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INFLUENCE OF CRITICAL SUCCESS FACTORS IN THE PERFORMANCE OF INFRASTRUCTURE PROJECTS IN QATAR

BY

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ABSTRACT

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Title: Influence of Critical Success Factors in the Performance of Infrastructure Projects in Qatar

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Project success depends on many factors and knowledge that are used before and during the project lifecycle. They might depend on the type of projects and the level of understanding of project managers.

In this thesis, a systematic literature analysis is used. The analysis provides 23 critical success factors, which are later grouped into top management support, project manager's skills, project team's skills, and stakeholder management knowledge. The review also provides four main project success criteria: delivering on time, within the budget, with expected quality, and satisfying stakeholders.

The thesis explores the relationship between project performance and success factors through 23 hypotheses and that for project knowledge and project performance through ten hypotheses based on the response to a survey conducted for this thesis. The tests show a positive relationship to all hypotheses except for the relation between procurement knowledge and project performance. The thesis also provides research direction.

DEDICATION

I dedicate this thesis to my wonderful parents and family. The completion of this work would not have been possible without their patience, understanding, encouragement, and love.

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PRAISE AND THANKS TO ALLAH (SWT) THE ALMIGHTY

I would like to express my sincere gratitude and deep thanks to Dr. Shaligram Pokharel and Dr. Khalid Naji for the professional assistance, guidance, encouragement, and patience.

I would like to acknowledge the continuous support from my lovely parents and family. They have been one of the essential drivers to motivate me to work on this thesis.

I would also like to thank all the respondents for participating in the survey that was sent to them for developing this research.

Finally, I firmly acknowledge that the study mentioned in this thesis is done by myself only. All the analysis, outcomes, and recommendations are the sole responsibilities of the author of this thesis.

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CHAPTER 1: INTRODUCTION

As per (Project Management Institute, 2017), “A project is a temporary endeavor undertaken to create a personalized product or service”. It is also mentioned that “Project Management is the use of knowledge, expertise, ways, and means applied to project activities to fulfill the project requirements” (Project Management Institute, 2017). Therefore, identifying the complexity of the projects and applying the right tools and techniques becomes paramount for completing the projects.

Infrastructure development is an important sector in a country’s economy. Qatar's current drive for infrastructural development is led by FIFA 2022 World Cup and Qatar National Vision 2030 (QNV). This drive motivates this study to provide an understanding of project success in Qatar. Measuring the construction projects’ performance can be different from the perspectives of contractors or a client. While contractors focus mainly on cost and time reduction, clients concentrate on achieving the stakeholder’s requirements.

Factors related to projects have been provided in many studies such as (Alias & Aris, 2014), (Bekr, 2017), (Iyer & Jha, 2005), (Liu & Seddon, 2009), (Müller & Jugdev, 2012), (Michael & Tong, 2014), and (Niagara & Datche, 2015). Such studies have compared various project management methods and studied the effects of project management tools, methods, and management practices (Hyväri, 2006). It seems that methods for identification and measurement of performance are still being researched (Slevin & Pinto, 1986); (Culler, 2009).

Project managers should be aware of different projects requiring different management styles to achieve project success. Although some projects may have highly talented managers, professional teams, the latest project management tools, and support

from the top management, they may fail to deliver the expected outputs and outcomes. Construction project management requires both modern managerial knowledge and an understanding of the design and construction processes (Arnaboldi, 2004). The project management knowledge areas and their relationship with project performance have been studied, for instance, (Chou, 2013), (Ibrahim, 2019), (Khamaksorn, 2018), and (Hwang, 2013). Therefore, project management practices should be identified to achieve the project's success. The main goal of identifying those practices that impact the success or failure of the project is the motivation for the development of this thesis.

1.1 Research Objectives and Methodology

This research aims to analyze and study the critical success factors and criteria influencing the performance of construction projects in Qatar. The specific objectives are as the following:

1- To identify the key success factors and criteria in construction projects, especially in the government sector in Qatar.
2- To evaluate the relationship between project performance and application of project knowledge areas.

The research methodology adopted in this thesis is given in Figure 1. The research uses the literature, development of hypotheses, conduct of the survey, and analysis of the response in order to develop the conclusions.

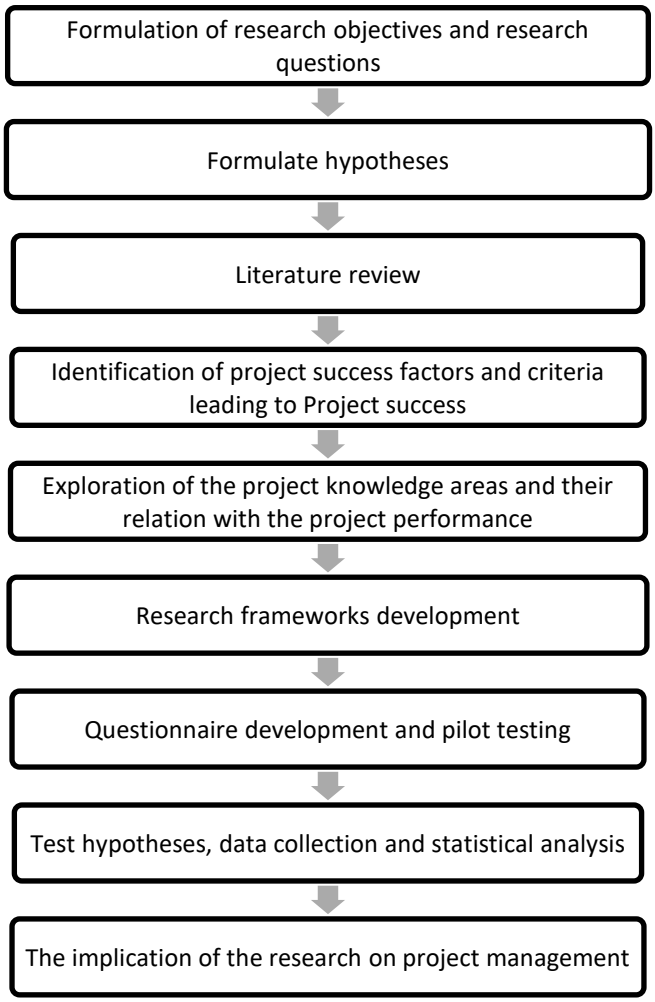

Figure 1. Research methodology

1.2 Research Questions

The research questions are framed as follows, due to the importance of the project performance and the various factors that affect their success:

RQ1: What are the most important factors that contribute to the success of projects?

RQ2: What are the critical project knowledge areas that affect construction project performance?

1.3 Contributions of the Research

This thesis focuses on the construction sector.

1. It contributes by developing a list of applicable success factors that can be considered in construction. This study contributes to a comprehensive understanding of project manager's perceptions on project performance in Qatar's construction projects.
2. The study provides knowledge into the importance of a clear project management practice and the variability in the perception among different groups of project managers. This understanding is important for the organization to see the need for continuity of current thrust on the knowledge or on the development of programs.

1.4 Research Scope

This thesis focuses on construction projects such as roads, drainage, and buildings. Moreover, among the project life cycle. Data collection focuses on planning s and construction stages only. The initiation and closing phases are not considered.

The identified success factors for this research are studied based on the government's perspective, but the contractor and consultant can also benefit from the research results. This study is limited to specific success factors, which have been repeatedly listed in literature studies.

1.5 Research Organization

The research is organized as follows; In the beginning, research problem, objectives, questions to answer, contributions, scope, and research organization are

provided. Chapter 2 provides the success factors, criteria, and knowledge areas that obtained from the literature. In Chapter 3, the research hypotheses and framework adopted in this research and the questionnaire development are discussed. The data analysis, sampling method, and statistical methods are provided in Chapter 4. The chapter also provides discussions on the implications of the results from the analysis. Finally, in Chapter 5, conclusions, limitations, and future research directions are presented. The research methodology for this thesis is given in Figure 1.

CHAPTER 2: LITERATURE REVIEW

A successful project performance contributes to the delivery of a good project. Project performance depends on the complexity of the projects, context of the project, type of the projects, size of the projects, location of the projects, and the stakeholders' involvement. Al-Sobai et al. (Al-Sobai, Pokharel, & Abdella, 2020) mention that infrastructure projects are strategic, and therefore, consideration of the application of knowledge areas during the project lifecycle are important. Therefore, studying the factors that are considered and the level of success on those factors become important. In addition, project success also depends on the application and management of knowledge areas throughout the project lifecycle.

These aspects of the factors and the knowledge areas, as mentioned earlier, are the focus of this literature review. However, it should be noted that the focus in this study is on the construction of infrastructure projects (building and infrastructure that are funded by the State of Qatar government). Figure 2 provides the framework used for the literature review. The literature search and analysis use the content analysis method through the keywords and phrases search on the literature databases. Content analysis is good to locate, analyze and report the theme-based content from the literature (Snyder, 2019). The keywords and phrases used for this literature review were construction, infrastructure, project management construction, project management knowledge area, success factors construction, success criteria construction, and project performance. The search is done in the journal and book databases available at Qatar University library and over the official websites of the databases, ScienceDirect, Wiley, Taylor and Francis, Inderscience, and EmeraldInsight. This type of search method and subsequent literature analysis is seen in ((Al-Sobai, Pokharel, & Abdella, 2020), (Rebeeh, Pokharel, Abdella, & Hammuda, 2019), (Pokharel & Mutha, 2009)).

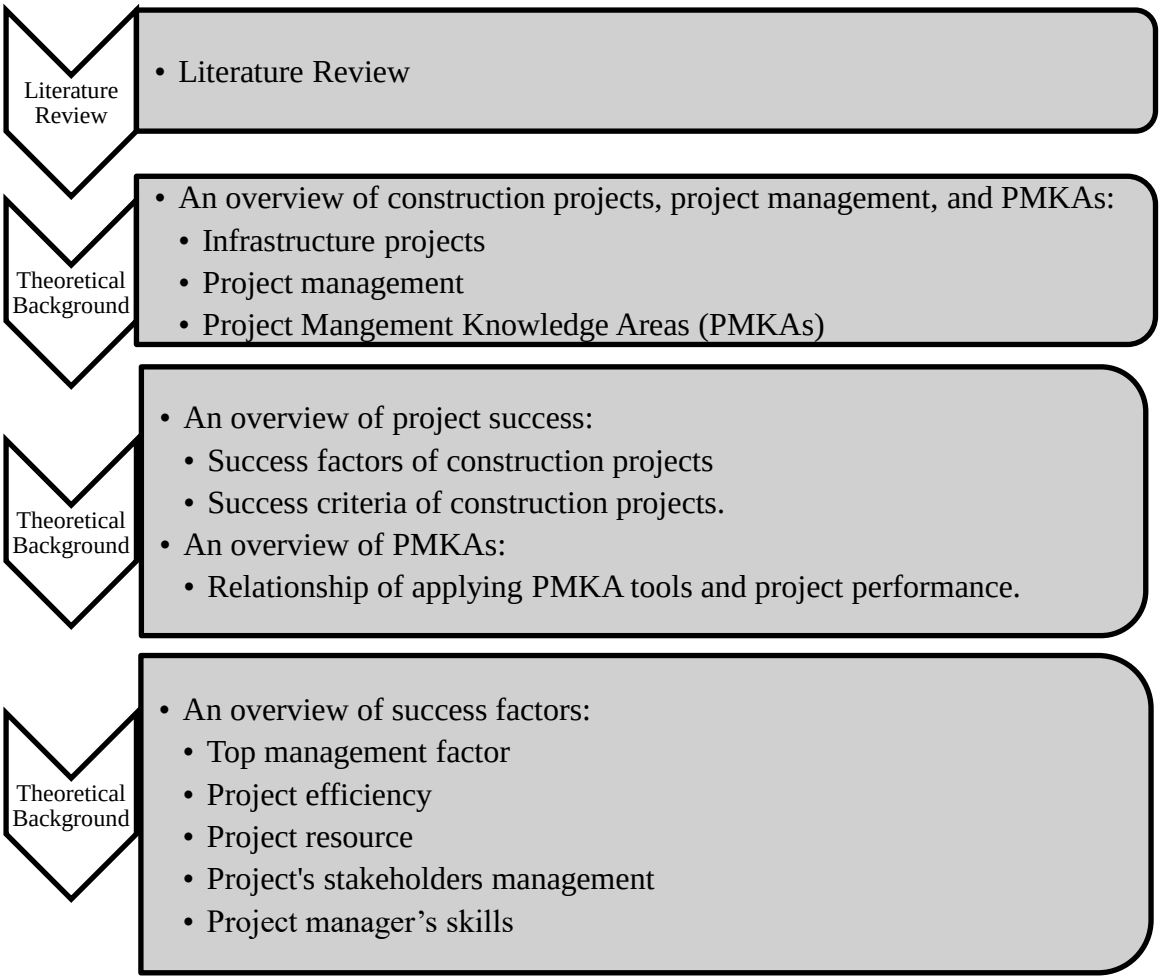

Figure 2. Structure of the literature review

2.1 Infrastructure Projects

The review focuses on the infrastructure projects that are initiated by the government to enhance its service delivery, like transportation, communication, sewage, and water and electrical networks. These kinds of projects have high investments and are important for national development (Cantarelli, 2010).

Infrastructure projects are also critical in fostering economic competitiveness, quality delivery, and skills development inside the country. For example, economic

benefits from the light rail project are cited as important as the completion of this project would provide greater accessibility to the labor catchment area, promotion of diversification in the workforce, and boost economic activities at different places (Knowles, 2016). In another example, the focus of transport infrastructure projects to spur economic growth and the competitiveness of cities has been mentioned (Mullen & Marsden, 2015). Transport projects, for example, create employment and promote labor mobility (OECD, 2020).

Large infrastructure projects often face challenges due to the complexity that the project inherits due to its design, the time it is taking, and the stakeholders involved. If these challenges are not tackled adequately, they will impact the performance of the projects, often resulting in cascading effects into other projects. It is mentioned that some of the challenges could be due to cost variations, delayed completion of the project, and mistrust between construction stakeholders (Ntayi, 2010) and (Odeck, 2004).

Examples of cost and time overruns in some Australian infrastructure projects are mentioned by (Love, Ahiaga-Dugbui, & Irani, 2016). Similar challenges have been mentioned for projects in Nigeria (Zadawa, 2018), Gaza Strip (Tayeh, 2018), UK (Gledson B, 2018), Ghana (Effah, 2017), and Kenya (Ngacho C, 2014).

2.2 Defining Project Success

Project success has been discussed by many authors ((Michael & Tong, 2014); (Montequin, 2014); (Ngacho C, 2014); (Msafiri Atibu Seboru, 2015); (Niagara & Datche, 2015) (Yong, 2017)), and they are related to the project mission, objectives, schedules of projects, resources, and outcomes ((Baker, Murphy, & Fisher, 1988);

(Slevin J. K., 1987); (Pinto J. , 1988), (Lim & Mohamed, 1999) (Lim & Mohamed, 1999)), stakeholders role (Freeman & Beale, 1992), stakeholder satisfaction ((De Wit, 1988), (Baker, Murphy, & Fisher, 1983), (Verzuh, 2016)) constraints on time, cost, and quality performance ((Kerzner H. , 2017), (Kerzner H. , 2018)).

2.3 Success Criteria

Project objectives and performance can be compared using success criteria (Lim & Mohamed, 1999), (Atkinson, 1999), and (Chan, Scott, & Chan, 2004). For example, if the main goal is project success, then accepted project objectives are the criteria to achieve success.

The PMBOK® (Project Management Institute, 2017) emphasize that project delivery within the constraints of time, within the planned budget, and scope also referred to as the Iron Triangle are the criteria that demonstrate project success. The current research of project management considered the time, cost, and quality as the most significant criteria to measure the project such as ((Kerzner H. , 2017), (Al-Tmeemy, 2011), (Wai S. Y., 2013), (Nguyen, 2013), (Mukhtar, 2016), (Silva, Warnakulasuriya, & Arachchige, 2016a), and (Serrador, 2014)).

(Nyangwara, 2015) mentioned that project performance based on cost, and the satisfaction of the owner and affected people. The culture of the owner organization and project management application are also cited as important for performance (Mushatat, 2016). (Bekr, 2017) provides 64 factors to measure the performance. These factors are grouped into seven categories: time, cost, quality, productivity, client satisfaction, community, and health, safety, and environment.

Success criteria may depend on stakeholders, project’s scope, project’s size,

technological implications (Atkinson, 1999), (Chan, Scott, & Chan, 2004), (Han, 2012), and (MDA Masrom, 2013), or on project efficiency, the impact of the project on customer and team, project's positive influence on the environment or the stakeholder, and project option to develop future capabilities (Shenhar & Dvir, 2007).

Other criteria related to business, and technical aspects are also mentioned in the literature, for example in (Al-Tmeemy, 2011), (Wai, Yusof, & Ismail, 2012), (Khan, 2013), (Nguyen, 2013), (Silva, Warnakulasuriya, & Arachchige, 2016a). Although fewer researchers mentioned stakeholder satisfaction as a critical criterion, this criterion is very important in large-scale public projects as mentioned by (Toor & Ogunlana, 2010), and (Eskerod & Jepsen, 2013).

In addition, strategic goals and competitiveness are also considered as a means to measure project success. When large-scale projects are being considered, achieving strategic goals and competitiveness in achieving the project may be considered as important (Almamlook, 2018). Effective communication also has been defined as critical success criteria to facilitate the resolution of project issues as discussed by (Hwang, 2013).

2.4 Critical Success Factors

The factors become critical when they are repeatedly used in different projects in order to achieve the required performance as mentioned in (Silva & Arachchige, 2016b) and (Yong, 2017). The project goal is including the scope determination, missions, objectives, requirements, and priorities. Furthermore, the top management support and the commitment of senior organizational executives from the early stages of development can dramatically increase the possibility of the project's success

(Ahmed R. M., 2016).

The project's team competency has been discussed in the previous studies as a success factor. (Wenxin Shen & Wei, 2017) mention that the motivation of the team affects the performance. The author also states that the team's competency contributes to completing the project according to the requirement.

(Cooke-Davies, 2002) emphasize stakeholder involvement to achieve project success. The author also discussed the project's effectiveness and efficiency as critical factors. Efficiency measures are associated with good management and internal organizational processes such as compliance with schedule plan, budget, and specification; however, efficiency measures are related to customer satisfaction and project utilization. Moreover, it can only achieve efficiency by providing standards, frameworks, and methodology. The author demonstrates the relationship between success factors, the performance of projects, and the success of the projects.

(Takim & Akintoye, 2002) agreed that the performance of successful stakeholders should be measured and managed in order to ensure their continued participation and cooperation in the construction project. The author suggested a conceptual model for the performance of construction projects, integrating the success factors and their relation with different measures of project performance. Therefore, a proper understanding of the project objectives, goals, and missions for all stakeholders involved in the project is a prerequisite for project success.

In addition, the communication factor, project monitoring, control, and project manager's skills are considered as critical success factors based on the quantitative reference frequency index (Alias & Aris, 2014); (Montequin, 2014); (Osei-Kyei, 2015); (Silva & Arachchige, 2016b); and (Yong, 2017). Project monitoring and controlling allow the project manager and each stakeholder to be informed about the project's

progress. Furthermore, during the project's lifecycle, internal and external communication is ranked as a top success factor. In comparison to the traditional factors of technical success, it is also clear that the project manager has a significant impact on the project's success.

Feedback, risks, and organization of project are also considered for overall project success (e.g., (Khan, 2013); (Wai S. Y., 2013); (Ofori, 2013); (Alias & Aris, 2014); (Silva & Arachchige, 2016b); (Yong, 2017)). The technological environment, technology knowledge, and technology availability are consist of the external environment definition which affecting the project's success (Alias & Aris, 2014); (Montequin, 2014); (Osei-Kyei, 2015); (Silva & Arachchige, 2016b); (Yong, 2017). These factors can ultimately significantly affect a project's success at different stages of its lifecycle. (Michael & Tong, 2014) provided 46 factors and mentioned that the factors related to project management resources, client satisfaction, project's team, procurement management, and any externalities are important to consider.

(Schultz, 1987) provides classify strategic and tactical critical success factors. Strategic factors are related to the organizational mission, strategic support, and value whereas the tactical would involve the program for capacity enhancement, selecting the right skills and right consultants, and so on. The need for continuous evaluation of the measurements and improvement is also mentioned (Griffith, 1999).

2.5 Project Implementation

Project management has been central in the implementation of complex tasks for more than 50 years. The fundamental goal of using the principles of project management is to minimize the time cycle and unnecessary budgets while improving the quality of the finished product and services rendered in different sectors. (Takim,

Akintoye, & Kelly, 2004) discussed the difficulties of managing the construction projects and failure to apply project management strategies throughout the project phases in the government sector. Over the years, there are some studies such as; (Yong, 2017), and (Toor & Ogunlana, 2009) conducted to investigate the critical factors for project success.

Project Management follows common practices, where certain project management practices will be unique depending on the industry. However, universities loaded with different capacity research projects might share the same practices and behaviors as other industries that have benefited from project management practices (Ibrahim, 2019). (Hwang, 2013) claimed that project leadership is essential to the effective implementation of project management; however, this discussion was conducted concerning the management of the company. The idea is that the team working in government construction projects needs to learn the skills required to handle the political representatives of government projects in order to be successful.

There's no doubt that businesses seeking a competitive advantage are using project management to ensure business success. Companies are achieving the required profit from investing resources by hiring project management expertise, as they understand how to achieve the optimum cost, meet stakeholder's satisfaction, and higher competitive advantage so much that it has been instrumental in bringing companies out of recession (Project Management Institute, 2010).

2.6 Project Efficiency

(Ahmed R. M., 2016) agreed that the project efficiency can be measured in terms of cost, time and resources. While effective project management does not guarantee project success in the long run, it does provide the company with long-term

benefits (Shenhar & Dvir, 2007).

2.7 Top Management Support

Involvement of top management is important for the project ((Liu & Seddon, 2009); (Young & Poon, 2013); (Ahmed & Mohamad, 2016)). The top management should provide facilities, support, funding, and resources to the project managers for completing the project successfully ((Shah, Bokhari, Hassan, Shah, & Shah, 2011), (Young & Poon, 2013)). The involvement of top management helps to gain the required oversight for project success and ease the implementation of the projects (Belassi & Tukel, 1996).

2.8 Project Resources

Resource-Based View Theory (RBV) is proposed by (Wernerfelt, 1984), and (Rumelt, 1984). Strength in all resources both direct and intangible supports competitiveness. The RBV theory confirms that a company with sufficient resources will likely have a competitive advantage and excellent performance over other companies. It contends that every project manager needs to continually enhance the performance of the projects undertaken. However, these companies suffer from limited resources and time available to invest in order to make the required changes to enhance the company's performance (William, 2007).

2.9 Project Manager's Skills

In multi-project organizations, there is an increasing need for leadership skills models to manage and improve project performance (Todorović, 2015). (Attakora-Amaniampong, 2016) examine the relation between project manager's competency with project success. (Anantatmula, 2010) defined leadership skills based on a systematic literature review and used the Interpretive Structural Modeling (ISM) methodology and survey questionnaire to evaluate 69 project management professionals. The results of (Khamaksorn, 2018) show that planning and scheduling management is an important competency while delegation, leadership, decision-making, and problem-solving are the key competencies for project success. Understanding different challenges in implementing project becomes an important attribute for the project manager (Slevin & Pinto, 1988).

2.10 Stakeholder Management

PMBOK mentions stakeholders as the "individual, group, or organization who may affect or be affected by, or perceive itself to be affected by a decision, activity, or outcome of a project, who may be actively involved in the project or have interests that may be positively or negatively affected by the performance of completion of the project" (Project Management Institute, 2017). Therefore, this context illustrates the interactions between stakeholders and the organization.

According to a large number of studies, stakeholder management has become extremely important in construction projects. Stakeholder management has attained great success in other sectors such as manufacturing, compared to that in the construction sector (Aaltonen, Jaakko, & Tuomas, 2008).

Stakeholder management issues could be related to insufficient participation, project managers with undefined stakeholder management priorities, difficulty recognizing invisible stakeholders, and poor communication with stakeholders. (Nauman & Piracha, 2016) have mentioned the importance of social responsibilities of stakeholder management factor from four different views such as; economic, ethical, legal, and environmental. (Buertey, Amofa, & Atsrim, 2016) have established that the management of stakeholders requires the setting of comprehensive objectives, interests, goals, tasks, and priorities. (Olander & Landin, 2008) also recommends stakeholder analysis in project planning and implementation. (Freeman, Harrison, & Wicks, 2007) stated that the reactions and behaviors of the stakeholders should be aware of project managers. Therefore, understanding the influence of stakeholder in project success also becomes important.

2.11 The Relationship between PMBOK® Knowledge Areas and Project Performance

The PMBOK ® covers project management process groups, knowledge areas, their corresponding procedures, and the project performance definition (Project Management Institute, 2017). (Ibrahim, 2019) highlights the importance of PMBOK® considered by the researchers. (Chou, 2013) studied the impact of eight areas of PMBOK® knowledge on construction engineering projects. Similarly, the impact of nine areas are studied by (Ling, 2008) PM Knowledge Area (PMKA) has certain Project Management processes in order to achieve the necessary result, it also uses other tools and techniques to process certain outputs.

2.12 Critical Success Factors and Project Type

Research also focuses on complexity in different projects ((Turner, 2009), and (Westerveld, 2003)) although project success also depends on its type (Pinto & Prescott, 1988). For instance, infrastructure projects have significant characteristics, such as social and non-profit nature, complicated networks of relationships between stakeholders, and the variability of their performance. Therefore, (Do & & Tun, 2008) argued that detailed identification of critical success factors is needed for infrastructure projects.

2.13 Summary of Literature Review

The review shows that the performance of projects is an important measurement, and several factors can be considered for the measurement. The performance can also be based on factors like newness, complexity, and the use of technology in the project.

In this thesis, as the focus is on the infrastructure sector, a list as given in Table 1 is developed to understand their importance on project performance. It should be noted that some of these may not be applicable as well and is tested in this thesis. Also, some of these criteria are more important than the other, given the country, or organizations, maturity in terms of project development and funding availability.

Table 1: Summary of Project's Success Factors From the Relevant Literature

Success factor group	Project Success Factors	Sources
Top management support	- Sufficient resources for successful implementation of the project. - Sufficient resources to facilitate project adaptations in the organizational setting. - Sufficient resources to encourage a supportive stakeholder environment. - Availability of required resources to assist the project team in crisis situations. - Effective formal and informal communication with project team members. - Continuous discussion during the project life cycle with various groups of stakeholders. - Communication with the stakeholders to enhance organizational efficiency.	(Ahmed & Mohamad, 2016), (Ahmed R. M., 2016)
Project Team skills	- Efficiency skill for project success. - Communication among project team members. - Cooperation with all project stakeholders to achieve project goals. - Coordination with all team's project - Productivity habits to run the project on time. - Learning capability - Understanding project mission for achieving the project objectives. - The relationship among project team members. - Involvement stage of key stakeholders - Response rate and frequency for project procedures such as approvals.	(Sudhakar, 2016), (Assaf, 2014), (Scott-Young & Samson, 2008) (Wenxin Shen & Wei, 2017)
Project manager skills	- Communication with project team members and stakeholders. - Leadership skills - Persuasion and negotiation skills. - Influence project team. - Motivate project team. - Direct the project team - Decision-making skills. - Enough experience in project management.	(Sudhakar, 2016)
Resources	- Availability of hardware, software, machines - Utilization such as (people, equipment, processes, materials, documents)	(Sudhakar, 2016) (Ahmed & Mohamad, 2016)

Success factor group	Project Success Factors	Sources
Technical Factor	- Machine return time - Process time - Time used for manual processes - Troubleshooting capability - Availability of Technology - Feasibility of implementation - Cost of Technology - Commercialization of Technology - Understanding of technology - Skill level of manpower	(Sudhakar, 2016)
Knowledge of stakeholders' management	- Manage the social responsibilities of stakeholders. - Formulate a clear statement of project missions. - Identify the right stakeholders properly. - Understand stakeholders' requirements. - Explore the stakeholders' needs and constraints. - Assess the stakeholders' behavior. - Predict the influence of stakeholders accurately. - Analyze the conflicts and coalitions among stakeholders. - Promote a good relationship with all of the stakeholders. - Communicate with stakeholders properly and frequently.	(Yang, Shen, Drew, & Ho, 2009)

CHAPTER 3: RESEARCH METHODOLOGY

This chapter provides the research methodology adopted in this thesis. A brief description of the research strategy, research hypotheses, research frameworks, survey design, sampling method and target respondents, the sample size needed, and statistical methods used for questionnaire analysis are given below.

3.1 Research Strategy

There are two types of research strategies usually adopted by the researchers: quantitative and qualitative research. The quantitative strategy aims to collect factual data and to investigate the relationship between facts, as well as those facts and relationships that align with the hypotheses and results of previous studies. Qualitative strategy, on the other hand, is aimed at gaining insights and understanding of the perception of people as individuals or groups on the topic of research.

In this thesis, a quantitative strategy is implemented to understand the identified success factors and their relation to project performance. Moreover, to recognize the relationship between the project management knowledge areas and project performance. A qualitative strategy is implemented to gain insights from the professionals who are involved in the project field to identify the critical factors that can contribute directly to project success in infrastructure projects in Qatar. In addition, to investigate how the knowledge areas were adopted by project managers to complete the projects successfully. The required quantitative and qualitative data will be obtained from a questionnaire.

3.2 Research Hypotheses

In this section, a series of hypotheses have been developed to evaluate the relationship between success factors and project success, as well as to estimate the relationship between the management knowledge areas and project performance. Research hypotheses are divided into two parts; the first part is the hypotheses related to success factors, while the other section is related to PMKAs hypotheses. The following hypotheses have been used to test the research questions:

3.2.1 Hypotheses Related to Critical Success Factors:

The null hypothesis for this study is the following:

Ha_0: There is no significant relationship between the critical success factors and the project's success. For ease of understanding, the hypotheses are defined in terms of alternative hypotheses. This type of definition of alternation hypothesis is also mentioned in (Msafiri Atibu Seboru, 2015).

3.2.1.1 Hypotheses Related to Top Management Support:

The literature has discussed the importance of top management support and their relation with project performance such as, (Liu & Seddon, 2009); (Young & Poon, 2013); and (Ahmed & Mohamad, 2016)). Top management communication and discussion with stakeholders lead to project success. Therefore, (Boonstra, 2013) concludes that successful top management support functions involve effectively influencing stakeholders through providing resources, communicating, persuading, and encouraging strong parties to support implementers. In addition, they should have a clear understanding of the project context, content, and implications as well as, be aware of stakeholders' requirements and their influence on the project, as studied by

(Ehsani & & Tojari, 2013). Therefore, this study proposes the following hypothesis:

Ha1: *Continuous discussion during the project life cycle by the top management with various groups of stakeholders contributes to the project's success.*

Communication is an important aspect of project success. (Boonstra, 2013) mentions that, in order to support the project, top management regularly communicates, motivates the project team, discusses operational consequences and organizational improvements, and explains future framework changes. The intended meaning of communication is the provision of an effective network and the necessary data to all key stakeholders involved in the implementation of the project. Therefore, this study proposes the following hypothesis:

Ha2*: Effective formal and informal communication by the top management with project team members contributes to the project's success.*

Top management can be considered as one of the main critical factors that affect the success of the project. (Boonstra, 2013) mentioned that top management plays a critical role in project success when they are strongly supportive of providing the project team with sufficient resources whatever the project conditions, whether it is in the implementation stage, variations, or crisis. The intended sense of the provision of resources refers to sufficient human, financial, and material resources for projects. In most industries, top management support and resource availability are ranked at the highest level for project success. In contrast, unsupportive top management is one of the main reasons for project failure (Belassi & Tukel, 1996). Thus, this study proposes the following hypotheses:

Ha3*: Providing sufficient resources for implementing the project by the top management contributes to the project's success.*

Ha4*: Providing sufficient resources to facilitate project variations by the top management contributes to the project's success.*

Ha5*: Providing the necessary resources to support the project team during the crisis by the top management contributes to the project's success.*

3.2.1.2 Hypotheses Related to Project Team's Skills:

Literature shows that there is a positive relationship between effective project teams and project success (Assaf, 2014). (Gido, 2011) defines successful teams as having a high level of coordination, trust, open communication, efficient timely communication, and ethical behavior. Therefore, the performance of every project is strongly affected by the project team responsible for delivering it. Even the best projects planned can fail to achieve their goals unless the project team performs to the best of its ability. According to the previous studies, this study proposes the following hypothesis:

Ha6*: The capabilities of project team efficiency contribute to the project's success.*

Effective communication is one of the most frequently studied project team performance factors since these studies have shown that effective communication has a clear correlation with project success (Rad, 2003); (Williams, 2002); (Clutterbuck, 2007). Insufficient communication is a major impediment to developing good teams because it leads to low levels of motivation and low team spirit; It contributes to poor goal setting and poor project control, coordination, and workflow. Accurate, useful, timely, and efficient communication is critical to sustaining a productive team environment and achieving a successful outcome. All project information should be communicated continuously during each stage of the process so that all team members are equally aware. Therefore, this study proposes the following hypothesis:

***Ha7**: The communication among project team members contributes to the project's success.*

The project team that coordinates together is usually more successful, and so project leaders must understand the importance of the coordination between the team members. This collaboration allows the team members to achieve individual achievements while contributing to the overall objectives of the project. Previous studies discussed the importance of coordination among the project team members that contribute to project success such as (Wenxin Shen & Wei, 2017), and (Khan, 2013). Hence, this study proposes the following hypothesis:

***Ha8**: The coordination of the project team with all team members contributes to the project's success.*

The project team's cooperation with all of the stakeholders is contributing to project success. An efficient project team includes stakeholders at all of the project stages, from the initiation to the closing stage. (Khamaksorn, 2018) emphasized that high-performing teams have clear and understandable roles and responsibilities, so the teams work incoherence and a high level of cooperation between them and stakeholders. Therefore, this study proposes the following hypothesis:

***Ha9**: The cooperation of the project team with all project stakeholders contributes to the project's success.*

The productivity of tasks significantly improves when all project team member agrees on the goals of the team (Assaf, 2014). Also, the author mentioned that project team productivity has been recognized as a key factor in overall project success. Moreover, he clarified that when project teams are encouraged to make decisions, despite the involvement of a specific team leader, their reliance on mutual leadership

increases which leads to project success. Therefore, this study proposes the following hypothesis:

Ha10*: Project team's productivity contributes to the project's success.*

The learning capability of the project team is the key to project management because many successful projects lie in adapting to the changing environment for any project. It is very important to develop project teams with high learning capability, technical competencies, and management skills to enhance project performance (Khamaksorn, 2018). Team learning is conceptualized as an ongoing process of action and reflection in which knowledge is acquired, integrated, and implemented by teams. The importance of project team learning capability has been emphasized because this learning is a fundamental variable in the efficacy of the work teams, which contributes to the success of the project. Therefore, this study proposes the following hypothesis:

Ha11*: The learning capability of the project team contributes to the success of the project.*

The project team needs to understand the criteria and deliverables of the project and to be aware of the overall vision, goals, and drivers of the organization. Simply project can fail due to a lack of understanding of the project's vision and project's success criteria. Thus, the project's vision must be successfully communicated to all of the project's team members and the project's stakeholders. The whole team should be able to visualize the results, in order to work towards a common goal. Therefore, this study proposes the following hypothesis:

Ha12*: Understanding the project mission by the project team contributes to the success of the project.*

3.2.1.3 Hypotheses Related to Project Manager's Skills:

The literature demonstrates that project managers must possess important leadership skills and competencies, in addition to management skills, in order to achieve successful project and project outcomes. (Berg, 2016) focused on evaluating and understanding the project manager's leadership skills and a lack of leadership skills have been described as the cause of many project failures. Moreover, (Ahmed & Mohamad, 2013) also mentioned that leadership is an important technique to be used by the project manager to moderately influence the outcome of the project. Therefore, the lack of leadership skills is directly related to the failure of the project. This competency is one of the key reasons why project managers can coordinate the available resources, fulfill the demands of stakeholders, meet milestone times, and implement actions to enhance project performance (Sunindijo, 2015). Therefore, this study proposes the following hypothesis:

Ha13*: Project manager leadership skills contribute to the project's success.*

PMBOK (Project Management Institute, 2017) mentions that negotiation is a good project management method and that it is very important to get the best contract for a project. It is a required tool in the day-to-day activities of the project manager, such as during employment, communicating with other resources, convincing management, and asking for additional resources. Therefore, project managers must also have strong skills across a variety of interpersonal skills and continue to develop their skills to ensure success in their projects and careers. Thus, this study proposes the following hypothesis:

Ha14*: Project manager persuasion and negotiation skills contribute to the project's success.*

Project managers should be knowledgeable to take the right decision in project situation. Also, they should be knowledgeable on the project situation at any time and allocate, if necessary, the task to the person who can execute the task successfully. All of these actions need a project manager who has the decision-making skills in order to deliver a high-performance project (Ahmed & Anantatmula, 2017). Therefore, this study proposes this hypothesis:

Ha15*: Project manager decision-making skills contribute to the project's success.*

(Ahmed & Anantatmula, 2017) explored the importance of project manager's knowledge on project management as mentioned in PMBOK®, IPMA and project competency and found that such knowledge is important in managing the projects. Therefore, this study proposes the following hypothesis:

Ha16*: Project manager knowledge in project management contribute to the project's success.*

Previous studies proved that effective project managers continuously improve their leadership skills in motivating, influencing, directing their teams (Ahmed & Anantatmula, 2017), (Berg, 2016), and (Assaf, 2014). Theretofore, project managers play an important role in motivating, directing, and influencing project teams to complete projects successfully through leadership competencies. Managers of construction projects must combine technical and managerial skills, that can ensure effective coordination and communication between several different stakeholders. Therefore, this study proposed the following hypotheses:

Ha17*: The influence of the project manager on the project's team contributes to the project's success.*

Ha18*: The motivation of the project manager on the project's team contributes to the*

project's success.

Ha19*: Project manager direction skills contribute to the project's success.*

Project manager's capability on communication is also important. (Müller & Jugdev, 2012). (Niagara & Datche, 2015) mention the need for effective communication throughout the project within or outside the team. It is also important that the right information exchange is made with stakeholders as well to align project with the overall strategy (Ahmed & Mohamad, 2013). Project managers should interact efficiently to construct a bridge between the project's various stakeholders, share different levels of knowledge, and build an atmosphere of confidence to achieve project goals (Project Management Institute, 2017). Therefore, this study proposes the following hypothesis:

Ha20*: The communication of the project manager with project team members and stakeholders contributes to the success of the project.*

3.2.1.4 Hypotheses Related to Stakeholder Management Knowledge:

Literature addresses the importance of proper identification of project stakeholders and is considered to be one of the primary factors influencing the project performance such as (Davis, 2014), (Toor & Ogunlana, 2010), and (Buertey, Amofa, & Atsrim, 2016). Therefore, project managers are expected to identify stakeholders who need to be involved during the primary stages, due to their decisive role during each phase of the project (Assudani and Kloppenborg, 2010). The fact that some stakeholders have the power to disturb, change and intervene at any time during the project. Therefore, this study proposes:

Ha21*: Identification of the right stakeholders contributes to the project's success.*

From studies, for instance, by (Young & Poon, 2013), (Aaltonen, Jaakko, &

Tuomas, 2008), and (Buertey, Amofa, & Atsrim, 2016), it is possible to recognize factors supporting the project performance in construction projects, such as analyzing stakeholder needs. In addition, project managers should be highly qualified negotiators and communicators capable of meeting the needs and constrain of the various stakeholders. (Nauman & Piracha, 2016) have shown that it is important to understand how stakeholder's needs affect the success of the project. (Nauman & Piracha, 2016) ranked the stakeholders' needs and constraints as the first critical success factor that can influence the project. Therefore, this study proposes the following hypothesis:

Ha22*: Explore stakeholder's needs and constrain contributes to the project's success.*

Stakeholders of any project may have a positive or negative effect on the project. Therefore, identifying stakeholder influence is a critical activity for project managers to improve the probability of project success. Moreover, project managers need to determine the key stakeholders, consider their priorities, and be aware of their possible effect on project success (Cleland & L.R, 2007). Maintaining and promoting a good relationship among stakeholders is critical to the project's success (Nauman & Piracha, 2016). Since it is necessary to understand how stakeholders influence the project. Therefore, this research proposes the following hypothesis:

Ha23*: Predict the influence of stakeholders contributes to the project's success.*

3.2.2 Hypotheses Related to PMKAs:

Project management literature mentioned that there is a positive relationship between PMKAs and project success (Project Management Institute, 2017). It can be stated that individual PMKAs have the potential to contribute to project success, while (Chou, 2013) proved that interacting PMKAs with each other can enhance project

success. Identifying weakly executed areas of knowledge enables continuous improvement to be centered, e.g., by awareness building or training, to ultimately increase the project's overall performance outcomes. Therefore, this study proposes the following hypotheses:

Hb1 *Project Integration Management has a positive direct relationship with Project performance.*

Hb2 *Project Scope Management has a positive direct relationship with Project performance.*

Hb3 *Project Time Management has a positive direct relationship with Project performance.*

Hb4 *Project Cost Management has a positive direct relationship with Project performance.*

Hb5 *Project Quality Management has a positive direct relationship with Project performance.*

Hb6 *Project Human Resource Management has a positive direct relationship with Project performance.*

Hb7 *Project Communication Management has a positive direct relationship with Project performance.*

Hb8 *Project Risk Management has a positive direct relationship with Project performance.*

Hb9 *Project Procurement Management has a positive direct relationship with Project performance.*

Hb10 *Project Stakeholder Management has a positive direct relationship with Project performance.*

3.3 Research Framework

Based on research hypotheses, the dependent and independent variables have been identified to develop the research framework. For success factors, the independent variables are those elements of success factors that can be influenced or implemented to increase project success. These factors are obtained from the project processes and knowledge areas given in (Project Management Institute, 2017). While the dependent variables in this thesis are those project outcomes (project success criteria) that are influenced by the outputs of the independent factors. These established criteria are mainly based on the literature analysis and the project management experience of the researcher.

The independent variables related to project management knowledge areas (PMKAs) hypotheses are the individual Project Management Knowledge Areas, while, the dependent variable is the project performance. The frameworks used for this research analysis are shown in Figure 3 and Figure 4.

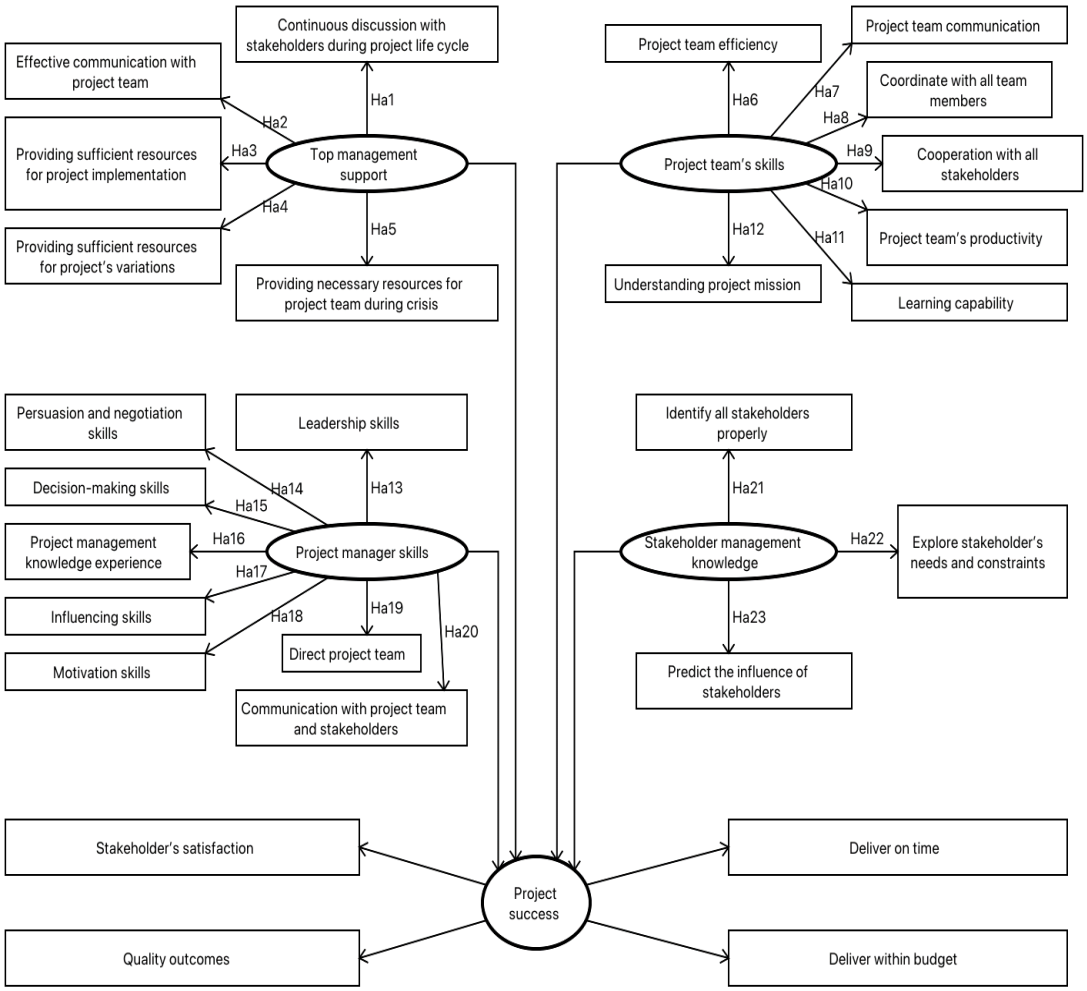

Figure 3. Conceptual framework model for the developed hypotheses related to success factors

Project success is generally attributed to the success in completing the project based on three competing major aspects time, budget, and scope (Project Management Institute, 2010). The need to include customer satisfaction as the fourth aspect is also mentioned by some studies (Lipovetsky, 1997); (Lim & Mohamed, 1999); (Zwikael, 2007); (Kerzner H. , 2017); (Davis, 2014). Accordingly, schedule, cost overrun, project outcomes, and customer satisfaction are the four project aspects used as the dependent variables of this research. It can be shown that these four variables are directly linked to the success of projects. While the variables (top management support, manager's

skills, project team's skills, and stakeholder management knowledge) are linked directly to those factors that enhance projects' success. Each PMKA mentioned in Figure 4 adopts certain processes, to achieve the necessary results. Therefore, the study of how they are related to project performance in Qatar becomes the topic of exploration in this thesis.

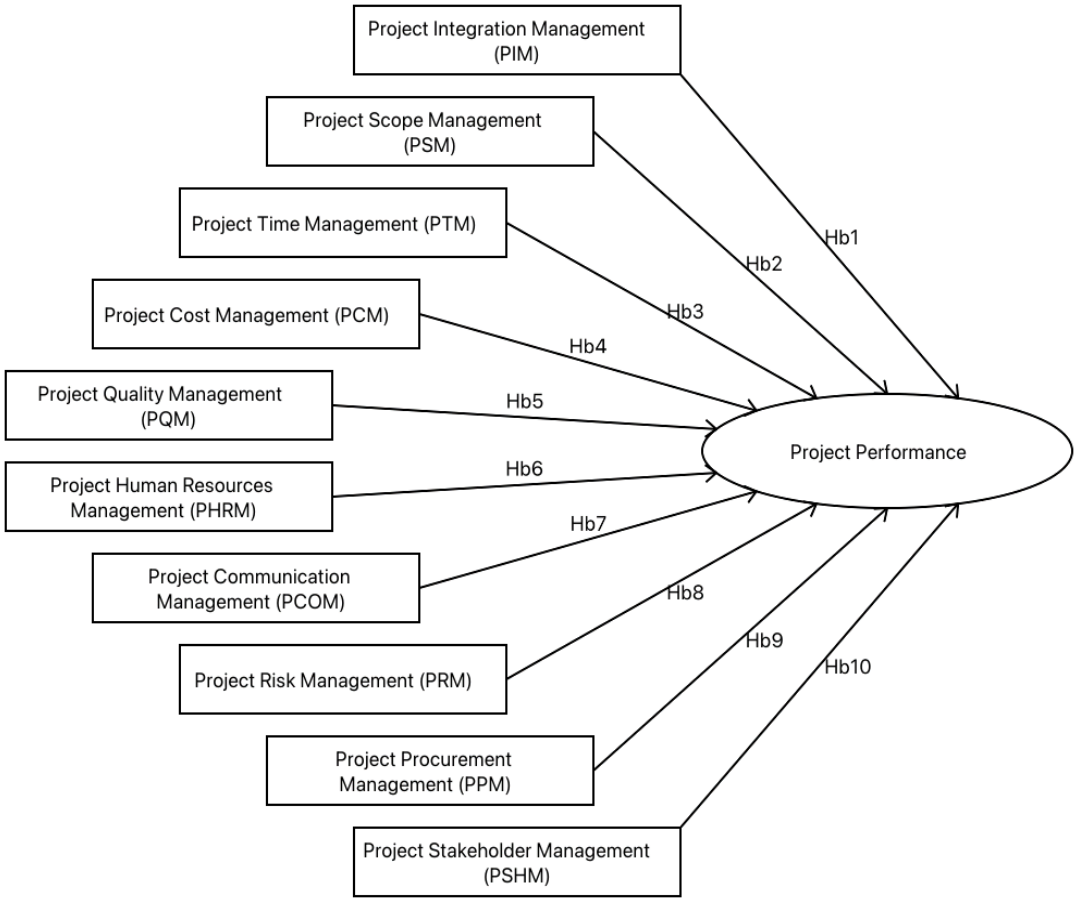

Figure 4. Conceptual framework model for the developed hypotheses related to PMKAs

3.4 Survey Design

Survey is designed by categorizing it in three parts mentioned below.

Part 1: This part consists of questions relating to the respondents' profile such as in terms of years in the role, the position, and the awareness of the knowledge areas.

Part 2: This part consists of understanding perception of the impact of critical success factors and criteria on the construction project's performance. The criteria are based on the time, cost, quality and stakeholders as shown later. Twenty-three factors were identified and divided into four different groups as the following: (top management support, project team' skills, project manager' skills, and knowledge of stakeholder management). The respondents provide the perception of their importance in a 5-point Likert-type scale (5= Extremely important, 4= Very important, 3= Moderately important, 2= Slightly important, 1= Not important).

In addition, the respondents were requested to choose the most important factor and the best criteria that contribute to project success. The numerical score was ranked to determine the most important factor and criteria influencing the project's success.

Part 3: This part is focused on the PMKA based on PMIBOK®. The respondents were to provide their perception based on a 5-point Likert-type scale (5= Strongly agree, 4= Agree, 3= Neutral, 2= Disagree, 1= Strongly disagree).

It is to note that this thesis focuses on the ten PMKA as mentioned earlier. In PMBOK® construction extension there are two additional knowledge areas (Project Management Institute, 2016), which are related to health, safety, security, and environmental management (HSSEM), and financial management.

The survey, in this thesis, covers infrastructure projects in which the project manager must follow Qatar Construction Specifications. (QCS, 2014) has 29 sections and 34 parts (chapters). The specifications contain different parts (chapters) that are related to the HSSEM knowledge areas. For example, the knowledge on occupational health and safety and waste management are given in part 10; the knowledge on site, safety and security are given in parts 2,3,8, 11, and 12; the knowledge on traffic

management is given in part 16; the knowledge on handling hazardous materials are given in parts 8, 10, 12, mainly in 19; knowledge on waste management and regulatory environment are given in part 19. The applicable specifications must be understood and adhered to by the project manager. As following of QCS is a must in Qatar, the survey of this knowledge area was not considered in the survey.

Project financial management covers a few aspects such as project financial management planning (for example, establishing the source of funds, catering to economic environment, dealing with legal entity, developing contract requirements) and financial monitoring and control. In monitoring and control the focus is on project accounting systems, audits, and financial analysis.

In the government infrastructure projects, the financial department (procurement section) of the organization that is driving the project handles financial part. Therefore, it is expected that the project managers working in these projects should have some basic knowledge in financial and accounting system so that they are able to coordinate the development of project financial transactions. Financial monitoring, control and forecasting parts are not under the purview of the project manager directly, although the financial department conducts such activities in coordination with the project manager. Therefore, although some financial management skills are required, this was not surveyed because the primary responsibility of financial management as mentioned in the standard is the responsibility of the persons assigned by the financial department.

3.5 Sampling Method

A convenience sampling strategy was used for acquiring data for this research by approaching a group of professionals involved in the construction industries in

Qatar. The professionals working in the construction field such as infrastructure were targeted. The questionnaires were distributed to the individuals rather than the organizations that they are working in as the focus of the research is to capture their perception of the professionals. This strategy has been used by many previous studies to collect the required data from targeted people. For instance, (Bekr, 2017) used the same strategy by conducting a survey to rank the factors affecting the construction project's performance from the targeted people. As well as (Sinesilassie, Tabish, & Jha, 2018) conducted a questionnaire survey approach to evaluate the effect of the defined project performance attributes on project cost performance. In this type of data collection, it is essential that the individuals' particulars are not related to a particular organization and the questions avoid personal information beyond the professional attributes. This type of structuring helps in getting a better view of the professionals towards the questions.

The number of engineers and other professionals who are working in Qatar not exactly known. Also, the Qatar Society of Engineers includes all engineering specializations, however, it cannot be ascertained as to how many engineers are exactly working on the projects. Therefore, convenience sampling is considered better (Hesse-Biber & Leavy, 2011). The calculation of the sample size is based on the formulation given in Equation 1.

$$\boldsymbol{n_0 = \frac{z^2 \times p(1-p)}{e^2}}$$

Equation 1- Sample Size

Where:

z^2 - Z value corresponding to the confidence level as obtained from the Normal Distribution table.

p - Variability of the population working in the project management professional.

e - The confidence level interval (margin of error).

The confidence level for this research is selected to be 95% (the value of (1-α) in Standard Normal Distribution Table, z=1.96). The value of Z score and margin of error is dependent on the confidence interval. A standard deviation of 50% has been used. This number ensures that the sample size would be large enough to represent the variability of the population (which is maximum). The margin of error is assumed to be 5%, which is consistent with other researchers as well. These assumptions provided a minimum sample size required for the survey to be about 385 as shown below. Therefore, in order to increase the response rate and to reach a large number of respondents, 400 is used in this study.

$$\boldsymbol{n_0 = \frac{(1.96)^2 \times 0.5(1-0.5)}{(0.05)^2} \approx 385}$$

The survey was developed in the Survey Monkey platform (surveymonkey.com), and the link was distributed to the professionals in targeted organizations and to the members of the Qatar Society of Engineers. This platform allows the convenience of distributing the questionnaire and collecting the response that can be easily edited and analyzed. The response was to be filled by only those professionals who are working in the projects field.

To achieve a better number of respondents, the survey was distributed to almost 400 professionals, out of which 266 of them completed the survey by answering most of the required questions. The survey response rate is, therefore, 66.5%. It is to note that out of 266, only 231 responses could be used, giving a response rate of 58.25%.

However, the reliability of the responses is tested before they can be used for the analysis.

3.6 Statistical Methods for Analysis

Statistical techniques are used in this study to describe data, compare two or more data sets, evaluate the relationship between factors, test the hypotheses, and estimate population measurements. The statistical methods mentioned in the following paragraphs were used to conduct a quantitative analysis of survey results. These methods aid in a well-designed study and lead to valid and reliable results.

3.6.1 KJ- Method

The KJ method is a qualitative technique for grouping factors into organized groups based on their interrelationships and similarity of characteristics. Twenty-three success factors were grouped into four groups to facilitate objective analysis. Therefore, KJ-method was adopted in this research to sort out the 23 success factors collected from the literature. These groups, namely: top management support, project team skills, project manager's skills, and knowledge of stakeholder management by project managers. (Dziekonski, 2017) used clustering analysis to group the operational measures of project manager's competency in the construction industry in Poland based on their similarity, rated by respondents. This method contributes to aggregates the elements that are correlated in order to make possible a reduction of variables. The author proposed to use this method to build the research model, he determined four different clusters: basic managerial skills, formal skills, emotional intelligence, and team management abilities. In addition, (Bekr, 2017) used the grouping method to categorize the identified factors from the literature review. Therefore, the author

grouped 64 factors into 7 groups to facilitate the analysis of factors affecting the performance of construction projects.

3.6.2 Relative Importance Index (RII)

RII is used to rank the importance level for each factor and criteria, as well as the PMKA. A 5-point Likert Scale was applied to assess the importance level of the factors and criteria. The value of the RII varies between 0 to 1, whereas a higher value indicates that the factor is more significant than other factors.

Several studies in the construction sector have used this technique to explore and rank the factors according to their relative importance ((Bekr, 2017); (Gunduz & Khan, 2018); (Michael & Tong, 2014)). (Msafiri Atibu Seboru, 2015) studied the factors that contribute to delays in road construction projects. The authors used RII to evaluate and rank the data obtained from the questionnaires. The main five causes of delays were client payment, slow client decision-making, insufficient planning and scheduling, and rain. In addition, (Rooshdi & Ismail, 2018) identified a set of evaluation criteria for sustainable road design and construction activities. The criteria were obtained from the previous studies and discussions with selected experts on highway projects. The relative ranking of the success criteria was determined using RII. Moreover, (Gunduz & Khan, 2018) applied RII to investigate the root causes of change orders and their effects on project goals in the construction industry. Therefore, RII can be calculated as given in equation 2:

$$RII = \sum_{i=1}^{5} \frac{Wi * Xi}{A * N}$$

Equation 2- Relative Importance Index (RII)

Where:

RII - Relative Importance Index.

W - Weight is given for each factor by respondents from (1-5).

X - Frequency of i^{th} response given for each factor.

A - Highest weight (i.e., 5 in this research).

N - Total number of respondents (in this research = 231).

3.6.3 Spearman Rank Correlation

The Spearman rank correlation coefficient has been widely used by many researchers for statistical analysis, mainly when the rank is used for data analysis ((Gunduz & Khan, 2018); (Yang, Shen, Drew, & Ho, 2009)). (Kassem & Hamzah, 2020) described this approach as "a non-parametric test, does not require the normality of the distribution or the homogeneity of the data, which is believed to have a significant advantage over other approaches".

In addition, as cited in (Msafiri Atibu Seboru, 2015) "The Spearman's rank correlation is a evaluate the relationship among different factors, based on their category in order to estimate the strength of the relationship between responses". Therefore, this thesis uses the rank correlation of Spearman to demonstrate the degree of agreement between two different categories. The following formula is used to calculate the Spearman rank correlation.

$$\rho = 1 - \frac{6 \sum di^2}{n^3 - n}$$

Equation 3- Spearman's Rank Correlation

Where:

ρ - Spearman rank correlation coefficient

di - Difference between ranks assigned to variables for each success factors

n - Number of success factors in each data set (in this study = 23).

According to (Msafiri Atibu Seboru, 2015), the correlation strength was measured using two approaches:

- Comparing the value of Spearman Rank correlation (ρ) based on the strength of the relationship between the two sets of variables which takes a value between -1 and 1. Where the positive values show the agreement correlation while the negative values show the disagreement correlation. The guide below could explain the strength of the relationship, taking into account the absolute value of ρ.

  From 0.0 to 0.19 → considered as "very week"

  From 0.20 to 0.39 → considered as "week"

  From 0.40 to 0.59 → considered as "moderate"

  From 0.60 to 0.79 → considered as "strong"

  From 0.80 to 1.0 → considered as "very strong"

- Comparing the value of (ρ) to the critical values (r_s) of Spearman Rank order correlation from the statistic tables, where the level of significance in this research is 95% ($\propto = 0.05$). Therefore, if the ρ value is greater than 0.05 that means there is "no significant difference between the two sets of data", however, if the ρ value is less than 0.05 that means there is "a significant difference between the two sets of data".

3.6.4 T-test

The t-test is a statistical method used to evaluate how close are two unrelated factors and whether there is a significant difference or not (Kim, 2015). T-test has been

used widely in most of the recent papers to test the hypotheses. For instance, in order to verify the non-response bias of the responses (Prachi & Gangadhar, 2020) used the t-test, in order to test the difference between the response at one point of time and the at the second point of time.

Therefore, in this research, t-test has been used to identify the influential factors affecting infrastructure project's performance that have a large degree of agreement between the factors. The key value used to evaluate the relationship of the factors is called (p-value) (Kim, 2015). If the p-value is less than the significance level (0.05), then the null hypothesis will be rejected in favor of the alternative hypotheses. However, if the p-value is greater than the significance level, then the null hypothesis fails to be rejected. This value can also be used to evaluate the degree of correlation between the critical success factors and project success. Therefore, if the p-value is greater than 0.05, this means that there is no statistically significant relationship between the factor and project success. In contrast, there would be a statistically significant relationship between the factor and project success when the value is less than or equal to 0.05.

Equation 4 given below to calculate the two-sample t-test:

$$t = \frac{x1 - x2}{\sqrt{\frac{S1^2}{n1} + \frac{S2^2}{n2}}}$$

Equation 4- T-Test Method

Where:

x1 - Mean of the first set of values.

x2 - Mean of the second set of values.

s1 - Standard deviation of the first set of values.

s2 - Standard deviation of the second set of values.

n1 - Total number of values in the first set.

n2 - Total number of values in the second set.

3.6.5 Reliability Statistics

This section describes the reliability test of the questionnaire. Cronbach's coefficient alpha is developed as an internal consistency test and used to measure the reliability of the questionnaire between fields. The standard range of Cronbach's alpha values is between 0.0 and + 1.0 when the Alpha value is close to 1, which means that there is a perfect consistency in measurement.

Most recent studies used this tool to test the data reliability. (Rooshdi & Ismail, 2018) mentioned that his reliability result was high internal consistency where the Cronbach's Alpha was more than 0.7. (Dziekonski, 2017) used the same methodology by clustering the operational measures of project manager's efficiency in the construction industry and testing the data reliability using Cronbach's alpha test. The author calculated the Alpha value to be equal to 0.9. In addition, (Sinesilassie, Tabish, & Jha, 2018) performed the same tool to evaluate sample reliability and the values were 0.75 for success attributes and 0.76 for failure attributes. The authors suggested that the overall sample reliability was accepted for factor analysis.

The formula below evaluates the value of Alpha is straightforward, where k is the number of items (factors) and r is the mean correlation between the items.

$$\propto = \frac{\boldsymbol{k\,r}}{\boldsymbol{1 + (k - 1)r}}$$

Equation 5- Cronbach's alpha

The value of alpha ($\propto$) becomes larger when the value of k increases. Also, the corresponding Alpha will be large if the inter-correlation between items is large. Since

a large number of variables inflate the alpha value, there is no fixed meaning as to what an appropriate alpha value is (Santos, 1999). The thumb rule that applies to most situations is as follows:

- The reliability can be considered as excellent when, $0.9 \leq \propto \leq 1.0$
- The reliability can be considered as good when, $0.8 \leq \propto < 0.9$
- The reliability can be considered as acceptable when, $0.7 \leq \propto < 0.8$
- The reliability can be considered as questionable when, $0.6 \leq \propto < 0.7$
- The reliability can be considered as poor when, $0.5 \leq \propto < 0.6$
- The reliability can be considered as unacceptable when, $0.0 \leq \propto < 0.5$.

The reliability test was conducted to all factors produced in this study. The reliability statistics results were positive with the Cronbach Alpha value for all 23 success factors giving 0.909, and 0.987 for PMKAs suggesting excellent internal consistency reliability for the scale with this sample. After demonstrating this consistency, further statistical analysis was performed as detailed in Chapter 4.

CHAPTER 4: RESULTS AND DISCUSSION

This chapter presents the description, using various statistical methods of data obtained from the survey. The questionnaire was sent through email to a professional network of engineers and managers who were involved in the project's field. The data collection period was set for three weeks, from November 12, 2020, to December 3, 2020. This research does not consider any response after this period in order to have a reliable analysis. This time setting was important to guide the respondents for early response and set a cut-off time to do the analysis part. Although it is generally assumed that more surveys could be collected if a longer period was provided, the majority of responses were mostly received within the first eight days. In the last four days, only a few responses were collected. There was no response obtained after the specified date.

As mentioned earlier, although the total number of received responses was 266, only 231 of them were usable for this study, giving a response rate for a usable questionnaire at 58.3%. The response rate for this thesis is consistent compared to the rates of previous studies. Although a higher response rate of 82% is mentioned in (Gunduz & Khan, 2018) in their global study, most of the other studies have mentioned a much lower response rate. For example, (Msafiri Atibu Seboru, 2015) report 61.3% of positive response rate, although the author mentioned that the percentage of responses for survey-type research usually between 20% and 30%. (Prachi & Gangadhar, 2020) report 54% as a sufficient response rate for research in the construction industry and (Sinesilassie, Tabish, & Jha, 2018) report about 49.1% in a similar study.

4.1 Reliability Test

Reliability test is performed by using Cronbach Alpha for all success factors developed in this study, as well as to PMKAs. The results of the reliability statistics in this research were positive value and close to 1 for success factors and PMKs. These results indicate an excellent internal consistency of the scale for this sample comparing to (Rooshdi & Ismail, 2018). Even though the value of Cronbach alpha for top management support is considered as "questionable", the reason behind this value is that the respondents might not consistently be understanding the questions related to top management support. Tables 2 and 3 presents the summary of reliability tests of Cronbach Alpha values.

Table 2. Summary of Reliability Tests Using Cronbach's Alpha Values for Success Factors.

Success factors	Cronbach's Alpha	Number of individual success Factors
Group 1: Top management support	0.650	5 factors
Group 2: Project team's skills	0.756	7 factors
Group 3: Project manager's skills	0.864	8 factors
Group 4: Project Manager's knowledge of stakeholder's management	0.818	3 factors
All success factors which contribute to project success	0.909	23 factors

Table 3. Summary of Reliability Tests Using Cronbach's Alpha Values for Components PMKAs.

Project Management Knowledge Areas	Cronbach's Alpha	Number of components of PMKAs
Project Integration Management	0.772	6
Project Scope Management	0.823	6
Project Time Management	0.910	7
Project Cost Management	0.869	4
Project Quality Management	0.883	5
Project Human Resource Management	0.861	5
Project Communication Management	0.863	5
Project Risk Management	0.945	10
Project Procurement Management	0.892	6
Project Stakeholder Management	0.898	7
All PMKAs contribute to enhancing the project performance.	0.987	61

4.2 Hypotheses Test

To test the research hypotheses, t-test was used on the regression coefficients obtained in simple linear regression. The results indicated that all alternative hypotheses were supported through the statistically significant relationship ($p<0.05$) between the independent variables and the dependent variable. As evident from Table 4, the results substantiated that all of the identified success factors have a significant relationship with project success.

Table 4. Summary Results of Success Factors Hypotheses Testing Using T-test

	Supported	Not Supported
Success factors hypotheses	All identified hypotheses are supported since $p<0.05$	None.

PMKAs hypotheses have been tested by using t-test as well, most of the hypotheses were supported through the statistically significant relationship ($p<0.05$) between the independent variables (PMKAs) and the dependent variable (project performance). However, Project Procurement Management was not supported since the p-value is greater than 0.05. This can be explained as that the project managers might be thinking that it is not their role to look at the project procurement management because it can be done by specialized people in the organizations. Indeed, if the test fails to detect the relationship, it does not mean that the relationship does not exist. It might mean that the sample contained an insufficient amount of evidence to conclude that it exists. However, it is possible that the relationship truly does not exist in the sample. Table 5 presents the summary results of PMKAs hypotheses test:

Table 5. Summary Results of PMKAs Hypotheses Testing Using T-test.

	Supported	Not Supported
PMKAs hypotheses	PMKA1, PMKA2, PMKA3, PMKA4, PMKA5, PMKA6, PMKA 7, PMKA8, and PMKA10 are supported since $p<0.05$	PMKA9 is not supported since $p>0.05$.

4.3 Respondents Profile

The profiles of the respondents are given below. Respondents are profiled in terms of the total number of years' experience in projects, professional registration, organization position, organization type, project management knowledge areas awareness, and contribution of project management knowledge to enhance the project performance.

4.3.1 Total Number of Years' Experience in Projects

The profile of the respondents (*n=231*) in terms of years of experience in construction project management is given in Figure 5. Of the total respondents, 24% are junior engineers (less than or equal to 5 years), 18% are at the senior-most level (more than 25 years), 15% are at the senior level (20-25 years), and the rest are in the mid-level in terms of their experience. This is a good mix of respondents with a large bulk in the mid to senior management level.

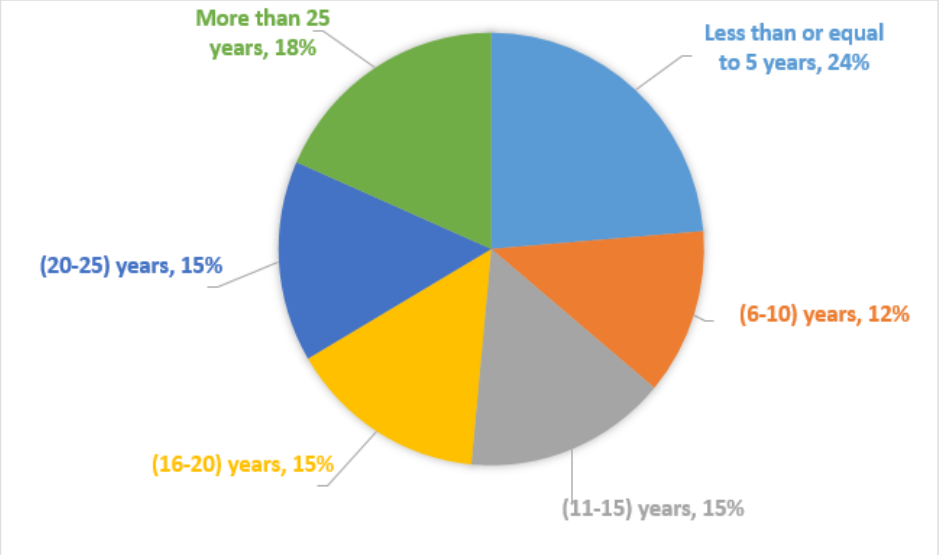

Figure 5. Total number of years of work experience in the projects field

4.3.2 Professional Registration

Figure 6 shows the respondent's professional registration. Of the total respondents, 72% are registered professionals (as a member of a professional organization or certified professionals in the work field). However, the remaining 28% are the respondents not involved in any professional organization. Membership usually provides the respondents with the current standards and applicability of such standards in the job.

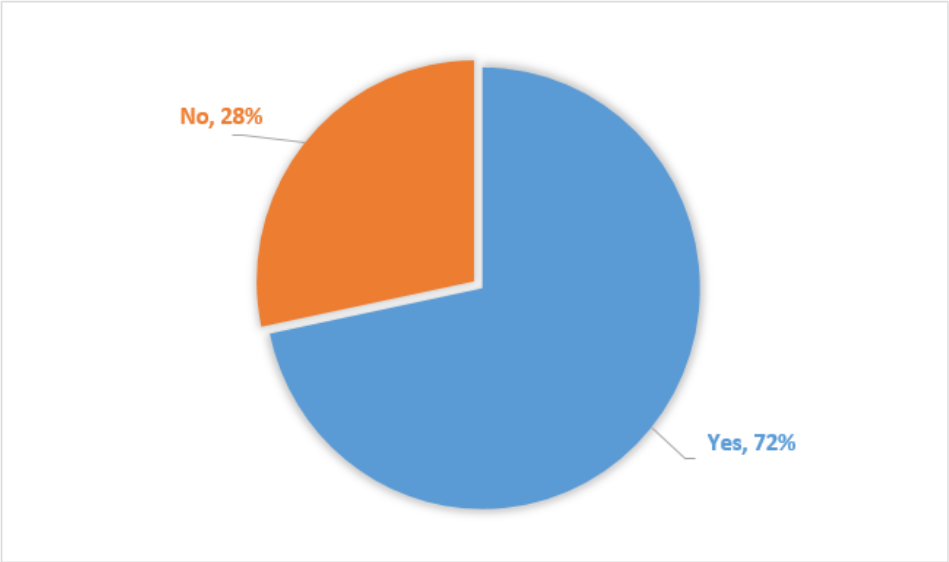

Figure 6. Professional registration

4.3.3 Organization Position

Figure 7 illustrates the respondents based on organization positions. The majority of the respondents are senior and junior engineers with a percentage of 33% each in terms of their job title. The position name as project manager represented 17% of the total survey respondents. The rest of the respondents were department managers

(6%), executive managers (4%), project directors (3%), program managers (2%), and portfolio managers (1%). It is to note that all respondents are involved in different aspects of construction project management.

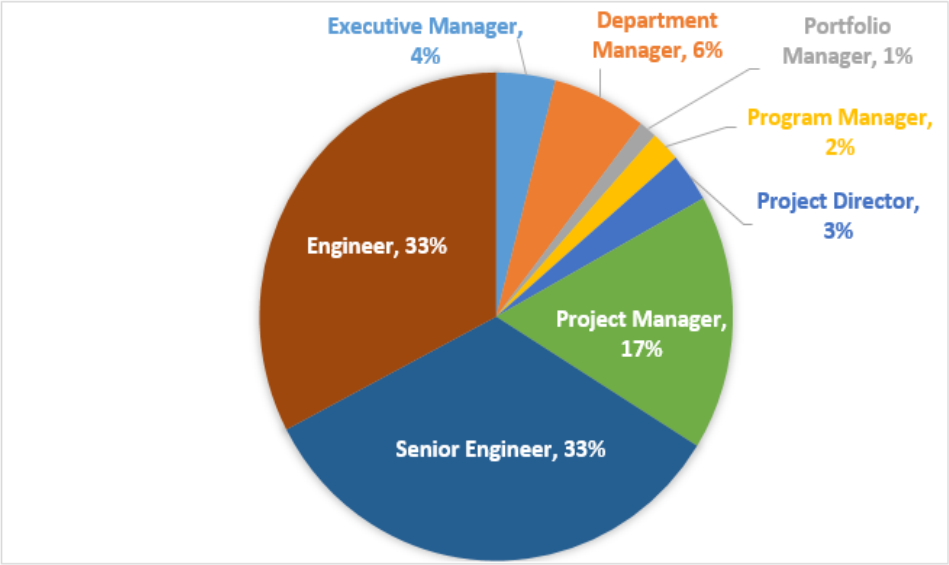

Figure 7. Organization position

4.3.4 Organization Type

The percentage of respondents based on the type of organizations they work for is given in Figure 8. A significant portion 46% of the respondents are from infrastructure projects, followed by building construction 27%. The remaining percentages represented the other construction projects in different construction-related projects such as energy generation, transportation, petrochemical industry, manufacturing, and healthcare.

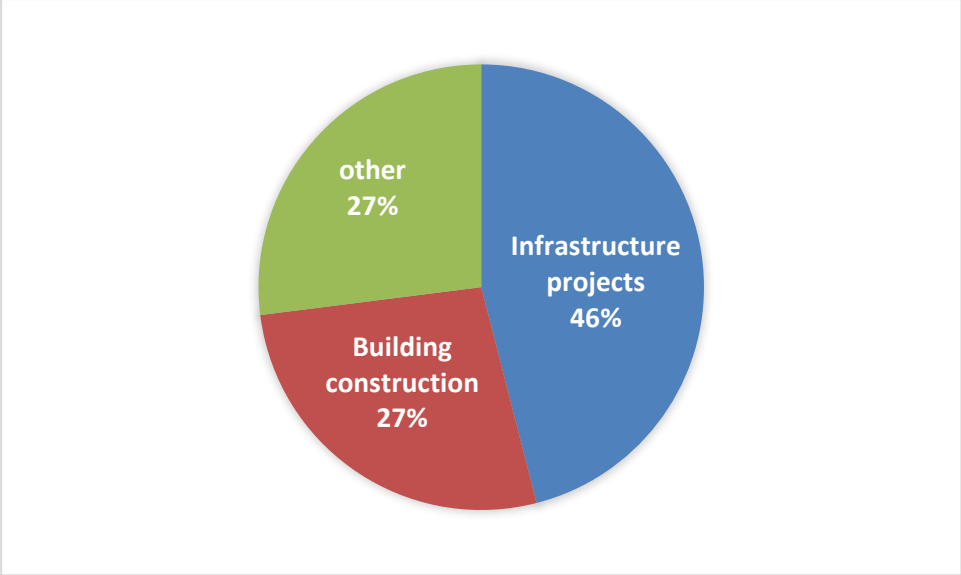

Figure 8. Organization type

4.3.5 Awareness of Project Management Knowledge Areas

As per the project management standards, the project engineers and managers have to apply different project management knowledge areas when working on a project. Figure 9 illustrates that 87% of the respondents are aware of project management knowledge areas. This shows that awareness in terms of standards and their use in project management.

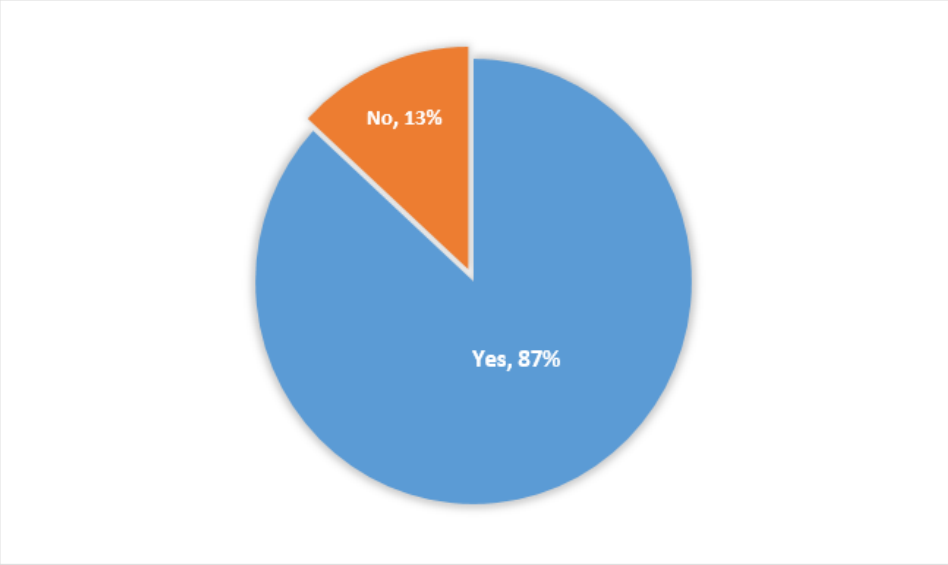

Figure 9. Awareness of project management knowledge areas

4.3.6 Contribution of Project Management Knowledge to Enhance the Project Performance

Figure 10 is a representation of the total percentage of respondents who agree/disagree on whether project management knowledge plays a role in project performance. Of the total respondents, 96% agree that project knowledge does enhance the performance of projects. This high percentage indicates that project management knowledge contributes to project success.

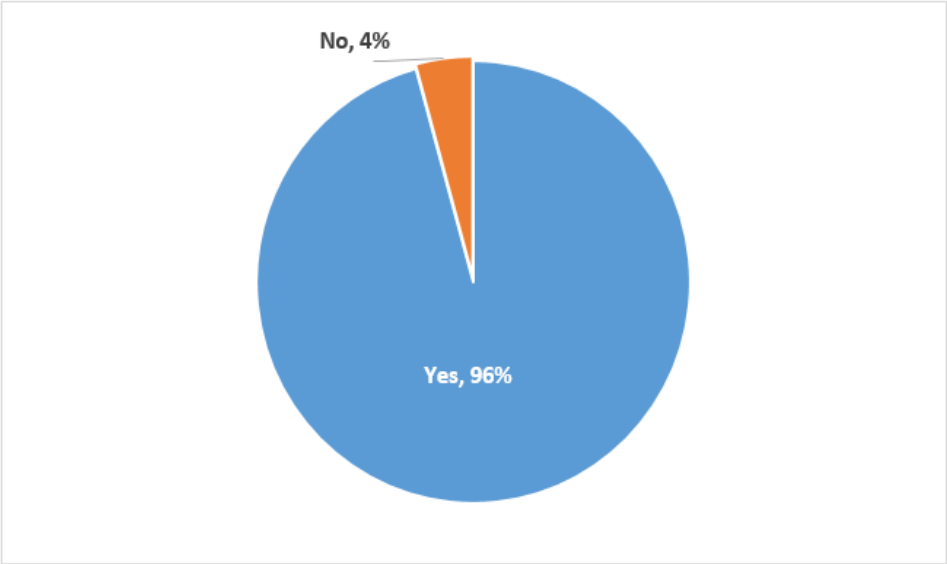

Figure 10. Contribution of project management knowledge to enhance the project performance

4.3.7 Ranking the Success Criteria by Respondent's Distribution

Figure 11 shows the critical success criteria that affecting the infrastructure projects performance in Qatar, ranked by the respondents. Seniors and all other respondents are believing that the stakeholder's satisfaction criterion has a significant relationship with project performance. Where both categories ranked "Stakeholder's satisfaction" as the first criterion which can affect the project's success. The second-ranked criterion by both categories is the quality outcome. While delivering the project on time and within budget were ranked third and fourth by both categories. The results illustrated the strong relationship between senior and junior engineer's perception about the success criteria which contribute to project success. In addition, this demonstrates the importance of satisfying stakeholders and end-users of infrastructure projects, which has an impact on project performance.

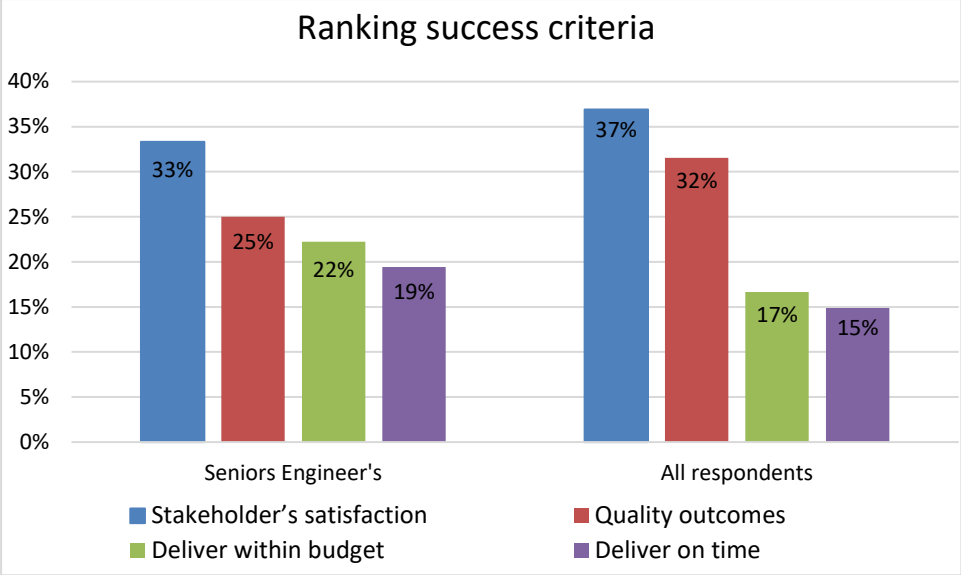

Figure 11. Ranking success criteria by respondent's distribution

4.3.8 Ranking the Success Factors by Respondent's Distribution

Figure 12 shows the success factors that contribute to project success in Qatar, ranked by the respondents. Seniors and all other respondents agree that the project team's skills factor is the most critical success factor that has a significant relationship with project success. Where both ranked "project team's skills" as the top success factor which can lead to project success. However, Senior engineers believing that "Top management support" is a critical success factor as well, so they ranked it as a top success factor as shown in the figure below. While project manager's skills and stakeholder management knowledge were ranked as third and fourth by both categories. The outcomes proved the strong relationship between senior and junior engineer's perception about the success factors which lead to project success. Finally, this demonstrates the importance of the project team's skills and top management support which contributes to project success.

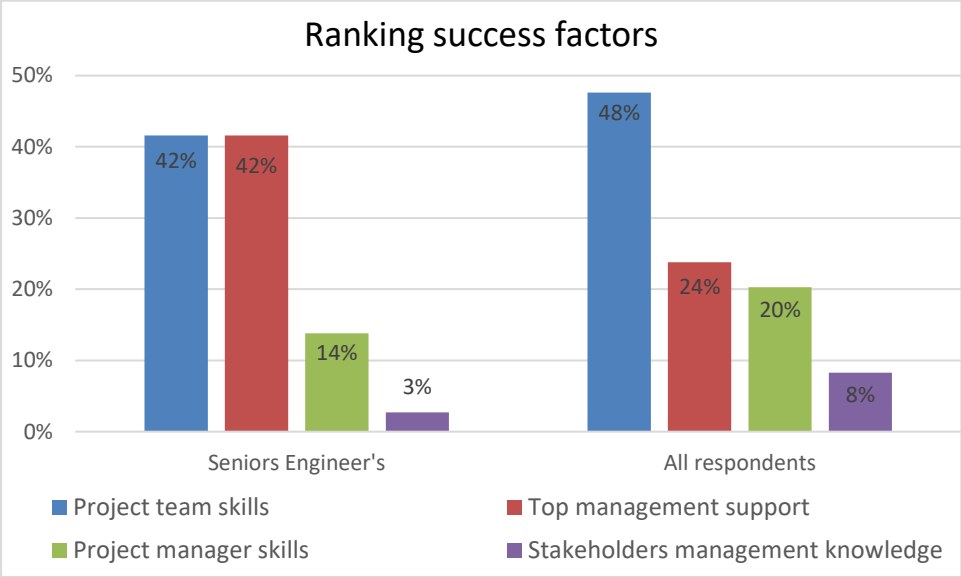

Figure 12. Ranking success factors by respondent's distribution

4.4 Evaluation of Critical Success Factors

The main objective of this thesis is to evaluate and rank the critical success factors in construction projects, especially in an infrastructure project in Qatar by getting the perceptions of the construction industry professionals about the critical success factors which contribute to enhancing the project performance. As discussed previously, respondents were asked to evaluate the importance of success factors. Then the data collected was analyzed to develop RII for each factor.

Therefore, the following sections of this chapter will present the ranking approach (RII) to evaluate and rank the critical factors contributing to project success. Spearman's rank correlation coefficient is used to study the relationship of success factors based on the perception of seniors and juniors. This approach is used to demonstrate the applicability of the study framework.

4.4.1 Ranking Critical Success Factors Using Relative Importance Index (RII)

This section presents (RII) ranking approach to evaluate the success factors which contribute to project success. Thus, to demonstrate the critical success factors affecting construction projects in Qatar. Table 6 presents the calculated RII and ranking values of success factors based on the technical experience of respondents. In addition, table 7 shows the top five success factors that affect project performance, namely: effective communication with the project team, continuous meetings with the stakeholders during the project life cycle, project team communication, decision-making skills, and providing sufficient resources for the project.

Although the Cronbach's Alpha value for top management support was showing less reliability, the value presented here is based on the scores by the respondents. Therefore, it is noticeable that Group 1 (Top Management Support) ranks first, second and fifth, so it can be said that the support of the top management is one of the critical factors that determine the success of the project.

Table 6. RII Values of Each Success Factor

Success Factor	RII	Rank per Group	Total Rank
Group 1: Top management support			
Continuous meetings with the stakeholders during the project life cycle	0.930	2	2
Effective communication with the project team	0.967	1	1
Providing sufficient resources for the project	0.913	3	5
Providing sufficient resources for the project's variation	0.804	5	22
Providing necessary resources to the projects team during a crisis	0.899	4	7.5

Success Factor	RII	Rank per Group	Total Rank
Group 2: Project team skills			
Project team efficiency skills	0.880	4	12
Project team communication	0.928	1	3
Cooperation by the project team with all stakeholders	0.872	6	14
Internal team coordination	0.899	2	7.5
Project team productivity	0.882	3	11
Team's learning capability	0.814	7	20.5
Understanding the project mission by the project team	0.878	5	13
Group 3: Project manager's skills			
Leadership skills	0.901	2	6
Persuasion and negotiation skills	0.825	7	19
Decision-making skills	0.915	1	4
Project management knowledge experience	0.854	4	15
Influencing project team	0.814	8	20.5
Motivating the project team	0.835	6	18
Directing the project team	0.849	5	16
Communicating with the projects team and stakeholders	0.891	3	9
Group 4: Project Manager's knowledge of stakeholder's management			
Identifying all the stakeholders who involve in the project	0.889	1	10
Exploring stakeholder's needs and constraints in the project	0.845	2	17
Predicting the influence of stakeholders	0.775	3	23

Table 7. Top Five Ranked Success Factors

Group number	Top success factors	RII	Rank
Group 1: Top management support	Effective communication with the project team	0.967	1
Group 1: Top management support	Continuous meetings with the stakeholders during the project life cycle	0.930	2
Group 2: Project team skills	Project team communication	0.928	3
Group 3: Project manager's skills	Decision-making skills	0.915	4
Group 1: Top management support	Providing sufficient resources for the project	0.913	5

4.4.2 Correlation test Using Spearman's Rank Correlation Coefficient

The Spearman rank correlation coefficient was applied in this research to study the relationship strength between different factors and different categories. A correlation test is used to compare the different rankings by different categories (level of experience), using the rankings obtained from RII outcomes.

Table 8 below illustrates the ranking comparison of the senior and junior engineers. In addition, the same table indicates that there is a very strong relationship between the perception of senior and junior engineers as the Spearman correlation coefficient is equal to 0.926. As well as p-value is less than the significance level (p-value < 0.001) which also illustrate that there is a statistically significant relationship between the success factor based on the respondent's responses.

Table 8. Correlation Between the Perception of Seniors engineers (More Than 25 Years) and Junior Engineers (Less Than or Equal to 5 Years)

Success factors	Senior Eng. Mean	Senior Eng. Rank	Junior Eng. Mean	Junior Eng. Rank	d	d^2
Continuous meetings with the stakeholders during the project life cycle	4.714	2	4.600	3	1	1
Effective communication with the project team	4.833	1	4.836	1	0	0
Providing sufficient resources for the project's implementation	4.619	5	4.527	6	1	1
Providing sufficient resources for the project's variation	3.976	22	4.054	21	1	1
Providing necessary resources to the projects team during a crisis	4.428	12	4.545	5	7	49

Success factors	Senior Eng. Mean	Senior Eng. Rank	Junior Eng. Mean	Junior Eng. Rank	d	d^2
Project team efficiency skills.	4.452	10.5	4.363	13.5	3	9
Project team communication.	4.642	3.5	4.636	2	1.5	2.25
Cooperation by the project team with all stakeholders.	4.357	14	4.363	13.5	0.5	0.25
Internal team coordination.	4.571	6.5	4.436	8	1.5	2.25
Project team productivity.	4.404	13	4.418	9.5	3.5	12.25
Team's learning capability.	4.214	18.5	3.963	22	3.5	12.25
Understanding the project mission by the project team.	4.452	10.5	4.407	11	0.5	0.25
Leadership skills.	4.642	3.5	4.463	7	3.5	12.25
Persuasion and negotiation skills.	4.166	20	4.148	18	2	4
Decision-making skills.	4.571	6.5	4.581	4	2.5	6.25
Project management knowledge experience.	4.309	15.5	4.236	16	0.5	0.25
Influencing project team.	4.047	21	4.090	20	1	1
Motivating the project team.	4.238	17	4.127	19	2	4
Directing the project team.	4.309	15.5	4.200	17	1.5	2.25
Communicating with the projects team and stakeholders.	4.523	8	4.400	12	4	16
Identifying all the stakeholders who involve in the project.	4.476	9	4.418	9.5	0.5	0.25
Exploring stakeholder's needs and constraints in the project.	4.214	18.5	4.296	15	3.5	12.25
Predicting the influence of stakeholders.	3.952	23	3.924	23	0	0
					$\sum d^2$	149
				Spearman rank correlation coefficient ρ		0.926
					N	23
					T statistic	11.357
					Degree of freedom	21
					p-value	0.000
					R^2	0.858

As shown in figure 13 that there is a statistically positive relationship between the perceptions of senior and junior engineers on evaluating and understanding the critical success factors that contribute to project success, as R^2 is equal to 0.858. This figure represents how senior and junior engineers ranked the success factors based on the importance on their perceptions. Therefore, the results demonstrate that the perceptions of junior engineers in Qatar are consistent with the perceptions of senior engineers who have experience in project management.

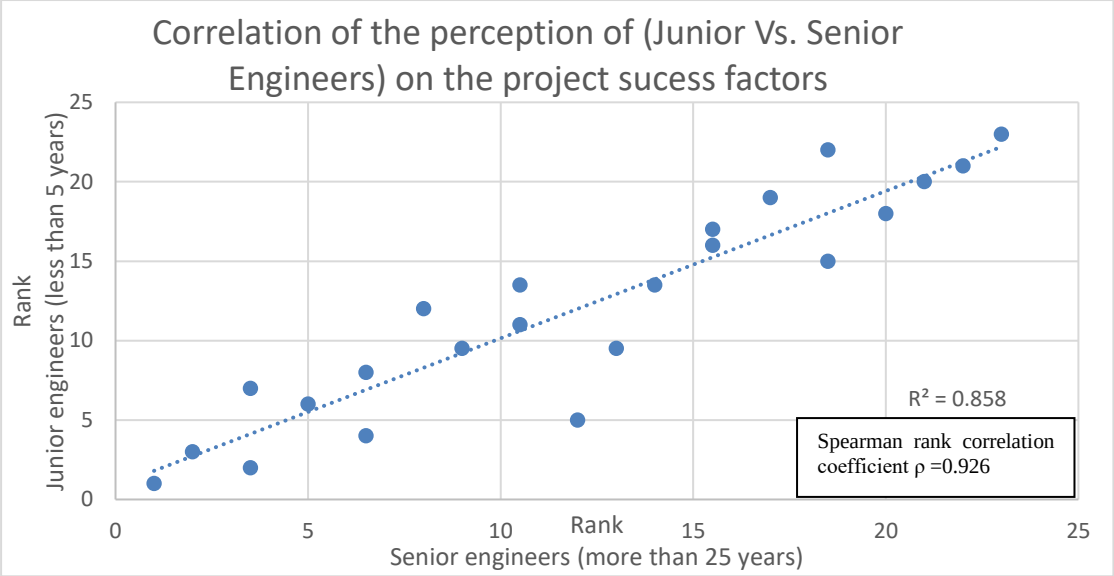

Figure 13. Spearman correlation of success factors analysis (**ρ**) and linear regression analysis (R^2)

4.5 Evaluation of Project Management Knowledge Areas (PMKAs)

The second main objective of this thesis is to evaluate the relationship between the project's performance and the application of project knowledge areas. The following sections will present the results of RII to highlight the most important knowledge areas which enhance the project performance. Then, the Spearman rank

coefficient will be applied to analyze the relationship of PMKAs by comparing two different categories.

4.5.1 Ranking PMKAs Using Relative Importance Index (RII)

This section presents the ranking approach by using (RII) to evaluate the project knowledge areas which contribute to enhancing the project performance. Thus, to demonstrate the extent of the project manager's awareness of knowledge areas and the contributions of these knowledge areas on Qatar's construction projects performance. The majority of the respondents who answered this part were senior engineers (more than 15 years) in the construction field with a percentage of 47%. This percentage supports the goal of this study, in order to analyze the awareness of managers of knowledge areas.

Based on the professional experience of respondents, Table 9 presents the calculated RII and ranking values of PMKAs. Therefore, the table shows the top five knowledge areas that lead to enhancing project performance, namely: Project Cost Management, Project Quality Management, Project Time Management, Project Scope Management, and Project Human Resource Management.

Table 9. RII Values of Each PMKAs

Project management knowledge areas	RII	Rank
Project Integration Management	0.889	6
Project Scope Management	0.908	4
Project Time Management	0.913	3
Project Cost Management	0.921	1
Project Quality Management	0.915	2
Project Human Resource Management	0.904	5
Project Communication Management	0.877	9
Project Risk Management	0.886	8
Project Stakeholder Management	0.889	7

4.5.2 Correlation Test Using Spearman's Rank Correlation Coefficient

The Spearman rank correlation coefficient has been used to study the relationship strength between different knowledge areas and different categories. This approach is used to compare the different rankings by different levels of experience, using the rankings obtained from RII results.

Table 10 shows the ranking comparison of the senior and junior engineers and illustrates that there is a very strong relationship between the perception of senior and junior engineers as the Spearman correlation coefficient is equal to 0.926. The p-value is less than Alpha 0.05 (p-value $\leq$ 0.001) which indicates that there is a statistically significant relationship between the PMKAs ranking based on the responses.

The top three critical project management knowledge areas that affect project performance, namely: project time management, project quality management, project cost management, project human resource management, and project scope management.

Based on the research outcomes it can be concluded that the first three ranks in this study proved the importance of the project management triangle (Time, Quality, Cost). Since early research into project management literature in the 1970s, the project management triangle has been an indisputably fundamental component of project management. Despite important previous studies arguing that the Iron Triangle does not tell the full story of assessing project performance, the criteria of on-time, under budget, and expected quality still a preeminent place in our understanding of whether a project has been delivered as anticipated.

Table 10. Correlation Between Senior & Junior Engineers View on PMKAs Contribution on Project Performance

PMKAs	Senior Eng. Mean	Senior Eng. Rank	Junior Eng. Mean	Junior Eng. Rank	d	d^2
Project Integration Management	4.466	7	4.426	7	0	0
Project Scope Management	4.521	5	4.551	4	1	1
Project Time Management	4.564	1	4.563	3	2	4
Project Cost Management	4.558	3	4.644	1	2	4
Project Quality Management	4.559	2	4.585	2	0	0
Project Human Resource Management	4.523	4	4.519	5	1	1
Project Communication Management	4.400	9	4.377	9	0	0
Project Risk Management	4.479	6	4.397	8	2	4
Project Stakeholder Management	4.454	8	4.434	6	2	4
					$\sum d^2$	18
				Spearman rank correlation coefficient ρ		0.891
					N	10
					T statistic	5.548
					Degree of freedom	8
					p-value	0.001
					R^2	0.794

As shown in figure 14 that there is a statistically positive relationship between the perception of senior and junior engineers on ranking and understanding the Project Management Knowledge Areas that enhance the project performance, as R^2 is equal to 0.7225. This figure represents how senior and junior engineers ranked the PMKA components based on the importance on their perceptions. Therefore, the results prove

that junior engineers in Qatar are consistent with senior engineers who have experience in project management.

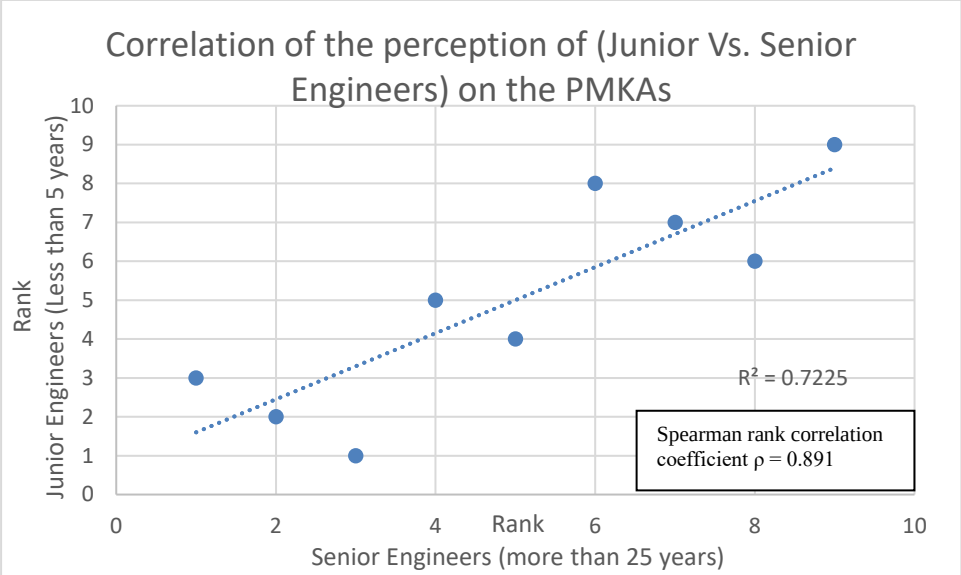

Figure 14. Spearman correlation of PMKAs analysis (**ρ**) and linear regression analysis (R^2)

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

In this chapter, the conclusion of the thesis and the importance of the analysis are also given. The answers to the research questions based on the findings of the research are also highlighted. The limitations of the study and future work are also provided.

5.1 Conclusion

The government is investing heavily in infrastructure projects in Qatar in order to support the large-scale events and to lead the country to the next level of competitiveness in having a world-class infrastructure to support economic and social growth. The government has also invested heavily in terms of developing the manpower and many engineers are involved in the various aspects of the infrastructure project. This trend is going to continue at least for the foreseeable future as the country is aiming to move towards a non-oil and gas economy.

The focus of this study is to understand what knowledge, criteria, and factors can lead to a higher level of effectiveness based on the literature review and assessing their performance with the professionals involved in the infrastructure sector. The reason is to look at the consistency of the understanding of the importance of performance requirements of projects and the factors that the engineers need to focus on.

The study provides the results from the literature review and the survey of professionals. Twenty-three hypotheses are developed for the success factors and ten hypotheses are developed for the knowledge area. The survey which resulted in about 58% of responses is found to be consistent in terms of responses and used for the

analysis. The study used different statistical tests in order to arrive at conclusions based on the proposed hypotheses.

The results also show that the perception of both senior and junior engineers are also similar on the factors and knowledge areas. These results indicate that the perception of the engineers is positive. Although not tested, one of the conclusions that can be derived is that in order to achieve a higher level of productivity and effectiveness, further exposure through training and practice in specific success factors and knowledge areas can support better project development in Qatar.

The research tested different hypotheses based on the two research questions mentioned earlier.

RQ1: What are the most important factors that contribute to the success of projects?

The literature showed that 23 critical success factors can be considered to understand their impact on the performance of the project. These factors may or may not be applicable in the context of infrastructure projects, which is the focus of this thesis. The analysis of the response to the survey shows that all of the chosen factors impact the performance of the projects. The thesis also provides a grouping of the identified critical success factors.

RQ2: What are the critical project knowledge areas that affect construction project performance?

It is often mentioned that project managers should have adequate knowledge of the project management tools and techniques concerned with the inception, planning, execution, and closing of the project. This may also differ with the scale and the nature of the project. For example, in small software-type projects, only a few of the knowledge areas could be useful. The analysis of the response shows that in infrastructure projects in Qatar, project managers consider all of the ten knowledge

areas as mentioned in PMBOK® (Project Management Institute, 2017), except procurement management are important. This might have happened due to two reasons: one, the organization proceeds with the procurement of services (like contracting, consulting, and designing) for infrastructure projects, and the project manager's role may be limited to communicating with them for project activities. Second, regular activities of supply of materials and payments related to the contractor and subcontractors, and suppliers may have been handled differently by the respective department for which project manager's input is sought for completeness and quality assurance. In large-scale infrastructure projects, due to intensity and the legal requirements, procurement becomes more complex to be handled by the project manager.

5.2 Research Limitation

There are some limitations to this study. The listing of critical success factors is limited to the literature review, the knowledge of the supervisors and the author based on their work, and indirect interaction with some of the professionals in the infrastructure sector. The list and the type of hypotheses developed, are, therefore, extensive but may not be inclusive. There may be other factors or other types of knowledge used in successful projects.

Although Qatar is a small country, and most of the engineers are working in the government sector and the companies which are associated with government sector infrastructure projects, the survey may not have captured a good mass of engineers with current or previous experience in this sector.

The response of 58.3% is quite high compared to some related studies. A higher response rate could have captured a more meaningful analysis. The results show

questionable reliability in terms of top management support, which might have been in either direction, had more response could be collected. It is possible that engineers may be thinking that top management support is basic and does not need to be explicitly mentioned as the factor. They might also be thinking that infrastructure projects might not be started if there is no top management support. Therefore, the analysis, although supports the hypotheses in general, results should be carefully used to make the final judgment. It should be noted that the focus of the study is mainly on project planning and execution; therefore, the findings should be associated only with these phases of the project.

5.3 Future Work

As success factors are not only limited to the project lifecycle, they might be associated with project conditions during the inception as well. Nevertheless, it is assumed that these factors are also implicitly related to other phases of the projects as well because every phase of the project can be considered as a project itself. There are a few research directions that can enhance the study presented in this thesis.

1. The response time was limited in this study due to the time constraints in the thesis and COVID-19 situation. Much better results might have been obtained if the researcher could visit infrastructure sites to elicit the success factors and to distribute the questionnaire. This could have helped to increase the sample size and also the responses. Once the respondents identify the value of the research, they might be more eager to participate in it. Therefore, research can be enhanced by distributing more surveys and providing longer time, with potential follow-ups to generate a much higher response rate.

2. With Qatar focusing on development and innovation strategy and more complex infrastructure projects in the future, more updated technologies might be used to decrease the project development time and costs or to decrease the overall operations and maintenance costs. The success factors for projects with a high content of newly developed projects would need to be considered against a different set of success factors that are not considered here. Therefore, action research can be taken up to elicit such factors and relate them with the project performance.
3. Future studies can also consider multidimensional success factors by exploring the impact of complexity, novelty, technology, and the pace to complete the projects. This type of concept is proposed by (Shenhar & Dvir, 2007). The changes in the project management practice, from achieving project efficiency to achieving future capabilities, can also be considered for future research. Also, the significance of changes in any aspect of the novelty, complexity, technology, or pace can be studied to develop new management techniques for successful project completion.
4. The study identified critical success factors for infrastructure projects. However, these factors and criteria may be applicable in other sectors as well. Therefore, testing the relevance of success factors to other sectors can provide a better insight into how success factors and knowledge areas should be utilized in different projects.
5. Construction sector is increasingly looking at sustainability issues and social responsibility has been one of the recent research areas as it is also included in (Project Management Institute, 2016) construction extension. A few recent research on this area can be seen in (Wang, Zhang, & Lu, 2018) and

(Almahmoud & Doloi, 2020). The need for social sustainability is important as it can impact social cohesion, social equity (Almahmoud & Doloi, 2020), and environmental footprint. Environmental sustainability is also being used in construction in terms of using and disposing of construction-related materials such as water, materials, and equipment, which can also lead to a decreased environmental footprint. Economic sustainability could mean the justified use of resources during construction and the minimal cost per value generated by the infrastructure.

Sustainability concept is being adopted in Qatar as well. For instance, the Qatari government is pushing for lean management and sustainability in construction projects, where the lean management sectors are looking at leaning the process and making the process more sustainable. Although in the short term, the cost to change to sustainable practices can be challenging, but in the long term, it will bring about a culture of using sustainability to do projects in Qatar. Although the concept is catching up in Qatar, the project managers should understand these sustainability concepts to develop, propose, and adopt alternative methods to increase the project's sustainability. Therefore, the future extension can be in terms of understanding the perception of the project managers on the sustainability of some of the targeted infrastructure projects.

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APPENDIX

Appendix A: Detailed Results of Success Factors Hypotheses Testing Using T-test.

Success factors hypotheses	Mean (x)	SD (s)	Standard Error of mean (SEM)	Degree freedom (DF)	T-statistics	p-value
Ha1: Providing sufficient resources for implementing the project by the top management contributes to the project's success.	4.589	0.582	0.038	230	119.815	0.000
Ha2: Providing sufficient resources to facilitate project variations by the top management contributes to the project's success.	4.095	0.757	0.050	230	82.190	0.000
Ha3: Providing the necessary resources to support the project team during the crisis by the top management contributes to the project's success.	4.494	0.665	0.044	230	102.685	0.000
Ha4: Effective formal and informal communication by the top management with project team members contributes to the project's success.	4.818	0.419	0.028	230	174.807	0.000

Success factors hypotheses	Mean (x)	SD (s)	Standard Error of mean (SEM)	Degree freedom (DF)	T-statistics	p-value
Ha5: Continuous discussion during the project life cycle by the top management with various groups of stakeholders contributes to the project's success.	4.524	0.651	0.043	230	105.538	0.000
Ha6: The capabilities of project team efficiency contribute to the project's success.	4.455	0.609	0.040	230	111.191	0.000
Ha7: The communication among project team members contribute to the project's success	4.636	0.533	0.035	230	132.092	0.000
Ha8: The cooperation of the project team with all project stakeholders contributes to the project's success.	4.277	0.781	0.051	230	83.241	0.000
Ha9: The coordination of the project team with all team members contributes to the project's success.	4.476	0.671	0.044	230	101.358	0.000
Ha10: Project team’s productivity contributes to the project's success.	4.398	0.623	0.041	230	107.246	0.000

Success factors hypotheses	Mean (x)	SD (s)	Standard Error of mean (SEM)	Degree freedom (DF)	T-statistics	p-value
Ha11: The learning capability of the project team contributes to the success of the project.	3.978	0.771	0.051	230	78.376	0.000
Ha12: Understanding the project mission by the project team contributes to the success of the project.	4.364	0.773	0.051	230	85.790	0.000
Ha13: The communication of the project manager with project team members and stakeholders contributes to the success of the project.	4.403	0.727	0.048	230	92.042	0.000
Ha14: Project manager leadership skills contribute to the project's success.	4.541	0.644	0.042	230	107.189	0.000
Ha15: Project manager persuasion and negotiation skills contribute to the project's success.	4.147	0.794	0.052	230	79.386	0.000
Ha16: The influence of the project manager on the project's team contributes to the project's success.	4.017	0.769	0.051	230	79.423	0.000

Success factors hypotheses	Mean (x)	SD (s)	Standard Error of mean (SEM)	Degree freedom (DF)	T-statistics	p-value
Ha17: The motivation of the project manager on the project's team contributes to the project's success.	4.156	0.747	0.049	230	84.540	0.000
Ha18: Project manager direction skills contribute to the project's success.	4.234	0.790	0.052	230	81.500	0.000
Ha19: Project manager decision-making skills contribute to the project's success.	4.541	0.630	0.041	230	109.511	0.000
Ha20: Project manager knowledge in project management contribute to the project's success.	4.312	0.677	0.045	230	96.732	0.000
Ha21: Identify the right stakeholders properly contributes to the project's success.	4.433	0.730	0.048	230	92.240	0.000
Ha22: Explore stakeholder’s needs and constrain contributes to the project's success.	4.247	0.760	0.050	230	84.900	0.000
Ha23: Predict the influence of stakeholders contributes to the project's success.	3.939	0.852	0.056	230	70.233	0.000

Appendix B: Detailed Results of PMKAs Hypotheses Testing Using T-test.

PMKAs hypotheses	Mean (x)	SD (s)	Standard error of mean (SEM)	Degree freedom (DF)	T-statistics	P-value
Hb1: Project Integration Management	4.459	0.617	0.043	206	103.914	0.000
Hb2: Project Scope Management	4.551	0.574	0.040	206	114.017	0.000
Hb3: Project Time Management	4.574	0.562	0.039	206	117.151	0.000
Hb4: Project Cost Management	4.596	0.563	0.039	206	117.419	0.000
Hb5: Project Quality Management	4.526	0.577	0.040	206	112.827	0.000
Hb6: Project Human Resource Management	4.504	0.611	0.042	206	106.083	0.000
Hb7: Project Communication Management	4.352	0.659	0.046	206	94.988	0.000
Hb8: Project Risk Management	4.445	0.666	0.046	206	95.999	0.000
Hb9: Project Procurement Management	4.380	0.686	0.048	206	91.812	0.010
Hb10: Project Stakeholder Management	4.398	0.665	0.046	206	95.087	0.000

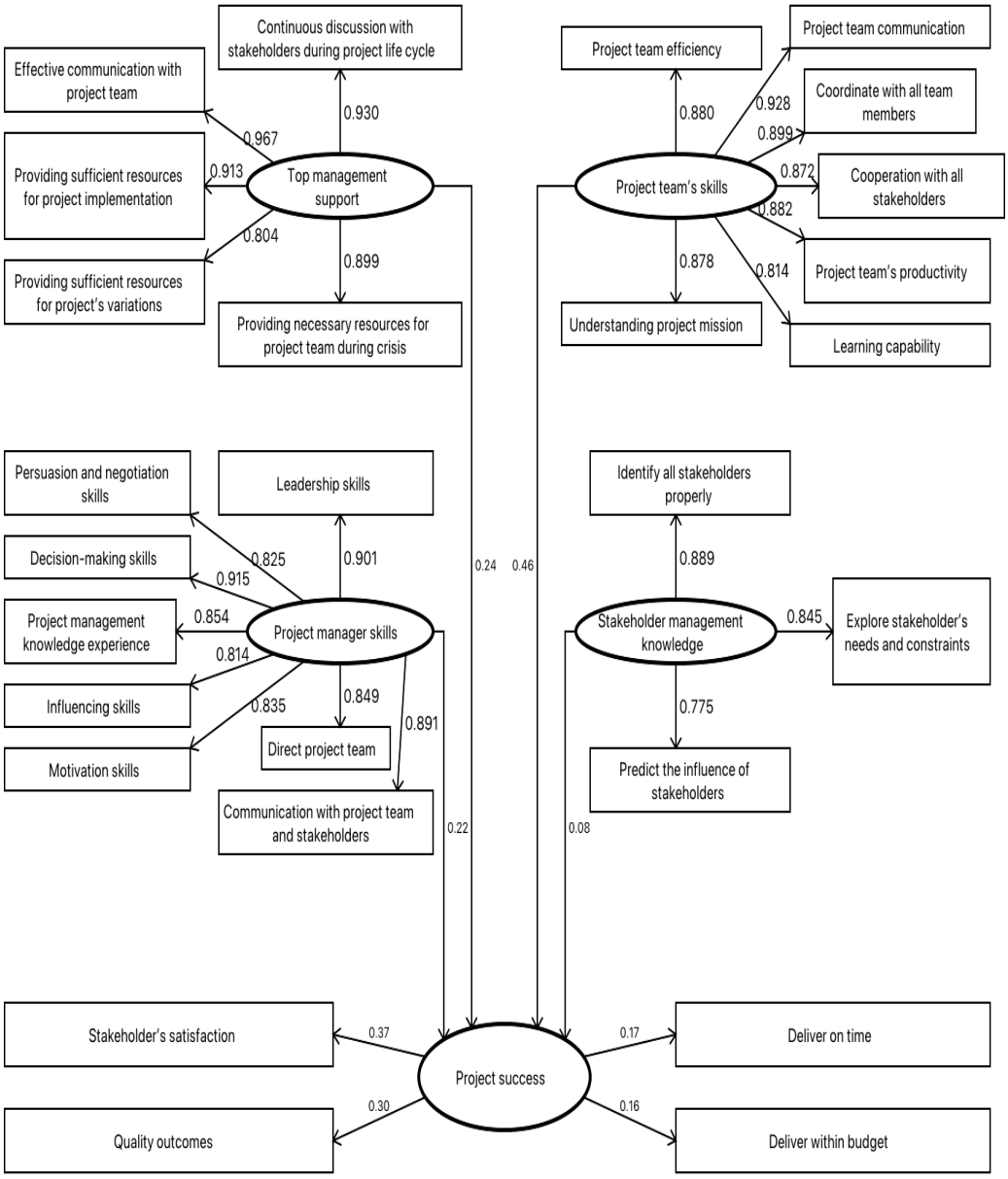
Appendix C: Relative Importance Index for Success Factors Based on the Perception of Junior and Senior Engineers Only

	Extremely imp.	Very imp.	Moderately imp.	Slightly imp.	Not imp.	RII
Group 1: Top management support						
Continuous meetings with the stakeholders during the project life cycle	66	28	3	0	0	0.930
Effective communication with the project team	81	16	0	0	0	0.967
Providing sufficient resources for the project	58	36	3	0	0	0.913
Providing sufficient resources for the project's variation	26	49	20	2	0	0.804
Providing necessary resources to the projects team during a crisis	54	37	6	0	0	0.899
Group 2: Project team skills						
Project team efficiency skills	44	48	5	0	0	0.880
Project team communication	65	29	3	0	0	0.928
Cooperation by the project team with all stakeholders	48	38	9	2	0	0.872
Internal team coordination	54	37	6	0	0	0.899
Project team productivity	47	43	7	0	0	0.882

	Extremely imp.	Very imp.	Moderately imp.	Slightly imp.	Not imp.	RII
Team's learning capability	30	45	21	1	0	0.814
Understanding the project mission by the project team	53	32	10	1	1	0.878
Group 3: Project manager's skills						
Leadership skills	57	34	5	0	1	0.901
Persuasion and negotiation skills	32	48	15	1	1	0.825
Decision-making skills	62	30	4	1	0	0.915
Project management knowledge experience	42	40	14	1	0	0.854
Influencing project team	32	40	25	0	0	0.814
Motivating the project team	35	47	13	1	1	0.835
Directing the project team	41	41	14	0	1	0.849
Communicating with the projects team and stakeholders	54	35	7	0	1	0.891
Group 4: Project Manager's knowledge of stakeholder's management						
Identifying all the stakeholders who involve in the project	54	34	8	0	1	0.889
Exploring stakeholder's needs and constraints in the project	41	42	10	3	1	0.845

	Extremely imp.	Very imp.	Moderately imp.	Slightly imp.	Not imp.	RII
Predicting the influence of stakeholders	26	41	24	4	2	0.775

Appendix D: A Hypothesized Path Model of the Relationships Between Project Success and Critical Success Factors



Appendix E: A Hypothesized Path Model of the Relationships Between PMKAs and Project Performance