by the contractors which would increase the performance of the quality management's performance so as project management's success.

5.6. Resource Management

Considering the importance factor in Table 4.1 as 7.3%, it could be stated that resource management is a factor for the success in project management. This is supported by the literature as well-set project team plays a critical role in the fast progress of the projects as indicated in several research studies (Buller & McEvoy, 2012; Khan & Rasheed, 2015). Human resources (knowledge, skills, and competencies) are often highlighted as the most important resources and determinants of project success or failure (Denicol et al., 2020; do Vale et al., 2018).

The performance factor of this knowledge area is rated as 88 in the Table 4.1. Considering the general performance of this knowledge area to the project management is rated as 6.41 as per the Table 4.1.

The project had structured the project organization as investigated under the post project review and this case is in line with the conceptual framework's planning process. Furthermore, allocation of the resources and their productivities were also tracked down during the executing and controlling process groups respectively. With regards to the closure

process group, the EPCM project had a staffing plan which was updated regularly indicating the needed duration of resources for at the project life cycle.

On the other hand, there was no clear policy for HR training and development. It was found that only mandatory pieces of training were considered but in general, there was no allocated classroom training budget for HR resource development. One could state that, if this was not the case, the resource management's performance could have achieved higher performance. In this respect, the literature also supports this statement as the frequency of staff training and performance development for the project success was previously shown in past studies (Birasnav, 2014; Huselid et al., 1997; Minbaeva, 2005).

Considering resources as the primary need of project to be executed, it could be stated as the resource management has relations with all other knowledge areas. This statement is supported by the Lai et al. (2011) study indicating that human resource practices are strongly related to the effective safety management. Moreover, Huselid (1995) indicated that effective human resource management practices have both economic and significant effect on firm's financial performance, turnover, and productivity. Furthermore, despite the importance of the Procurement aspect, Darvik and Larsson (2010) estimated that approximately half of all material (resource) deliveries on construction projects include delivery deviations in terms of quality, quantity, and time and identified the 'Lack of communication' to be the leading cause of such deviations. This study by itself reveals the interaction of resource management with procurement management and communication management.

5.7. Communications Management

Considering importance factor in Table 4.1 as 8.0%, it could be stated that communication management is a factor for the success in project management. This is supported by the literature as improved communication contributes to improved project performance and project success; therefore, this question asks the transparency level of communication in each project in notifying stakeholders with project information (Chang &

Shen, 2009). Construction firms, which implement better coordination and collaboration practices are more likely to achieve higher success (Arriagada D. & Alarcón C., 2014; Huang & Zhang, 2013; Senescu et al., 2013). It was also mentioned that projects are executed with enhanced communication when knowledge sharing is performed in a successful manner (Arriagada D. & Alarcón C., 2014). Effective communication can help to achieve considerable cost savings and reduce project duration (Yap & Skitmore, 2020).

The performance factor of this knowledge area is rated as 83 in the Table 4.1. Considering the general performance of this knowledge area to the project management is rated as 6.62 as per the Table 4.1.

By looking at the conceptual framework and the post project evaluation report, communication seems to be a part of a whole chain: producing a plan, sharing goals via communication channels and control of execution. This fact is also supported by literature. Aligned actions between project team players, project sponsor and customer are of particular importance for achieving project goals and successfully delivering the final result (Al-Qudsi, 1995). Therefore, it seems likely that developing communication channels inside projects key players teams help to create team spirit between the members. If there is a collaboration spirit between project key players and they act as one team it is likely that effective communication procedures exist as well. Communication can serve as a great part for the project team to carry out the mission that they are set to do during the project as well as creating motivation for the team members. This is supported by Ahmad et al. (2020) that he explains some of the reasons why communication is so important for an effective project management.

Majority of the past studies underlined the importance of setting communication strategies and enhancing multi-cultural communication for the success of projects (Badir et al., 2012; Meng, 2012; Ochieng & Price, 2010; Pheng & Leong, 2000). Furthermore, communications management seems to have a direct relationship with project stakeholder management, according to Demirkesen and Ozorhon (2017a).

5.8. Risk Management

Considering the importance factor in Table 4.1 as 8.4%, it could be stated that risk management is a factor for the success in project management. Substantial attention has been devoted to risk management in project management literature as well. Schieg (2006) supports this concern and highlights the importance of risk assessment through risk reports because risk management can help prevent failure during the closing stage. Furthermore, project management associations and their bodies of knowledge claim that the risk is critical to the success of the project. Zwikael and Ahn (2011) demonstrate that even moderate risk planning levels would be sufficient to reduce the adverse impacts of risk on project success. However, multiple authors argue that in regular projects, and even in large and complex projects, risk management practices are still rarely used, and therefore a gap in the profession is identified (Carvalho & Rabechini Junior, 2015; Dvir et al., 2003; Ibbs & Kwak, 2000; Zwikael & Globerson, 2006).

The performance factor of this knowledge area is rated as 69 in the Table 4.1. Considering the general performance of this knowledge area to the project management is rated as 5.77 which falls in the least performing group as per the Table 4.1.

As per the conceptual framework, the project is expected to focus the risk management during and controlling stages. This makes sense to the extent that a tailor-made risk evaluation to be worked out by taking the contract conditions, bidding documents, risk analysis and respective insurance necessities. This is supported by the literature as in construction projects, there are various risks and uncertainties. This not only prevents completion of projects within budget but also jeopardizes the quality, safety and operational requirements (Öztaş & Ökmen, 2005). Since the primary objective of project risk management is to identify, analyze and control the risk for project success (Lee et al., 2009). Furthermore, several studies emphasized that accurate identification of risks is critical for achieving higher success in projects (de Sousa Jabbour et al., 2014; Hoffmann et al., 2013; Oehmen et al., 2014). It is also implied that a successful risk analysis leads to improved performance and risk management practices (Teller & Kock, 2013).

Once the risks are identifying, during the controlling process group of the project, one could state that controlling is the key to evaluate the risk factors and make amendments and mitigations where required. This effort is also supported by the literature as project managers spend a great deal of time and effort on the mitigation and management of risks that would negatively affect the project, but as the literature has already shown, enhancing, embracing and maximizing positive risks can have a significant effect on the likelihood of success in the projects (Perrenoud et al., 2017). Past studies also mentioned that risk management practices are effectively conducted through the careful consideration of risk control and allocation (de Sousa Jabbour et al., 2014; Yildiz et al., 2014). Although every risk has a certain probability of occurring and can have a certain impact on a project, high probability risks and high impact risks need to be especially monitored (Zubari, 2020).

On the other hand, from the interviews it was observed that the performance of the project evaluated in the case study did not achieve a high-performance rate. This might be the failing of mitigation plans during controlling process group as the project management had limited influence to the project owner. This case could be used as a good demonstration of the stakeholder management with the risk management.

5.9. Procurement Management

Considering the importance factor in Table 4.1 as 6.4%, it could be stated that procurement management is a factor for the success in project management. This is supported by the literature as it was indicated that project procurement management has a strong influence on project performance in Ling et al.'s (2009) study.

The performance factor of this knowledge area is rated as 75 in the Table 4.1. Considering the general performance of this knowledge area to the project management is rated as 4.80 as per the Table 4.1.

Although the case study project has maintained many of the elements listed under the planning, executing, controlling and closure process groups, from the interviews, it could be

stated that the EPC contractor did not have a strong engineering team to fulfill the requirements and challenges posed by the Owner e.g., material procurement was to be evaluated at the bidding stage and was to be finalized within the first 3 months, but was not completed as planned. As a result, these engineering deficiencies had a major impact on procurement, construction, and overall project planning and integration of the sub-packages. This case is backed-up by past studies as supplying resources in a timely manner and managing risks in the procurement process have a strong contribution to the success of procurement practices (Chopra & Sodhi, 2004; Meng et al., 2011). This is an example of relationship between procurement management with both schedule management and integration management. The conceptual framework is also directing the importance of setting up of procurement management plan and supply chain management at the planning stage of the project.

Moreover, it could be stated that the success of contractors working for the packages are related to the interface activities between both EPCM contractor and other subcontractors. The literature also states by Proctor Jr (1996) emphasizes that the general contractor is ultimately responsible for the success of a project, but subcontractors also play a major role since they are actually responsible for the implementation of the project. Moreover, the results of the project are highly dependent on the level of the general and subcontractor management within the boundaries of a given project (Jo et al., 2018). This is again parallel to the conceptual framework's "evaluation and selection of sellers" process that falls in the executing process group.

Furthermore, as the adopted procurement strategy for this project did not work well as initially anticipated. The execution was commissioned under a unit rate contract with some packages with an allowance for standby. But due to the nature of the project, work had inefficient period of time several times, causing the subcontractor to be idle even after mobilization. Hence it could be stated that a proper contract type with terms and conditions shall be selected with the sub-contractors with regards to the requirements of the main contract. This case is also supported by the literature as, the importance of selecting the

accurate type of contract for the success of procurement management was previously stated in several studies (Meng et al., 2011; Ruparathna & Hewage, 2015).

5.10. Stakeholder Management

Considering the importance factor in Table 4.1 as 8.3%, it could be stated that stakeholder management is a one of the major factors for the success in project management. In parallel, (Mok et al., 2015) underlined the necessity for the determination of stakeholder needs and interests for achieving success in stakeholder management. Moreover, accurate “identification of stakeholders” and successful handling of “stakeholder conflicts” were reported as essential for achieving improved performance in stakeholder management as previously evidenced by several research studies (Missonier & Loufrani-Fedida, 2014; Yang et al., 2011).

The performance factor of this knowledge area is rated as 68 in the Table 4.1. Considering the general performance of this knowledge area to the project management is rated as 5.62 as per the Table 4.1.

From the interviews it was understood that substantial efforts were given to manage interface points with stakeholders. From the case study, it was also understood that the EPCM contractor identified the external and community risks facing the project and developed mitigation strategies. It managed external issues and maintained effective communication with staff and project stakeholders in order to avoid the potential effects (risks) to the project schedule and budget. Furthermore, the elements noted under the conceptual framework was also followed up by the case study. However, the influence to the project owner was limited and the changes that have come from the project owner had adversely affected the project schedule and budget. The reason is presumably there was no proactive engagement with interface stakeholders to effectively solve the issues before hindering work progress. This is also parallel to the literature as researchers have previously indicated that project stakeholder management has a strong association with the project management performance or project success. Atkinson et al. (2006) also indicated that

consideration of the characteristics of project parties is important for effective project management.

Therefore, one could state that good communication and high-quality information sharing and exchange take place in successful projects. Effective communication ensures that project stakeholders can be connected easily, and project management and system development processes are facilitated with the high management support. Furthermore, studies have repeatedly shown that the strong support of top management, especially the sponsor, is a decisive factor in producing successful outcomes in projects (Crawford et al., 2008). In addition to recognizing this, successful managers are able to do everything that is required to ensure that their senior partners understand and fulfil this support role (Cooke-Davies, 2005).

Under the light of the above, one could also say that, stakeholder management has relationship between communication management, procurement management and risk management.

5.11. Health, Safety, Security, and Environmental Management

Considering the importance factor in Table 4.1 as 8.0%, it could be stated that Health, Safety, Security, and Environmental Management is a one of the major factors for the success in project management. Studies prove that success in implementing safety leads to a more effective safety management system (Choudhry, 2014; de Sousa Jabbour et al., 2014; Tappura et al., 2015). In this respect, Hsu et al. (2012) revealed that safety inspection and monitoring is crucial for a successful safety management scheme. Research studies also revealed that an efficient safety plan results in improved performance (Cheng et al., 2012; Molenaar et al., 2009).

The performance factor of this knowledge area is rated as 90 in the Table 4.1. Considering the general performance of this knowledge area to the project management is rated as 7.18 as per the Table 4.1.

By looking at the conceptual framework, the Health, Safety, Security, and Environmental plan is the key document for the implementation of proper and effective management within the planning, executing and controlling process groups of a project. Furthermore, in the contracts with contractors of the sub-packages, there is also an agreement between the Owner and the project management that there were no major changes in the content with regards to the contractor's commitment for occupational safety and health, protection of the environment the provisions. In this regard, the project management was committed at the construction site to have an integrated schedule and cash flow with regards to the Health, Safety, Security, and Environmental requirements. Therefore, one could state that there is relation with Health, Safety, Security, and Environmental management with both schedule management and cost management.

The interviews identified that although the overall safety performance on the project is satisfactory, the safety culture in the overall project organization was inadequate. The lack of Owner's interest in HSE management was the key culprit. This lack of knowledge and negligence of the Owner towards the safety program had a cascading effect on the project team's willingness to implement safety measures, processes, and procedures. Therefore, it could be stated that the stakeholder management had adversely affected the Health, Safety, Security, and Environmental management as evidenced by Demirkesen and Arditi (2015), enhancing a safe aware culture among workers is very important in terms of achieving high safety performance in construction projects.

It was noticed from the post project evaluation that the Health, Safety, Security, and Environmental plan is comprising the regulations to follow for the environmental protection. The existence of this factor is parallel to the conceptual frame work. This is supported by the literature as previous studies showed that commitment to environmental issues such as policies, regulations, control measures and implementation are the facilitators for a successful environmental management scheme (Fuentes et al., 2013; Goh & Rowlinson, 2013; Park & Ahn, 2012). Moreover, construction projects require the development successful environmental management strategies, environmental implementation and

control measures for the effective project management and improved performance (Montabon et al., 2007; Yang et al., 2012).

5.12. Financial Management

Considering the importance factor in Table 4.1 as 7.7%, it could be stated that Financial Management is a one of the major factors for the success in project management. Accordingly, Arslan and Kivrak's (2008) study reveals that the most important success factors include business management, financial conditions and owner-manager characteristics. Several research studies emphasized the importance of improved performance in cash flow monitoring and control for the successful execution of projects (Akanni et al., 2015; Kao et al., 2009). The failure of construction projects and their association with financial difficulties has thus positioned financial management as a primary requirement for many construction activities and businesses (Mutti and Hughes, 2002). This has highlighted the significance of financial management strategies and the emergence of a multitude of financial models for projects.

The performance factor of this knowledge area is rated as 81 in the Table 4.1. Considering the general performance of this knowledge area to the project management is rated as 6.22 as per the Table 4.1.

When the financial management is checked out from the conceptual framework, it is seen that the planning and controlling process groups are comprising the respective actions. In the planning process group, one could state that all financial requirements are defined and provided. In financial planning, similar to normal project planning, tasks are defined, requirements are priced and placed on a timeline. With this information communicated to the project controls, the cost management is fed in terms of forecasting and tracking of the actual costs. On this regard, it is visible that financial management has a relation with cost management.

Similarly, during the controlling process group, financial control includes the provision of funds from shareholders when necessary and the timely execution of bank cash transactions. Therefore, financial control and cost control are carried out together to ensure that budget and financial cash forecasts are accurate and effective. This is another evidence that financial management and cost management are directly related and either of these performances could affect the other one which would ultimately affect the project management's performance.

The financial difficulties that could have affected the subcontractors and consequently, the project success (Eom et al., 2008; Eriksson & Westerberg, 2011).

Research studies also implied that accurate prediction and evaluation of foreign exchange risk has a considerable contribution to the success of financial management practices (Boussabaine & Kaka, 1998; Maravas & Pantouvakis, 2013; Mbabazize et al., 2014).

5.13. Project Management Performance

It was noted that the majority of the interviewees possessed considerable knowledge and experience in project management. In the construction sector, it is essential to implement a comprehensive project management approach to mitigate the potential risks of large-scale, high-cost construction projects, to optimize communication with stakeholders, to track project progress through regular monitoring and to manage change effectively. Successful project management demands due consideration and emphasis on processes encompassing all project management knowledge areas, as it is the only way to attain project objectives successfully.

The concept of project management began evolving globally in the 19th century, ultimately becoming an indispensable management approach in the construction sector. This universally accepted concept ensures that construction projects achieve desired outcomes efficiently concerning time, quality, and cost. This development in project management was purposefully tailored to meet the construction sector's needs and further its progress. This

knowledge from literature matches with this research as revealed in Figure 4.1; client satisfaction, time and cost with quality were rated as the required characteristics of a successful outcome of the project. Moreover, the most recognized and established knowledge areas among project managers are actually scope management, time management, and cost management (Papke-Shields et al., 2010).

One of the main focuses of this study was to identify the critical factors that influence the success of projects in the construction industry. The insights and opinions of experienced and successful interviewees, who have worked in the industry for many years, played a pivotal role in determining these critical success factors.

As per the interview feedback, success factors which were identified from the literature search are rated by the interviewees. These critical factors are also interrelated, suggesting that there is a direct link between the success of a construction project and effective project management. In addition, the interview responses emphasized the importance of the sub-disciplines of project management in improving project success. Therefore, it could be stated that project management, when integrated into projects in the right way, at the right time and with the right systems, minimizes risks and ensures that projects are delivered efficiently, with the highest quality and at the lowest cost.

Through the research, it has been observed that top management involvement and awareness, training and support for users, and implementation team composition are the most significant factors of ERP implementation that yields to project management success. The perception of these critical factors can enhance implementation performance. However, the ERP implementation process is an IT process in its core, most of the critical success factors point that the human factors are the most critical. The project management must have a clear definition of objectives, development of both a work plan and a resource plan, and careful tracking of project progress. ERP implementations may trigger large-scale changes in corporate culture that can cause resistance, confusion and redundancies if not managed effectively. In this regard, the top management, the implementation team composition and training of users are reported as the important CSFs.

In particular, the project manager's experience emerged as the most critical success factor, leading to a discussion of the characteristics and core competencies expected of an effective project leader. Interviewees concurred that an exceptional project manager should be reliable, proficient in communication across all levels, capable of motivating their team, adept at meticulous planning and decision-making, and skilled in problem-solving and quick decision-making. Additionally, they emphasized the significance of communication skills and empathy for project managers. From the research point of view, the following success factors were rated as very important to achieve the project success;

- Characteristics of the Project Team Leader: Visionary style of leadership, creating a trustful, cohesive and flexible working environment for the team and the ability to take timely calculated risks and decisions in order to gain confidence and respect of the team, especially when there is uncertainty prevailing in the project. This is supported by the literature as according to Belassi and Tukel (1996), were the factors related to the skills and the characteristics of the Project Manager and team members proposed for a successful completion of the project.
- Personnel (Training & Education): Keeping in the view the nature and dynamics of complex projects, team cohesion and motivation acts as crucial element to keep the team united especially when ambiguity and uncertainty prevails in a project. This is supported by the literature as J. K. Pinto and Slevin (1988b) mentioned that, although the Project Manager's commitment and competence are the most critical during the planning and termination stages, the team members' competences is also a critical factor during the project implementation phase (J. K. Pinto & Slevin, 1988b).
- Top Management Support: Senior management support becomes important in the case of a matrix organization as it helps in prioritizing work in the supporting departments, for the supporting departments are working on multiple projects, the work usually gets prioritized according to the strategic importance or by the focus of senior management. Senior management supports becomes critical in the case when the project is not progressing according to the plan, and in that case the support, push

and motivation provided by the senior management plays a vital role. This is supported by the literature as Belassi and Tukel (1996) mentioned that the top management support, the project organizational structure, the functional manager support and the project champion factors are mostly related to the organization.

- **Project Mission:** Having clear objectives and direction is an important project management aspect as it reduces ambiguities, provides clarity of responsibilities and gives a clear sense of direction as to what the objectives are. Clear objectives not only help to minimize uncertainty in a project but also it facilitates to clarify roles and responsibilities, especially when there are lots of interdependencies and interfaces in the project. This is supported by the literature as according to J. K. Pinto and Covin (1989), initial clarity of goals and general direction, support from the top management, a detailed specification of the plan and the client consultation are the most important factors for projects.
- **Monitoring and Feedback:** Project monitoring and control is important for the project where there are a lot of multiple interfaces in terms of people, product and process and are dependents on multiple aspects and processes in order to manage and track the progress and observe any deviations. This is included in the definition of project management as the planning, monitoring and control of all phases of a project, and the motivation of the project team to achieve the set objectives within the set time, cost, quality and performance (Atkinson, 1999).
- **Communication and Knowledge Sharing:** No doubt communication is an important aspect of any project, but in multi-located, multi-disciplinary projects communication is essential as it has a critical impact on the overall project. This is supported by the literature as the tasks of a Project Manager can be structured into six basic project manager's roles: managing, organization, recruitment, planning, controlling and coordinating. The emphasis is on the managing role as a key to the project success (Bezak & Nahod, 2011).

6. CONCLUSION

The construction sector holds a critical position in the economies of both developed and developing countries, serving as one of the principal drivers of global economic activity. Recent advancements in technology and the increasing scale of projects have introduced significant challenges for companies, intensifying competition and underscoring the necessity of effective project management to ensure project success and sustainability. In response to these challenges, this research aimed to examine the impact of project management knowledge areas on performance and project success within the construction sector.

The primary objective of this study was to develop a comprehensive, multi-criteria performance measurement model specifically tailored to construction projects. This model, based on the PMBOK Guide (PMI, 2017) and its construction extension (PMI, 2016), was applied in an EPCM case study to assess project success and the effectiveness of project management practices. Additionally, the study sought to CSFs and KPIs that align with predetermined project goals and contribute to the success criteria.

The research methodology included a case study approach, where data was collected through project documents, direct observations, and interviews with experienced professionals involved in the case study. An extensive literature review on construction project management and performance measurement provided a theoretical foundation for the study. Interviews focused on three key themes: project management knowledge areas and standards, performance indicators and CSFs, and the overall success achieved in implementing the project management framework within the case study.

The findings reveal a strong correlation between the application of project management knowledge areas and achieving project success. By implementing strategies that address the identified CSFs, projects can be completed timely efficient, with high quality, and at minimal cost, while managing the satisfaction of the client. The results further

emphasize that integrating project management from the project's inception, along with the timely application of suitable systems, facilitates comprehensive planning and coordination.

An important finding that emerged from this study is the indispensable role of enterprise resource planning (ERP) systems in supporting effective construction project management. By integrating multiple functions including procurement, inventory, finance, human resources, and risk management into a centralized digital platform, ERP systems enabled seamless collaboration among diverse project stakeholders. This integrated approach provided real-time data visibility, facilitated streamlined processes, and enhanced decision-making capabilities, as project teams could rapidly identify and address potential issues. As demonstrated in the case study, the synergy between ERP systems and the established project management knowledge areas underscores the importance of embracing technological innovations to maintain competitiveness and achieve project success in the continually evolving construction landscape.

Among the knowledge areas, cost, schedule, quality, scope and integration management were identified as the highest importance, while resource, procurement, and financial management were the lowest importance to reach the targets set for the project success. Furthermore, interviewees consistently highlighted the essential role of the project manager in influencing project success. According to the participants, effective project managers possess a diverse skill set that includes reliability, communication skills, team motivation, planning ability, and decision-making proficiency, among others.

This study contributes to the field of construction project management by categorizing the key factors that drive project success, and underscores the role of performance management in enhancing business outcomes within the construction industry. These insights offer practical implications for stakeholders and project managers, who may utilize similar assessment frameworks, implement corrective actions, and derive valuable feedback for future projects. The research findings also provide avenues for professional development within the built environment, particularly in fostering improved project management practices.

As an additional dimension, this study incorporated feedback from industry professionals beyond the immediate case study, further validating the identified strategies and knowledge areas (see Table 6.1). The feedback received from these additional participants offers practical guidance for organizations in evaluating project management strategies and assessing their impact.

While the single case study approach and the relatively small sample of interviewees provided rich, in-depth data, these same factors limit the broader generalizability of the findings. Additionally, potential biases may have arisen due to the subjective nature of some performance metrics and the possibility that interviewees withheld sensitive information. Nevertheless, examining an airport project encompassing diverse industrial, civil, mechanical, and electrical systems highlights the adaptability of the EPCM model and the relevance of comprehensive project management practices.

Future research could expand upon these findings by exploring additional case studies and further incorporating the knowledge areas from the PMBOK Guide's construction edition (PMI, 2016). Given that even the core knowledge areas are not consistently applied across the industry, there is a need for continued education and dissemination of these principles to relevant stakeholders. This study focused on an EPCM project; however, future research could involve various project types and perspectives, including those of contractors, clients, and other stakeholders, to establish a more robust basis for comparison.

Furthermore, identifying additional CSFs specific to construction management and engaging a wider range of managers could yield a more nuanced understanding of project success factors. Collecting data through broad-based surveys, rather than one-to-one interviews, could provide a comprehensive overview of project management practices across diverse projects and organizations.

Table 6.1 Identified Roles and Responsibilities of Respective Stakeholders.

Integration Management		
Strategy	Responsible Party or Parties	Responsibility
Prioritize key integration initiatives, develop sound feasibility reports and tracking mechanisms, consider issue and change management, make accurate status reporting	Project Manager	Integration initiatives are identified, prioritized, and implemented effectively.
	Project Team	Collaborate to identify integration initiatives relevant to their areas of expertise and provide input for feasibility reports and tracking mechanisms.
	Quality Control and Assurance Team	Ensure that the integration initiatives meet quality standards and that any changes implemented do not compromise the overall quality of the project.
	Client, investors, regulatory authorities	Review feasibility reports, providing input on integration initiatives, and receiving status updates to ensure alignment with project objectives and expectations.
Define measurable KPIs and control the project performance of each discipline through KPIs in regular intervals	Project Manager	Oversees the overall implementation of KPIs and ensures they align with project objectives.
	Discipline Leads	Identify discipline-specific KPIs that contribute to overall project success.
	Project Team	Contribute to achieving the established KPIs through their daily tasks and responsibilities.
	Quality Control and Assurance Team	Ensure that the KPIs related to quality standards are effectively monitored and maintained throughout the project lifecycle.
	Data Analysts	Collecting, analyzing, and reporting data related to KPIs.
	Client	Receive regular updates on KPIs and project progress and provide feedback and support as needed.
Key manager role to be added in each discipline to strengthen integration and delivery focus.	Project Manager	Identify the need for key managers in each discipline, define their roles and responsibilities, and oversee their implementation.
	Discipline Managers/Team Leaders	Work closely with the project manager to ensure that the key managers align with the project's goals and contribute effectively to integration and delivery.
Develop a structured program to document and share lessons learned for all project areas.	Project Manager	Initiate, organize, and oversee the lessons learned program.
	Project Team Members	Identify insights, challenges, successes, and opportunities throughout the project lifecycle.

Table 6.1 Identified Roles and Responsibilities of Respective Stakeholders. (cont.)

Integration Management		
Strategy	Responsible Party or Parties	Responsibility
Develop a structured program to document and share lessons learned for all project areas.	Quality Control and Assurance Team	Ensure that the lessons learned program complies with quality standards and best practices.
	Client	Provide feedback, share perspectives, and offer recommendations based on their experiences and interactions with the project.
	Document Control Team	Manage project documentation and maintain lessons learned records.
Clarify roles and responsibilities for all participants and stakeholders.	Project Manager	Define and communicate the roles and responsibilities of all participants and stakeholders.
	Client	Collaborate with the project manager to ensure that roles and responsibilities are aligned with project objectives and contractual agreements.
	Designer	Ensure that design requirements are met and integrated into the overall project framework.
	Subcontractors	Understand and fulfill their contractual obligations as outlined in the project documents.
	Regulatory Agencies/Authorities	Have oversight responsibilities related to permits, approvals, and compliance requirements for the construction project.
Assign a dedicated process “owner” to drive the interface management.	Project Manager	Identifies the need for a dedicated process owner for interface management and oversee the appointment and performance of this individual.
	Discipline Managers	Provide input on interface requirements, coordinating with their respective teams, and addressing interface-related challenges within their areas of responsibility.
	Project Team Members	Contribute to interface management by communicating interface requirements, identifying potential conflicts or dependencies, and collaborating with other team members to address interface issues.
	Contractors/Subcontractors	Manage interfaces within their scope of work to ensure seamless integration.

Table 6.1 Identified Roles and Responsibilities of Respective Stakeholders. (cont.)

Integration Management		
Strategy	Responsible Party or Parties	Responsibility
Assign a dedicated process “owner” to drive the interface management.	Client	Provide input on interface requirements, review interface management plans, and participate in interface coordination efforts to ensure that project objectives are met and interface-related risks are mitigated.
Utilize best-in-class tools for interface management	Project Manager	Select, procure and oversee the implementation of interface management tools.
	(IT) Department	Provide technical support and infrastructure for implementing interface management tools.
	Project Team Members	Using interface management tools effectively to support their roles and responsibilities.
	Tool Vendors	Provide technical expertise and support throughout the implementation process.
	Quality Control and Assurance Team	Verify the accuracy and completeness of data entered into interface management tools.
The Project objective has to be separated from the project scope	Client	Define the project objectives, which typically include high-level goals, desired outcomes, and the overall purpose of the project.
	Project Manager	Manage the project objectives into a well-defined project scope.
	Project Team Members	Contribute to scope definition efforts, participate in scope validation activities, and communicate any scope-related issues or concerns to the project manager for resolution.
Scope Management		
Clear objectives to be set at the beginning of the project	Client	Determine the project's overall objectives such as desired outcomes, performance criteria, budget constraints, and schedule targets.
	Project Manager	Clarify objectives, establish project scope, and develop project plans that outline how objectives will be achieved.
	Project Team Members	Contribute their expertise, skills, and efforts to achieve project goals within their respective roles and responsibilities.

Table 6.1 Identified Roles and Responsibilities of Respective Stakeholders. (cont.)

Scope Management		
Strategy	Responsible Party or Parties	Responsibility
Clear objectives to be set at the beginning of the project	Quality Control and Assurance Team	Ensure that project objectives are met in terms of quality standards and compliance requirements.
Ensure that the initial bid development process benefits from the experience of key project stakeholders with relevant technical and commercial experience.	Client	Initiate the bid development process and ensuring that it aligns with project objectives and requirements. They provide input on project scope, budget, and schedule constraints to inform the bid development strategy.
	Project Manager	Ensures that stakeholders with relevant technical and commercial experience are engaged in the bid development process and that their insights are incorporated into the final bid documents.
	Designers	Contribute technical expertise related to project design, construction methods, materials, and technology solutions.
	Project Team Members	Procurement professionals, estimators, and contract managers, provide expertise in pricing, contracting, and risk management to support bid development to ensure that bid pricing is accurate, realistic, and aligned with project objectives.
	Legal Advisors	Provide guidance on legal and regulatory requirements that may impact the bid development process by reviewing bid documents, contracts, and procurement strategies to ensure compliance with applicable laws and regulations.
Study and incorporate accurate activity duration estimations and determination of milestones in a correct manner.	Project Manager	Oversee the activity duration estimation process and milestone determination as well as develop a comprehensive project schedule.
	Planning Team	Develop and maintain the project schedule by utilizing scheduling software and tools to create Gantt charts, network diagrams, and other scheduling documents that visualize the project timeline and critical path.
	Contractors/Subcontractors	Provide input on activity durations and milestones related to their scope of work.

Table 6.1 Identified Roles and Responsibilities of Respective Stakeholders. (cont.)

Scope Management		
Strategy	Responsible Party or Parties	Responsibility
Create a common vision and mission for the project and communicate this strongly across the project team and overall organization.	Client	Initiates the process of creating a common vision and mission for the project.
	Project Manager	Facilitate the development of the project's vision and mission.
	Project Team Members	Embrace the project's vision and mission in their work.
Schedule Management		
Incorporate contingencies to the schedule based on the risk assessment results.	Project Manager	Oversee the risk assessment process and incorporating contingencies into the project schedule by identify project risks, considering factors such as project scope, complexity and external influences.
	Risk Management Team	Conduct the risk assessment and providing input on potential threats and opportunities that may impact the project schedule.
	Planning Team	Update the project schedule to incorporate contingencies based on the risk assessment results.
	Contractors/Subcontractors	Provide input on risk assessment and contingency planning based on their knowledge of project-specific risks and constraints.
Assigning an experienced leader to manage the project controls department.	Project Manager	Appoint the leader to manage the project controls department by identifying the need for a skilled and experienced individual to oversee project controls activities such as cost management, scheduling, risk management, and performance reporting.
	Human Resources Department	Recruit and onboard the leader of the project controls department by identifying job requirements, screening candidates, conducting interviews, and make hiring decisions.
	Project Controls Staff	Support the leader in executing project controls activities.
	Contractors/Subcontractors	Ensure that the appointed leader has the expertise and capabilities to facilitate efficient communication, collaboration, and coordination among project stakeholders.

Table 6.1 Identified Roles and Responsibilities of Respective Stakeholders. (cont.)

Schedule Management		
Strategy	Responsible Party or Parties	Responsibility
The planning process should be clear with assigned roles and responsibilities. It should be aligned with all the key stakeholders in all disciplines to support the planning process.	Project Manager	Establish the overall project plan, define project objectives, and allocate resources. They also facilitate alignment among key stakeholders in different disciplines to ensure that the planning process supports project objectives.
	Planning Team	Developing the detailed project plan by collaborating with stakeholders from various disciplines to gather input, assess project requirements, and develop a comprehensive plan that outlines tasks, timelines, dependencies, and resource allocations.
	Contractors/Subcontractors	Provide input on construction methods, sequencing, and resource requirements based on their expertise and experience.
Integrate interface management with project planning	Project Manager	Oversee the integration of interface management with project planning by ensuring that interface management processes are aligned with project planning activities to facilitate coordination, communication, and collaboration among various project components and stakeholders.
	Planning Team	Ensure that interface management activities are integrated into the project schedule and aligned with other planning activities to support seamless project execution.
	Contractors/Subcontractors	Provide input on construction sequences, work packages, and resource requirements that influence interface coordination and integration.
	Client	Provide input and feedback to support the integration of interface management with project planning. They contribute insights into project requirements, expectations, and priorities that impact interface management and project planning decisions.

Table 6.1 Identified Roles and Responsibilities of Respective Stakeholders. (cont.)

Cost Management		
Strategy	Responsible Party or Parties	Responsibility
Enhance the importance of cost control for the whole project organization by means of training.	Project Manager/Management	Communicate the significance of cost control to all project stakeholders, allocate resources for educational programs, and set expectations for cost-conscious behavior.
	Project Control Team	Develop educational materials, conduct training sessions, and provide guidance on cost control techniques and best practices.
	Human Resources Department	Identify training needs, develop training schedules, and engage external training providers as needed. The human resources department ensures that cost control education is integrated into the project organization's overall training and development strategy.
	Training Providers	Engaged to deliver specialized cost control education programs to the project organization.
	Project Team Members	Participate in cost control education programs and applying cost control principles in their daily work.
	Client	Provide input on cost management requirements, expectations, and priorities that influence educational content and delivery methods.
Allocating correct budget line-item owners with respect to the cost of account structure of the project budget.	Project Manager	Overseeing the budget allocation process and ensuring alignment with the project's cost account structure by defining the overall project budget, establish cost account codes or categories, and assign specific budget line items to corresponding cost accounts.
	Finance Department	Ensures that budget line items are allocated to appropriate cost accounts and are consistent with financial reporting requirements and organizational policies.
	Project Control Team	Allocate budget line items to specific cost accounts based on project needs and requirements to monitor budget performance, tracks expenditures, and identifies variances to ensure that budget allocations are effectively managed and utilized.

Table 6.1 Identified Roles and Responsibilities of Respective Stakeholders. (cont.)

Cost Management		
Strategy	Responsible Party or Parties	Responsibility
Allocating correct budget line-item owners with respect to the cost of account structure of the project budget.	Budget Line-Item Owners	Overseeing specific budget line items within the cost account structure of the project budget.
Set up an integrated cost control system to embrace the project cost with the reviews with management.	Project Manager	Define the objectives, scope, and requirements of the system, and oversee its implementation throughout the project lifecycle.
	Project Control Team	Design, implement and maintaining the integrated cost control system.
	Finance Department	Assist in defining cost categories, developing cost reporting formats, and integrating cost data into financial systems.
	Senior Management	Review cost reports, analyze cost performance metrics, and provide strategic guidance and support to address cost-related issues and challenges to ensure that project costs are managed effectively and aligned with organizational objectives.
Quality Management		
Empowering the QA/QC department to better integrate with other disciplines, such as engineering and procurement for quality assurance in these phases.	Project Manager	Provide leadership and support to ensure that quality management processes are effectively implemented throughout the project lifecycle.
	Quality Control and Assurance Team	Develop and implement QA/QC procedures, conducting inspections and audits, and verifying compliance with specifications and requirements.
	Engineering Department	Incorporate quality requirements into design specifications, review engineering drawings and documents for compliance, and address any quality-related issues or concerns.
	Procurement Department	Establish quality criteria for procurement, evaluate supplier capabilities and performance, and ensure that purchased items meet quality requirements.
	Client	Provide input on quality requirements, expectations, and priorities.

Table 6.1 Identified Roles and Responsibilities of Respective Stakeholders. (cont.)

Quality Management		
Strategy	Responsible Party or Parties	Responsibility
Set up a well-set quality management frame in which quality objectives are clearly defined.	Project Manager	Allocate resources, provides leadership support, and monitors adherence to QA/QC procedures throughout the project lifecycle.
	Quality Manager	Implement QA/QC procedures, developing quality management plans, and ensuring compliance with quality standards and requirements.
	Designer	Ensure that design specifications meet quality standards and regulatory requirements, review engineering drawings and documents for accuracy and completeness, and conduct design reviews to identify and address potential quality issues.
	Procurement Department	Ensure that purchased materials, equipment, and services meet quality standards and specifications by establishing quality criteria for procurement, evaluate supplier capabilities and performance, and conduct quality inspections and audits to verify product quality.
	Client	Provide input on quality requirements, expectations, and priorities, and participate in quality reviews and inspections to verify compliance with project specifications.
Establish reward mechanisms and performance development systems where higher performance is rewarded.	Project Manager	Define performance criteria, set performance targets, and communicate expectations to project teams.
	Human Resources Department	Supports the implementation of reward mechanisms and performance development systems by providing expertise in talent management, compensation, and employee development.
	Supervisors/Team Leaders	Evaluate individual and team performance, providing feedback, and coaching team members to improve performance.
	Client	Provide input on performance criteria, expectations, priorities, and participate in performance evaluations to assess project progress.

Table 6.1 Identified Roles and Responsibilities of Respective Stakeholders. (cont.)

Quality Management		
Strategy	Responsible Party or Parties	Responsibility
	External Consultants	Provide expertise in performance management and incentive design to support the implementation of reward mechanisms by offering insights into best practices, benchmarking data, and innovative approaches to performance measurement and recognition.
Resource Management		
Provide additional expertise and resources in HR development and training.	Project Manager	Identify training needs, allocate resources, and set training objectives aligned with project goals.
	Human Resources (HR) Department	Assess training needs, design training programs, and source external training providers as needed.
	Training Providers/Consultants	Collaborate with the HR department and project management to design customized training curricula, deliver training sessions, and assess training outcomes.
	Project Team Members	Responsible for participating in HR development and training activities by attending training sessions, workshops, and seminars to enhance their knowledge, skills, and competencies relevant to their roles and responsibilities.
	Client	Participate in training sessions and provide support and encouragement to project team members undergoing training to enhance their skills and performance.
Provide additional expertise and resources in HR development and training.	Project Manager	Identify training needs, allocate resources, and set training objectives aligned with project goals.
	Human Resources (HR) Department	Assess training needs, design training programs, and source external training providers as needed.

Table 6.1 Identified Roles and Responsibilities of Respective Stakeholders. (cont.)

Resource Management		
Strategy	Responsible Party or Parties	Responsibility
Provide additional expertise and resources in HR development and training.	Training Providers/Consultants	Collaborate with the HR department and project management to design customized training curricula, deliver training sessions, and assess training outcomes.
	Project Team Members	Responsible for participating in HR development and training activities by attending training sessions, workshops, and seminars to enhance their knowledge, skills, and competencies relevant to their roles and responsibilities.
	Client	Participate in training sessions and provide support and encouragement to project team members undergoing training to enhance their skills and performance.
Develop a clear corporate-level policy for HR resource development and implement it on each project.	Corporate Management/Executive Leadership	Define the overarching goals, objectives, and principles that guide HR resource development initiatives across the organization by allocating resources and provide support to implement the policy effectively on each project.
	Human Resources (HR) Department	Collaborate with corporate management to draft the policy, incorporating best practices, legal requirements, and industry standards.
	Project Managers	Implement the corporate-level policy for HR resource development on each project they oversee.
	Project Team Members	Adhering to the corporate-level policy for HR resource development.
Integrate the new employee onboarding process with the project plans. Investigate root causes for morale and turnover issues and implement corrective action plans.	Human Resources (HR) Department	Implementation of onboarding programs and monitor their effectiveness in improving employee engagement and retention.
	Project Managers	Integrate new employee onboarding with project plans and addressing morale and turnover issues within the team.
	New Employees	Participate in orientation sessions, training programs, and team-building activities designed to help them acclimate to their roles and the project environment.

Table 6.1 Identified Roles and Responsibilities of Respective Stakeholders. (cont.)

Resource Management		
Strategy	Responsible Party or Parties	Responsibility
Integrate the new employee onboarding process with the project plans. Investigate root causes for morale and turnover issues and implement corrective action plans.	Existing Employees/Team Member	Welcome the new hires, providing guidance and support, and sharing their knowledge and experiences.
Communication Management		
Ensure good communication between all participants of the project.	Project Manager	Establish communication protocols, channels, and tools to facilitate effective communication among project participants by fostering a culture of open communication, transparency, and collaboration among project teams, stakeholders, and external partners.
	Project Team Members	Ensure good communication by actively participating in communication activities and sharing relevant information with colleagues and stakeholders.
	Clients	Provide project requirements, expectations, and feedback to project teams and participate in project meetings and reviews.
	Contractors/Subcontractors	Communicate progress, challenges, and resource requirements to project managers and team members, coordinate work activities so that project goals are achieved efficiently.
	Designers	Communicate design specifications, technical requirements, and project constraints to project teams and stakeholders, ensuring that design intent is understood and implemented correctly.
	Regulatory Agencies/Government Authorities	Communicate regulatory requirements, inspections, and approvals to project teams and stakeholders and provide guidance on compliance matters.

Table 6.1 Identified Roles and Responsibilities of Respective Stakeholders. (cont.)

Communication Management		
Strategy	Responsible Party or Parties	Responsibility
Standardize project documents and reports such as request for information, progress reports, schedule and cost reports for the fact that project personnel easily communicate through those documents.	Project Manager	Ensure that standardized documents and reports meet project requirements, comply with industry standards, and facilitate effective communication among project personnel.
	Document Control Team	Implement document standardization procedures and maintaining document repositories by developing document templates, naming conventions, and version control protocols to ensure uniformity and accessibility of project documents and reports.
	Quality Control and Assurance Team	Conduct reviews and audits of project documentation to identify discrepancies, inconsistencies, or non-conformances and ensure that corrective actions are implemented promptly to maintain document quality standards and address any quality issues or concerns.
	Client	Provide feedback on document formats, content, and usability to improve communication and collaboration throughout the project lifecycle.
Risk Management		
Develop risk management plans and risk mitigation procedures.	Project Manager	Identify project risks, assessing their potential impact, and developing strategies to mitigate or manage them effectively by ensuring that risk management plans are integrated into project plans, budgets, and schedules.
	Project Team Members	Contribute their knowledge of project operations, technical expertise, and experience to identify potential risks and propose mitigation measures.
	Safety and Quality Assurance Teams	Identify and mitigate risks related to safety hazards and quality deficiencies on construction sites by conducting risk assessments, inspections, and audits to identify potential safety and quality risks and recommend corrective actions to address them.

Table 6.1 Identified Roles and Responsibilities of Respective Stakeholders. (cont.)

Risk Management		
Strategy	Responsible Party or Parties	Responsibility
Develop risk management plans and risk mitigation procedures.	Contractors/Subcontractors	Implementing risk mitigation procedures related to their specific scopes of work.
	Client	Provide input on project risks, priorities, and acceptable risk tolerance levels.
Assign an overall “Owner” of risk management.	Project Manager	Lead the development and implementation of risk management strategies, policies, and procedures by coordinating risk assessment activities, identify and prioritize project risks, and develop risk mitigation plans.
	Project Team Members	Participate in risk identification workshops, contribute their knowledge and expertise to identify project risks, and propose risk mitigation measures and communicate risk-related issues, concerns, and recommendations to the project manager and collaborate with other stakeholders to address project risks effectively.
	Senior Management	Receive regular updates on project risks and mitigation efforts from the overall owner of risk management and provide strategic guidance and direction as needed.
Train all stakeholders on risk management.	Project Manager	Develop the training program and ensuring that all stakeholders receive training on risk management principles, processes, and tools.
	Project Team Members	Attend training sessions, actively participating in discussions, and applying risk management principles to their respective roles and responsibilities.
	Contractors/Subcontractors	Participate in training sessions organized by the project manager or risk management team and apply risk management principles to their work activities.

Table 6.1 Identified Roles and Responsibilities of Respective Stakeholders. (cont.)

Risk Management		
Strategy	Responsible Party or Parties	Responsibility
Train all stakeholders on risk management.	Regulatory Agencies/Government Authorities	Require stakeholders to undergo training on specific risk management regulations or standards applicable to construction projects and provide guidance on regulatory requirements and expectations regarding risk management practices and may offer training resources or certification programs to stakeholders.
	Client	Attend training sessions to gain an understanding of risk management processes and their role in supporting risk mitigation efforts.
	External Consultants/Advisors	Provide specialized training sessions, workshops, or coaching tailored to the needs of project stakeholders.
Develop bid contingency based on risk assessment	Project Manager	Lead the risk assessment process, identify potential risks that may impact the project's cost, schedule, or scope, and prioritize them based on their likelihood and potential impact by ensuring that bid documents accurately reflect the identified risks and associated contingency provisions.
	Estimators/Quantity Surveyors	Quantifying the cost implications of project risks and incorporating them into bid estimates.
	Finance Department	Provide financial expertise and analysis to support bid contingency development by evaluating the financial viability of bid contingency amounts and assess their impact on project profitability and financial performance.
	Procurement Team	Manage the bidding process and negotiating contracts with subcontractors and suppliers by ensuring that bid documents include appropriate contingency provisions to cover potential risks and uncertainties associated with subcontractor bids and material prices.

Table 6.1 Identified Roles and Responsibilities of Respective Stakeholders. (cont.)

Risk Management		
Strategy	Responsible Party or Parties	Responsibility
Develop bid contingency based on risk assessment	Legal Counsel	Provide legal advice and expertise on risk allocation and contract terms related to bid contingency provisions by assisting in drafting contract language to clearly define the scope and limitations of bid contingency provisions.
Procurement Management		
There is a need to establish long-term strategic agreements with key suppliers and subcontractors, focusing on selecting those who demonstrate adaptability to changing circumstances, to improve procurement response.	Project Manager	Assess project requirements, identify critical materials, equipment, and services, and evaluate potential suppliers based on their capabilities, reliability, and cost-effectiveness.
	Legal Counsel	Provides legal expertise and guidance on drafting, negotiating, and finalizing long-term strategic agreements with key suppliers by reviewing contract documents, identify legal risks and liabilities, and advise the project manager and procurement team on contractual terms and conditions.
	Finance Department	Support the negotiation and management of long-term strategic agreements with key suppliers from a financial perspective by evaluating the financial implications of proposed agreements, including costs, savings.
	Procurement Team	Conduct supplier evaluations, solicits bids or proposals, and negotiates contract terms and conditions with key suppliers by ensuring that strategic agreements comply with procurement policies, regulations, and ethical standards and that contractual obligations are met throughout the contract period.

Table 6.1 Identified Roles and Responsibilities of Respective Stakeholders. (cont.)

Procurement Management		
Strategy	Responsible Party or Parties	Responsibility
The procurement process needs to be streamlined with all stakeholders, including the client's engagement, to reduce the overall project duration.	Project Manager/Management Team	Lead the efforts to streamline the procurement process and ensure alignment with project objectives and timelines by assessing current procurement practices, identify inefficiencies, and develop strategies to improve process efficiency and effectiveness.
	Procurement Team	Implement process improvements and streamlining procurement workflows by leveraging technology solutions, such as e-procurement platforms and digital procurement tools, to streamline sourcing, bidding, and contract management processes.
	Legal Counsel	Provides guidance and support on legal and contractual matters streamlining by reviewing procurement documents, including bid documents, contracts, and agreements, to ensure compliance with applicable laws, regulations, and industry standards.
Management needs to develop procurement KPIs and regularly evaluate performance accordingly.	Project Manager	Establish performance targets, benchmarks, and reporting mechanisms to track progress and evaluate procurement effectiveness.
	Procurement Team	Identify key areas for performance measurement, such as supplier quality, delivery reliability, and contract compliance by generating KPIs that reflect departmental objectives to overall project success.
The procurement department needs to be consistently engaging with project control to further streamline the procurement process with planned and ongoing project activities.	Project Manager	Establish communication channels and fostering collaboration between the two departments to ensure alignment between procurement activities and project schedules, milestones, and deliverables.
	Procurement Department	Collaborate closely with project control to ensure that procurement activities are synchronized with planned and ongoing project activities by providing timely updates on procurement progress, requirements, and milestones.

Table 6.1 Identified Roles and Responsibilities of Respective Stakeholders. (cont.)

Procurement Management		
Strategy	Responsible Party or Parties	Responsibility
The procurement department needs to be consistently engaging with project control to further streamline the procurement process with planned and ongoing project activities.	Project Control Team	Work closely with the procurement department to integrate procurement activities into project plans and schedules by monitoring procurement progress.
	Suppliers and Contractors	Provide timely responses to procurement requests, submit competitive bids or proposals, and adhere to project schedules and specifications.
Stakeholder Management		
Ensure awareness and buy-in of key stakeholders on the project control reports.	Project Manager	Communicating the importance of project control reports in monitoring project progress, identifying issues, and making informed decisions.
	Project Control Team	Generate and analyze project control reports to key stakeholders.
	Client	Provide feedback on project control reports, raise concerns or questions, and collaborate with the project manager and project control team to address any issues or discrepancies identified.
	Communication Team	Ensure effective communication and dissemination of project control reports to key stakeholders by utilizing various channels, such as meetings, presentations, emails, and project portals, to distribute project control reports and solicit feedback from stakeholders.
Develop stakeholder management plans at the beginning of construction projects to ensure stakeholder needs, influences, and interests are considered in further phases, and explore mechanisms such as incentives or bonus structures that Client can provide to the EPCM contractor to drive higher productivity and performance.	Project Manager	Identify project stakeholders, assessing their needs, interests, and concerns, and developing strategies to engage and manage stakeholder relationships effectively.

Table 6.1 Identified Roles and Responsibilities of Respective Stakeholders. (cont.)

Stakeholder Management		
Strategy	Responsible Party or Parties	Responsibility
Develop stakeholder management plans at the beginning of construction projects to ensure stakeholder needs, influences, and interests are considered in further phases, and explore mechanisms such as incentives or bonus structures that Client can provide to the EPCM contractor to drive higher productivity and performance.	Client	Collaborate with the project manager to develop stakeholder management plans that align with project goals and client expectations. The Client is responsible for setting clear performance metrics and implementing incentive mechanisms to ensure the EPCM contractor consistently delivers higher productivity and performance.
	Regulatory Agencies/Government Authorities	Provide guidance on regulatory standards, environmental regulations, zoning requirements, and other legal obligations that may impact project execution to ensure compliance with applicable regulations, address regulatory concerns, and obtain necessary permits or approvals.
	Local Residents Who May Be Affected by Construction Projects	Provide input on project impacts, such as noise, traffic, air quality, and property values, and advocate for their interests and concerns.
Key stakeholders must be identified and engagement of stakeholders in the processes should be satisfied to best address project needs.	Project Manager	Conducting stakeholder analyses to identify individuals, groups, or organizations that have a vested interest in the project.
	Project Team Members	Participate in stakeholder meetings, workshops, and consultations to provide subject matter expertise and support stakeholder engagement efforts.
	Client	Provide input on project objectives, requirements, and priorities and influence project decisions and outcomes.
	Regulatory Agencies	Provide guidance on regulatory standards, environmental regulations, zoning requirements, and other legal obligations that may impact project execution.
	Local Residents	Participate in community meetings, outreach events, and public consultations to voice their opinions, raise issues, and seek solutions that benefit the community.

Table 6.1 Identified Roles and Responsibilities of Respective Stakeholders. (cont.)

Health, Safety, Security, and Environmental Management		
Strategy	Responsible Party or Parties	Responsibility
Define and communicate clear corporate safety objectives and strongly communicate its vision for HSE management on the project. Company leadership must take initiatives to support the HSE vision and objectives, clearly indicating the new safety culture in the organization.	Senior Management	Set the tone for safety culture and promoting HSE objectives.
	Project Manager	Align project-specific HSE goals with corporate directives and ensure that HSE considerations are integrated into project plans, schedules, and budgets.
	Health and Safety Department	Develop HSE policies, procedures, and guidelines tailored to the project's specific risks and hazards.
	Project Team	Actively contribute to maintaining a safe work environment by following safe work practices, reporting hazards and incidents, and participating in safety meetings and training sessions.
	Client	Promote HSE management on the construction project by aligning project requirements and expectations with HSE objectives.
A system to be developed which interprets the leading indicators to identify any gaps in the safety program and then initiate a follow-up system to rectify those gaps.	Health and Safety Department	Develop and implement the safety system by analyzing leading indicators, such as near misses, safety observations, and safety audits, to identify trends and potential gaps in the safety program.
	Project Manager	Ensures that safety is integrated into project planning, execution, and monitoring processes.
	Construction Personnel	Participate in safety observations, inspections, and audits to identify potential hazards and risks and follow established protocols and procedures for addressing identified gaps in the safety program and contribute to continuous improvement efforts.
Financial Management		
The required time to be reserved to begin working on the project to fully understand the cost budgeted against each account.	Project Manager	Establish timelines and milestones for budget review and analysis, ensuring that team members have time to understand budget allocations.

Table 6.1 Identified Roles and Responsibilities of Respective Stakeholders. (cont.)

Financial Management		
Strategy	Responsible Party or Parties	Responsibility
The required time to be reserved to begin working on the project to fully understand the cost budgeted against each account.	Finance Department	Ensures that cost allocations are accurately reflected in the project budget and that sufficient funds are allocated to each account or cost center.
	Procurement Department	Ensures that budgeted costs for materials, equipment, and subcontractor services are accurately reflected in the project budget.
	Project Controls Department	Prepare cost estimates and quantity takeoffs and review budgeted costs against their estimates to identify any discrepancies or inconsistencies.
Taxes and levies at the location of the project shall be well studied at the initiation process group of the project life cycle.	Project Manager	Ensure that taxes and levies are adequately studied and accounted for in the project budget and schedule.
	Finance Department	Provide expertise in financial matters and analyze the tax implications of the project.
	Legal Team	Ensures that the project complies with all relevant laws and regulations, including tax laws and levies.
	Government Authorities	Provide information on applicable taxes, rates, and regulations that the project stakeholders need to engage with these authorities to understand the tax environment and obtain necessary permits and approvals.
	Consultants/Advisors	Assist project stakeholders in understanding the tax implications and developing appropriate strategies.
Cash flow calculations to be aligned every time the forecast budget of the project is updated.	Project Manager	Ensure that cash flow calculations are aligned with the updated forecast budget by coordinating with various stakeholders, monitoring expenses, and adjusting cash flow projections accordingly.
	Finance Department	Prepare cash flow calculations based on the updated forecast budget by analyzing income and expenses, tracking payments, and forecasting cash flows over the project timeline.
	Procurement Team	Provide input on anticipated expenses and procurement timelines, which influence cash flow projections.

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APPENDIX A: CASE STUDY INTERVIEW FORM

The interview questions were thoughtfully designed and tailored to construction professionals, with the following objectives in mind:

- Project management knowledge areas & project management standards: investigation of the application of the project management knowledge areas and project management standards.
- Project management performance: Investigation of the key performance indicators and critical success factors for the project's success.
- Project success: The interviews focused on the level of success that was achieved in the implementation of the Project Management Knowledge Areas within the case study project.

The interview questions are designed using the framework with criteria and alternatives, and answer format. The major criteria for the selection of an interview question was a reference to the PMBOK Guide (PMI, 2017).

In this interview questions, I have also opted the Smart method which was used to measure the effects on project success by calculating the overall project management success as a result of determining the importance of knowledge areas and multiplying them by performance values. The same analysis was performed for project success criteria.



BOĞAZIÇI UNIVERSITY
INSTITUTE OF GRADUATE STUDIES IN SCIENCE AND ENGINEERING
CIVIL ENGINEERING DEPARTMENT
CONSTRUCTION MANAGEMENT MASTER THESIS INTERVIEW FORM



Thesis : Project Management Success in Construction: A Case Study of an EPCM Project
 Student : Uğur İbrahim Yurttutan
 Professor : Prof. Beliz Özorhon

GENERAL INFORMATION (Interviewee)

- 1) Profession :
- 2) Experience in Construction :
- 3) Position in the Company :
- 4) Age :
- 5) Knowledge on the PMI Knowledge Areas :
- 6) Project management qualification :

INTERVIEW QUESTIONS

Project Integration Management

- Is there awareness about the need or importance of project integration management in your organization's and Project Management team?
- Had the project got support from senior management during the project life cycle?
- What is the level of application of integration management in your organization?
- What are the key performance indicators used in your company?
- What is the level of ERP application of Integration management in your organization?
- What kind of tools were being used to manage different knowledge areas in your project?
- Is there deficiency or overlaps in the processes, templates, tools, reports and procedures of project management?
- Do the processes such as developing project plan, definition of project objectives and benefits, preparation of project organizational structure and developing of responsibility matrix performed in your project?
- The main role of a PM is integration. Do you agree?
- What do you think is most important to integrate the project and why?

Project Scope Management

- Is there awareness about the need or importance of project scope management in your organization's and Project Management team?
- What is the level of application of scope management in your organization?
- Was there a formalized acceptance of the project in every project phase?
- What systems/tools do you currently use to manage your project scope?

- How is scope of a project developed and is formal customer approval obtained?
- Does the organization have a standard way to gather and document business requirements?
- What kind of documents do you provide to your customers for project scope management?
- How is the scope document used?
- Is there any effort of monitoring and controlling scope in your project?
- Is there a defined process for project close out?
- Are work results reviewed or inspected to ensure or verify that all scope of the work is complete?

Project Schedule Management

- Is there awareness about the importance of project schedule management in your organization's and project management team?
- What is the level of application of schedule management in your organization?
- What type of documents do you use for time management?
- What type of tools (software / systems) do you use for time management?
- At what level of detail is a typical project planned?
- Is WBS used when defining the schedule activities?
- Are relationships among activities identified and the activities sequenced?
- Is there a process of schedule buy-in / sign-off that involves the key stakeholders?
- Who ultimately approves the project schedules?
- Do the project schedules clearly identify the deliverables?
- Are baseline schedules maintained for the project?
- Are schedules published and accessible to all team members easily?
- Are project meetings held to review and status project schedules?
- Are schedules ever revised based upon risk assessment?
- Do you integrate your timing plans across functional departments / organization?
- Do you require schedules from your suppliers?
- Is progress of project activities continuously monitored and controlled?

Project Cost Management

- Is there awareness about the importance of project cost management in your organization?
- What is the level of application of cost management in your organization?
- What is included in the project budgets?
- What systems / tools do you currently use to manage your project Cost?
- Who prepares proposal cost estimates, are the assumptions for project cost documented?
- Do budgets tie to WBS or to separate Cost Accounts?
- Are all purchased items and subcontract costs coded to budget "buckets" and tracked?
- How often are budgets re-forecasted and re-baselined?
- Is project cost tracked against the baseline on regular update cycle?
- What kind of documents do you provide to your customers for project cost control?

- Does the estimate detail cost of labor, material, and machinery separately?
- Does the budget show the amount allocated for resources by category?
- Is the project cost tracked against the baseline on regular update cycle?

Project Quality Management

- Is there awareness about the importance of Project Quality Management in your organization's and project management team?
- What is the level of application of quality management in your organization?
- What systems / tools do you currently use to manage your project Quality?
- Are quality goals methods and systems established for the project?
- How are quality improvement goals communicated?
- What kind of documents do you provide to your customers for project quality management?
- Do you use customer satisfaction metrics?
- How does project quality track to work quality?
- Does your organization have quality management policies, procedures and guidelines?
- Is quality audit done in your project? (a review to determine whether project activities comply with policies, processes, and quality requirements)
- Does your project/organization inspect and control quality of subcontractors or suppliers to ensure compliance with quality requirement?
- Is there quality department or employees specializing in quality management?

Project Resource Management

- Is there awareness about the importance of project resource management in your organization's and project management team?
- What is the level of application of resource management in your organization?
- Are your Project management practices and process consistent across divisions and functional groups?
- Are roles of Project Managers, Planners, Budget Analysts, Team Members clearly defined?
- Does the training provide lead to professional certification?
- What are the required criteria of staff efficiency on your organization?
- Is there any planning for acquisition and management of human resource?
- Is project organization chart prepared for your project?
- Does your organization have resource allocation policy that guides acquisition, use, and replacement decisions?
- Is resource management performed in your project or organization?
- Is computer software used in resource equipment planning, assignment and tracking?
- Is there a procedure for resource equipment sharing among projects of the organization?
- Is there any effort of tracking and monitoring performance of the project equipment, their productivity, maintenance cost, time worked etc.?

Project Communications Management

- Is there awareness about the importance of project communications management in your organization's and project management team?
- What is the level of application of communications management in your organization?
- Do you prepare and use team rosters for project communication?
- Does IT provide support through the ERP system to customize reports and formats to standardize across divisions, departments?
- Is there a common management reporting requirement defined by your company?
- Does your project Manager have a process in place to share lessons learned?
- What kind of reports and key performance indicators are being used to manage projects and to whom are these reports and indicators visible to?
- Is there something that could/should be automated in terms of reporting?

Project Risk Management

- Is there awareness about the importance of project risk management in your organization's and project management team?
- What is the level of application of risk management in your organization?
- Are areas of risk identified for each project along with risk avoidance and mitigation plans? (time risk / cost risk etc.)
- What systems / tools do you currently use to manage your project Risk?
- Are any risk metrics used to monitor trends?
- What kind of documents do you provide to your customers for project risk management?
- Assuming that you have identified a number of risks in the project, how would you prioritize them?
- Is there any effort of identifying and documenting risks in your project?
- Is risk response strategy developed for the prioritized risks? (example: avoid, transfer, mitigate, accept)
- Is the risk response plan and strategy continuously updated?
- Is contingency time allowed in project schedule for potential risk impact?
- Is contingency budget reserved for potential risk impact?

Project Procurement Management

- Is there awareness about the importance of project procurement management in your organization's and project management team?
- What is the level of application of procurement management in your organization?
- Are contracting approaches, vendor lists developed for projects?
- Are schedules and cost targets available during the purchasing process?
- Is planning done for procurement of goods and services needed for your project?
- Are major and/or special supply items (such as: those required in large quantity, or those requiring special manufacturing or long lead-time etc.) identified and special attention given for them?

- Does your project/organization have standard procurement documents? (such as standard purchase order, standard sub contract / supplier agreement)
- Does your organization use preferred supplier/subcontractor or prequalify them?
- Does your project/organization have a documented contract management/administration process?
- Does your project/organization have a staff trained in contract /procurement management?
- Does your project monitor and control progress of subcontractors and suppliers?
- Does your project have a clearly defined process for contract closing?

Project Stakeholder Management

- Is there awareness about the importance of project stakeholder management in your organization's and project management team?
- What is the level of application of stakeholder management in your organization?
- How would you define the interaction of Project Stakeholders and their roles and responsibilities within the project?
- Could you inform regarding the motives of the project stakeholders in the interest of project?
- Is there awareness about the importance of stakeholder management in your organization's and project management team?
- Is a stakeholder management plan prepared (is there a devised strategy on how to handle the stakeholder's needs and expectations)?
- Is there any continuous effort of communicating and working with stakeholders to influence their expectation, address their concern and resolve issues?
- Is a strategy developed for managing each key stakeholder's expectation?

Project Health, Safety, Security, and Environmental Management

- Is there awareness about the importance of health, safety, security, and environmental stakeholder management in your organization and project management team?
- What is the level of application of health, safety, security, and environmental stakeholder management in your organization?
- Does your project/organization have organizational policies, procedures and guidelines for Safety management?
- Is Safety planning performed in your project? (determining safety standards and requirements, and devising actions plan/strategies)
- Is Hazard Analysis performed for activities of your project?
- Is Safety audit done in your project? (a review whether project activities comply with policies, processes, and procedures and safety requirements)
- Does your organization provide Safety training for workers?
- Does your project provide Personal Protective Equipment for site employees?
- Is Safety control process implemented in your project? (inspecting whether project products and activities comply with relevant Safety standards plans)
- Is safety surveillance and audit (control) performed in your project?

Project Financial Management

- Is there awareness about the importance of financial management in your organization's and project management team?
- What is the level of application of financial management in your organization?
- Is a Financial plan prepared for the project?
- Are effects of change in exchange rate, escalation of labor and material cost etc. considered in your financial plan?
- Is project cash flow analysis performed for the project?
- Is there any effort to control the project finance to ensure that money is spent appropriately as planned and with proper authorization?
- Does the project/company have clear expenditure authorization policy and procedure?
- Is financial audit done in your project?
- Are Financial Reports prepared regularly for the project?
- Does the project have an established system/procedure for creating and handling financial documents?
- Are computer systems used in filing and retrieval of financial information in your project?

Project Management Performance & Project Success

- In your opinion, how important is the project manager to the success of the project?
- According to your view, how can the Project Manager work be simplified, eased and supported more?
- How effective are project management knowledge areas in achieving project success?
- What is project teams' knowledge in understanding the application of project management knowledge areas?
- What is the most frequently applied Project Management Knowledge Areas within organization in order to achieve Project Success? What are some of the key outputs of each process group?
- What are the key performance indicators used in the project?
- What are some of the typical challenges project teams face during each of process groups?
- Briefly describe what happens in each of the five project management process groups (initiating, planning, executing, monitoring and control-ling, and closing). On which process should team members spend the most time? Why?
- According to your view, how can the Project Manager work be simplified, eased and supported more?
- How effective are project management knowledge areas in achieving project success?
- What is the performance measurement approaches used in the project?
- What do you think about the effect of Project Management Standards on project duration?
- What do you think about the effect of Project Management Standards on project cost?
- What do you think about the effect of Project Management Standards on project productivity?
- What do you think about the effect of Project Management Standards on customer/stakeholder satisfaction?
- Which issues in a project do you think are most difficult to handle? Which of the knowledge area helps in resolving the most difficult issue and why?
- What are the performance drivers in your job role and why?

IMPORTANCE OF KNOWLEDGE AREAS PER PROCESS

In this section, based on your past experience, please rank from 10 to 100 (1-least important, 100-most important) to indicate the importance of each knowledge area in ensuring a successful project:

Integration Management

Initiating
Engagement of Stakeholders and enterprise's standard considerations are applied to formally authorize the execution of projects. Ensure the commitment of the organization to begin the project.
Planning
The working plan which is used as project charter contains information regarding 'what work should be done, what to deliver and to whom'.
Executing
The project plan (includes sub project plans and delivery plans) is formally approved and documented to execute and monitor projects. It also includes other planning documents.
Controlling
Utilization of technology for process, supply chain, staff and knowledge integration.
Closure
Formal procedure for project closure after making provisional acceptance. Reports are prepared at the end. All the information's put together in the archive as lessons learned for performance improvement in future projects.

Scope Management

Planning
Project delivery plan is developed according to the agreement made with the client. Scope planning and scope definition are performed accordingly in a written and formal statement and as a basis.
Identifies the various project requirements and use computer applications or tools in the scope management process.
Controlling
Scope verification is performed accordingly in a written and formal statement.
Scope change control is handled separately by contract administrator.

Schedule Management

Planning
Consistent practices are adopted to estimate the duration of work packages and resource requirements Implement software-based system for scheduling, estimating and prioritizing work packages.
Controlling
Master schedule plan is used to follow- up the timely progress of each tasks and sub-tasks. Stakeholders are informed ahead when there is change in the plan.

Cost Management

Planning
A standardized method is practiced for resource planning (man-power, material, equipment etc.), cost estimation and cost budgeting of resources needed to complete the work packages.
Controlling
The accuracy of cost estimate changed as the project progresses from phase to phase. There is a built-in system for tracking cost changes rather, simple adjustments and corrective actions for changes in cost with close collaboration with project controls and finance departments.

Quality Management

Planning
Quality standards, policies and management plan defined for the project (requirements and quality standards are determined to support each quality objective, and strategies devised to meet them).
Executing
It is performed to routine activities based on quality management system (QMS) to project planning, execution and control of projects.
Controlling
Product and Projects quality assessment and the process of auditing the quality requirements were reviewed regularly in different project phases and necessary corrective actions were took place for poor applications. The process of monitoring and recording results of executing the quality activities to assess performance and recommend necessary changes.

Resource Management

Planning
The project team has a defined roles and responsibilities for project execution. Planning to acquire resources and manage the human resources, the use of project equipment, and the use of project materials.
Executing
Resource management plan is used for assigning and mobilizing project team members based on their previous experiences, technical knowledge, personal characteristics and availability.
Controlling
Resource productivity and consumption is tracked and reported on pre-defined time intervals. The process of tracking team member performance, providing feedback, manages conflict, resolving issues and appraises team member performance.
Closure
Resource usage reports along with their initial utilization plan are reported to project stakeholders.

Communication Management

Planning
Standardized way of applying communication management plan. Roles and responsibilities are clearly defined and made available to project members. Project information's are available to team members depending on the type of information that they need to do their task.
Executing
Project information is available on the start-up meeting and there is weekly meeting to update the status of the project progress. Apart from this, there are daily short meeting with in the project members.
Controlling
The project manager has the responsibility and strictly control that, everyone followed the stated role & responsibilities for the optimal information flow throughout the entire project life cycle to ensure the information needs of the project stakeholders are met at any moment in time.

Risk Management

Planning
A risk plan (contingency plan) is included in the project plan in order to treat the likelihood occurring risks. Risk identification is included in the quality plan and the risks are quantified and ranked as per their anticipated effect to the project. The process qualitative risk analysis to short list the risks for further analysis or action by assessing and combining their probability of occurrence and impact on the project. The process of quantitative risk information analyzing in order to reduce project uncertainty on overall project objectives.
Controlling
Risk analysis is done based on the project team member experiences and expert judgments while, risk response plan is usually made for large projects where the level of risk is high and an appropriate risk budget (contingency plan) is included in the project plan. Implementing risk response plans, tracking identified risks, monitoring residual risks, identifying new risks, and evaluating risk process effectiveness to continuously optimize risk responses throughout the project

Procurement Management

Planning
A consistent and standardized approach are practiced and facilitated by contract administration. A formal working procedure and formats are available for executing procurement processes.
Executing
The project department works closely with support services. There is a formal procedure and proper way of documentation shared with other departments in computer-based systems. Obtaining seller responses, selecting a seller, and awarding a contract with alignment of internal and external stakeholder expectations through established agreements
Controlling
Managing sellers and buyers' relationships, selection, monitoring contract performance, and making changes and corrections as appropriate according to the terms of the legal agreement.

Closure
Closing each project procurement by making agreements and related documentation for future reference.
The preparation of punch lists with the vendor and tracking the lists' closure over the course of project liability period.

Stakeholder Management

Initiating
Identifying the organizations that could impact or be impacted by a decision, activity, or outcome of the project; and analyzing and documenting relevant information regarding their interests, involvement, interdependencies, influence, and potential impact on project success.
Planning
Project sponsor/owner is actively involved in the project and its roles and responsibilities are also clearly stated in project plan.
Executing
Developing appropriate management strategies to engage project stakeholders throughout the project, based on their needs, interests, and potential impact on project success
Controlling
Monitoring overall project stakeholder relationships and adjusting strategies plans for engaging project stakeholders

Health, Safety, Security, and Environmental Management

Planning
Developing the project safety plan government laws and regulations, contract, and owner requirements must be considered which will be the guiding document for a safe construction project.
Identifying which environmental standards are relevant to the project and determining what impact the project will bring to the environment and how to satisfy them.
Executing
Safety plan execution involves the application and implementation of the safe construction practices by safety officer on-site in accordance with the requirements of the project plan.

Systematic activities implemented within the environmental management on a regular basis to provide confidence that the project will satisfy the relevant environmental standards.
Controlling
Records keep track of safety performance for use in improving performance

Financial Management

Planning
Project requirements of a financial related issues are identified, requirements are placed on a timescale by considering the project risks into consideration.
Controlling
The project accounting systems, audits and planned financial reports are issued.

IMPORTANCE SURVEY OF SUCCESS FACTORS & PROJECT MANAGEMENT PERFORMANCE

In this section, you are requested to rate and indicate the level of its importance for the performance indicators of the project.

PERFORMANCE INDICATORS	IMPORTANCE RATING (1 – 5)	CALCULATED IMPORTANCE RATING (0 – 5)
Time and Cost		
The Quality		
Health and Safety		
Client Satisfaction		
Employee Satisfaction		
Learning and Development		
Profitability		
Environment Performance		
Cash Flow Management		
Technical Performance		
Productivity		
TOTAL		

In this section, you are requested to select and add (if required) the critical success factors to the project and indicate the level of their importance to the project success.

SUCCESS CRITERIA	IMPORTANCE RATING (1 – 5)	CALCULATED IMPORTANCE RATING (0 – 5)
Project Mission		
Top Management Support		
Project Schedules/Plan		
Client Consultation		
Personnel (Training & Education)		
Technical Tasks		
Client Acceptance		
Monitoring and Feedback		
Troubleshooting		
Communication & Knowledge Sharing		
Characteristics of the Project Team Leader		
Power and Politics		
Environmental Events		
Urgency		
TOTAL		

APPENDIX B: CURRICULUM VITAE

I am a highly accomplished and versatile executive with 22 years of proven success in the construction industry. My expertise spans a wide range of disciplines, from detailed technical and commercial project management to high-level executive negotiations. I hold a Bachelor's Degree in Civil Engineering from Boğaziçi University.

Throughout my career, I have consistently delivered projects within the parameters of safety, quality, schedule, and budget. As a strong people manager, I foster a "can-do" attitude within my teams, driving high levels of customer satisfaction and achieving demanding targets. My experience encompasses a diverse portfolio of projects, including building construction, power plants, motorways, airports, quarry operations, and offshore civil construction, executed on an EPC basis for both governmental and private clients.

I possess extensive experience in all phases of project development, from initial proposal preparation and client engagement (including expression of interest, ITT, and RFQ) to successful project delivery. I have a strong foundation in FIDIC Contracts (Red Book, Silver Book) and have successfully negotiated and administered these contracts with various clients.

My professional journey has been marked by a series of challenging and rewarding projects in the energy and infrastructure sectors. Since 2002, I've been at the forefront of international construction, leading teams and driving projects to successful completion.

I began my career in 2002 at JFE Holding in Tokyo, Japan, where I delved into the intricacies of research and development. This foundational experience equipped me with a strong technical background that I've leveraged throughout my career.

Transitioning to the global stage, I joined ENKA İnşaat ve San. A.Ş. in 2008, taking on increasingly significant roles in large-scale power plant projects across Libya and

Romania. As a Senior Planning & Cost Control Engineer on the Zwitina Power Plant project, I honed my skills in project management and cost optimization.

From 2012 to 2015, I returned to Libya as Project Manager for the Obari Power Plant project, overseeing the construction of a critical energy infrastructure. This role provided me with invaluable experience in managing international teams and navigating complex regulatory environments.

In 2017, I expanded my scope to business development, focusing on identifying and securing new opportunities for ENKA. This experience allowed me to develop strong business acumen and negotiation skills.

Over the past few years, I've held key leadership positions on several high-profile projects, including the Aliğa Cogen Power Plant and the 650 MW Misurata and 671 MW Tripoli West Simple Cycle Power Plants. As Project Director for these projects, I've been responsible for overall project execution, from planning and design to construction and commissioning.

Throughout my career, I've successfully managed complex projects in challenging environments, leading multidisciplinary teams to deliver exceptional results. My expertise lies in project management, engineering, and business development, with a particular focus on the energy sector. I am passionate about driving innovation and delivering sustainable solutions that benefit local communities and economies.