# A NOVEL PROJECT MANAGEMENT MATURITY MODEL BY INTEGRATING KNOWLEDGE MANAGEMENT CAPABILITIES: EMPIRICAL EVIDENCE FROM INSTITUTIONS OF HIGHER EDUCATION IN YEMEN

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Thesis submitted in fulfilment of the requirements
for the award of the degree of
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'In the Name of Allah, Most Gracious, Most Merciful'

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## ABSTRAK

Perkembangan dalam pengetahuan pengurusan telah secara beransur menjadi sokongan yang amat diperlukan oleh banyak organisasi untuk mencapai sasaran kematangan pengurusan projek. Kebanyakan projek di organisasi Yemen telah gagal untuk menyampaikan perkhidmatan/produk yang dijangkakan disebabkan oleh kurangnya integrasi antara pengetahuan pengurusan dan pengurusan projek. Kajian ini telah menunjukkan keupayaan integrasi pengetahuan pengurusan dalam pengurusan projek dengan menghasilkan model pentaksiran yang baru. Model ini digunakan untuk menilai kematangan pengurusan projek di institut pengajian tinggi. Sejumlah 352 responden, seperti pengurus projek dan ahli-ahli projek dari 10 universiti awam yang terletak di utara dan selatan zon geopolitik di Yemen menyertai kajian ini. Hasil kajian telah menunjukkan bahawa keupayaan pengurusan pengetahuan projek boleh dianggap sebagai salah satu kaedah untuk mengenal pasti tahap kematangan dalam pengurusan projek, kecuali struktur organisasi yang berasaskan projek dan keupayaan penukaran pengetahuan projek yang memerlukan lebih banyak sokongan dan perhatian oleh institut pengajian tinggi. Secara menyeluruh, tahap kematangan projek pengurusan di universiti awam ialah 3.1 daripada 5 yang menunjukkan keupayaan pengetahuan pengurusan, alat pengurusan projek dan kaedah tertentu belum lagi digunakan secara efektif di Yemen.

## ABSTRACT

A rise in knowledge management has gradually become an essential support to many organizations to reach to their target project management maturity. Most of Yemen's organization projects failed to deliver the expected service/product due to the lack of integration of the management of knowledge with project management. This study reveals the integration of knowledge management capabilities into project management by developing a novel assessment model. The model was used to examine project management maturity in higher education institutions. A number of 352 respondents, such as project managers and other project members from 10 public universities located in the north and south geopolitical zone of Yemen participated in this study. The result shows that the project knowledge management capabilities are considered as a way of identifying the level of maturity in project management, except the project-based organizational structure and project knowledge conversion capability, where they should have more support and attention by the higher education institutions. Overall, the project management maturity level of the universities in the public sector is 3.1 out of 5, which indicates that the knowledge management capabilities, project management tools and methods have not yet been used effectively in Yemen.

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| | |
|---|---|
| AIPM | Australian International Project Management |
| APM | Association for Project Management |
| AVE | Average Variance Extracted |
| CB-SEM | Covariance-Based Structural Equation Modelling |
| HEIs | Higher Education Institutions |
| IPMA | International Project Management Association |
| JPMF | Japan Project Management Forum |
| KICs | Knowledge Infrastructure Capabilities |
| KM | Knowledge Management |
| KMCs | Knowledge Management Capabilities |
| KPCs | Knowledge Process Capabilities |
| OGC | Office of Government Commerce |
| P3M3 | Portfolio, Programme, & Project Management Maturity Model |
| PCM | Project Cost Management |
| PComM | Project Communication Management |
| PHRM | Project Human Resource Management |
| PIM | Project Integration Management |
| PjM3 | Project Management Maturity Model (P3M3) |
| PLS-PM | Partial Least Squares Path Modelling |
| PM | Project Management |
| PMBOK | Project Management Body of Knowledge |
| PMI | Project Management Institute |
| PMM | Project Management Maturity |
| PMMM | Project Management Maturity Models |
| PMOs | Project Management Offices |
| PProM | Project Procurement Management |
| PQM | Project Quality Management |
| PRM | Project Risk Management |
| PSM | Project Scope Management |
| PStkM | Project Stakeholders Management |
| PTM | Project Time Management |
| SEM | Structural Equation Modelling |
| SPSS | Statistical Package for the Social Sciences |
| VIF | Variance Inflated Factor |

# CHAPTER 1

# INTRODUCTION

## 1.1 Background of Study

Modern organizations are transforming into management by projects as a primary management structure and are using projects to develop both goods and services. The projects in the organizations are the basic building blocks of development, which are managed by project management. An organization has achieved full project management maturity when it has met the requirements and standards for project management effectiveness (Kent Crawford, 2006). Organizations that have competitive advantage attempt to maintain their competitiveness by increasing knowledge manipulation and managing its capabilities. Along with it, the level of project management awareness and recognition of the standards and knowledge sharing among professionals is rising from time to time.

Despite rapid development, many projects are continuing to fail to deliver their last service or products. The Project Management Institute (PMI) conducted an annual global survey of project management practitioners to chart current trends for project management failure and found that the projects in underperforming organizations are failing by 24% (Alexander, 2017). However, project failures require more contribution from project management practitioners, allocating the reasons behind this failure and innovating ways to assist the organization measuring their project management maturity (PMM). The maturity in project management is the progressive development of an enterprise-wide project management approach, methodology, strategy and decision making process in organizations (Ofori & Deffor, 2013).

In this context, maturity in project management becomes critical to circumvent the constraints of the public sector and to increase the organization's efficiency and competitiveness (Viana & Mota, 2015). Organizations struggle to measure their project management maturity and track its progress. According to Sawaya and Trapanese (2004), a number of organizations have been working on this problem and have developed what is known as the Project Management Maturity Models (PMMM). These models are systematic and sequential frameworks designed to help organizations quantify their project management maturity and improve their project management processes (Vergopia, 2008). It provides an assessment tool that compares organization project delivery with that of established best practices. As Skulmoski (2001) found that no specific model suits all types of project, many studies are arguing the effectiveness and validity of the existing project management maturity models.

On the other hand, Gharakhani and Mousakhani (2012) indicated that knowledge management capabilities have a positive and significant effect on organizational performance. From the practitioners' viewpoint, knowing the status of an organization's knowledge management capabilities is very important to indicate its strengths, limitations and causes of project failure.

Knowledge management capability refers to the condition and ability that individuals have within the area of knowledge management in the knowledge activity system (Abdul Rahman & Hassani, 2011). According to Rahman and Hassani (2011) knowledge management capabilities are categorized into KM infrastructure capabilities (i.e. technology, structure and culture) and KM process capabilities (i.e. acquisition, conversion, application and protection). Managing knowledge in the organization is important to improve organizational performance through approaching identified processes such as acquiring and converting knowledge into useful forms and then applying, using and protecting knowledge by an intentional and systematic method. These processes are executed through knowledge management, where an organization's innovative process allows the individual to search for creative problem solving (Y.-C. Lee & Lee, 2007). Galvis-Lista and Sánchez-Torres (2013) argued that organizations should take advantage of the knowledge they possess and create new knowledge to compete in their markets.

From the practitioners' viewpoint, the main reason for this complication is that there are no universally accepted methodologies or well defined processes to impartially measure project management practices in any organization or across different industries through its knowledge management capabilities (Ibbs & Kwak, 2000). Therefore, this failure has occurred frequently in many organizations, and there must be an important juncture by these organizations to start integrating project management with knowledge management (Levin, 2010). To achieve this integration, organizations should understand how this integration works and how can they start assessing maturity in project management through their knowledge management capabilities. Hence, it is now imperative to develop a well-defined system for an organization to measure project management practices through the mentioned capabilities towards building up project management maturity. As such, project failures could minimize the organizational project management maturity.

## 1.2 Problem Statement

According to Yeong and Lim (2010), a report by Standish Groups Chaos reported that only 32% of all surveyed projects are considered to be successful and are delivered on time and on budget with the required features and functions. Tomomitsu, Carvalho and Moraes (2017) stated that only few studies were identified with regards to the importance of knowledge for projects involving sustainability issues. There is lack of project management processes and practices which caused project failures in Yemeni organizations (Al-Sabahi, Al-Hamidi, Ramly, & Rejab, 2014); in many cases, projects failed to attain their designed plans and goals completely (Gamil, Rahman, Nagapan, & Alemad, 2017). Organizations have been continually using assessment models to help them cultivate their level of project management (Zaleha, Khairuzzaman, Hazlin, & Sang, 2014). These models were used to assess the maturity of an organization to ensure its efficiency and uniformity in delivering projects. Nevertheless, there is still a lack of consensus for the current generation of PMM models in terms of their purpose, design, and value being the subject of ongoing discussion. However, (Meliha Handzic & Bassi, 2017) recommended conducting empirical research to better understand how project success may be improved via integrating KM and PM.

Rad and Anantatmula (2010) stated that integrating knowledge management and project management is necessary to manage project knowledge effectively and to help

organizations improve their project performance. Also, Yeong and Lim (2010) suggested that further research should be conducted to understand how project may be achieved via integrating knowledge management and project management. Furthermore, a powerful integration or combination of KM and PM can create a synergy effect in order to deliver mature projects to the organizations (Durmic, 2017; Handzic, 2017).

The PM and KM integration helps educational institutes to improve their capacity of gathering and sharing information and knowledge and apply these to problem solving and support the research and continual improvement of their work (Dhamdhere, 2015). Similarly, Levin (2010) proposed that knowledge management must be integrated with project management to respond rapidly to gather information to solve specific problems and share knowledge assets effectively and efficiently. Handzic (2017) recommended integrating KM practices with PM by developing and implementing appropriate guidelines for creating, sharing and reusing knowledge in a project environment. Thus, continuous learning needs to occur throughout the project lifecycle to improve project-related competencies with regards to knowledge management (Handzic, 2017).

However, there is a significant gap in the existing literature that addresses knowledge management integration into project management from the beginning to prevent any inefficiency (Lierni & Ribière, 2008; Owen, 2008; Sokhanvar, Matthews, & Yarlagadda, 2014). Owen (2008) stated that very few academic publications focus on the role of using knowledge management to improve project management. In fact, previous studies have not clearly identified nor demonstrated the relationship between project management and the use of knowledge management (Al-Zayyat, Al-Khaldi, Tadros, & Al-Edwan, 2009). Zhu, Sun, Xu and Haider (2014) argued in their research that the question of how knowledge integration can be applied in projects remain largely unsolved. Moreover, to date, research on project management maturity models is relatively rare in the context of Yemeni industries, let alone in higher education institutions in Yemen. Hence, the study is aimed to integrate knowledge management with project management towards assessing project management maturity, especially in higher education institutions in Yemen.

Project failure has been a serious problem faced by higher education institutions in Yemen in the last decade. They were unable to find a way to benefit from their knowledge management capabilities in improving the project management maturity. The

results of this study examines the relationship between these capabilities and project management maturity, and the outcomes could have a significant influence on the projects activities in these institutions.

Finally, Yeong and Lim (2010) also mentioned that integration of knowledge management with project management enhances project maturity in organizations. Akhavan and Pezeshkan (2014) further assured that the implementation of KM is vital for organizations to be competitive in industries and to avoid wasting organizational resources, especially in project management.

## 1.3 Research Objectives

To address the research problems as elaborated above, the main objectives of this research are:

1. To define the knowledge management capabilities in project management.
2. To develop a novel assessment model of project management maturity through knowledge management capabilities.
3. To examine the level of project management maturity through knowledge management capabilities in higher education institutions in Yemen.
4. To examine the relationships between the knowledge management capabilities with project management maturity in higher education institutions in Yemen.

## 1.4 Research Questions

The intention of this study is to arrive at an understanding definition of knowledge management capabilities in project management as well as attempting to develop a novel model to assess and examine project management maturity through these capabilities. The research addresses the following questions:

1. What are the knowledge management capabilities in project management?
2. How can a measurement model to assess project management maturity through knowledge management capabilities be developed?
3. What is the assessed level of project management maturity through using knowledge management capabilities in higher education institutions in Yemen?
4. What are the relationships between project management maturity and knowledge management capabilities in higher education institutions in Yemen?

## 1.5 Scope of the Study

The study focuses on higher education institutions in the Republic of Yemen, since Yemen is one of the least developed countries in the Arab world and has its own attributes in terms of governmental, cultural and political characteristics. The study is limited to the PM maturity in higher education institutions, specifically in Yemen. The project managers and employees who are in charge of the project management perspective were considered in the research. Therefore, the PM maturity measurement that was required was a direct interaction with these people in order to get the most wanted and desired results. The study covered the 10 knowledge areas of project management body of knowledge according to the fifth edition of PMBOK 2013, as it was found that the current version of PMBOK guide was applied in higher education institutions in Yemen during the process of developing and collecting the questionnaires. In addition, it limits the study to use the two categories of the knowledge management capabilities proposed by Gold et al. (2001). The assessment model was designed based on a five-scale of PMM levelling system.

## 1.6 Significance of the Study

The reason for adopting project management in HEIs relates to the specific types of change that need to be managed (Bryde & Leighton, 2009). Bryde and Leighton's research findings suggest that HEIs may have difficulty in sustaining activity in which project management maturity is a pre-requisite. This research was designed to extend the body of knowledge by integrating both disciplines of project management and knowledge management. The fundamental concepts of knowledge management capabilities were re-constructed and re-defined according to the content of project management. A novel project management maturity assessment model was established from the perspective of project-related knowledge management capabilities. Empirical evidences were provided in the rarely-studied context of higher education institutions, particularly in Yemen.

The research contributed to the relevant knowledge domain both theoretically and empirically. The proposed model can be used in assessing the maturity level of project management for Yemeni organizations, especially higher education institutions. The maturity assessment result of this research can be used as an initial benchmark information not only to evaluate the success of achieving project management maturity,

but also to prioritize and design further improvement actions. The developed questionnaire can also serve as a guiding tool in implementing project management practices from the concrete ten project management areas through a novel perspective of KM capabilities.

As such, along with the enhancement of the knowledge management capabilities of the organization, the project management maturity of the organization could also be consolidated and the competitiveness of the organization would be materialized. Assessing the project management maturity could be useful for higher education institutions in this country, as they do not receive sufficient assessment and evaluation feedback to their ongoing and future projects. Developing a measurement tool is considered a good achievement for higher education institutions in Yemen since they do not use a standard tool for evaluating and assessing their projects' success or failure, which is due to limited resources and project management assessment experience.

## 1.7 Operational Definition

Project Management

Project Management involves applying knowledge, skills, tools, and techniques to project activities in order to meet or exceed stakeholder needs and expectations. It is the art of directing and coordinating human and material resources throughout the life of a project to achieve the project's objectives within specified constraints (PMI, 2013).

Project Management Maturity

As defined by PMI, the degree to which any organization practices organizational project management (PMI, 2013).

Knowledge Management

Knowledge management is the planning, organizing, motivating, and controlling of people, processes and systems in the organization to ensure that its knowledge-related assets are improved and effectively employed (William, 2009).

Knowledge Infrastructure Capabilities

It is the capability to manage infrastructures as technology, structure and culture in the organization in order to support and facilitate organizational activities (Chiu & Chen, 2016).

Project-related Technology

A combination of hardware, software and network infrastructure that ensure and support projects' success in the organization.

Project-based Organizational Structure

It can be defined as a group of rules, policies, procedures and processes, hierarchy of reporting relationships, and incentive systems which organize the project activities within the organization's boundaries.

Project-Oriented Organizational Culture

It can be defined as the knowledge, beliefs, art, morals, laws, customs, and any other capabilities and habits acquired by the employee as a member of the organization, which is one of the key influences on the project's activities.

Knowledge Process Capabilities

It is the capability of transforming knowledge that is stored in the form of standard operating procedures and routines throughout the organization into valuable organizational knowledge and experience (Chiu & Chen, 2016; Pirkkalainen & Pawlowski, 2014).

Project Knowledge Acquisition

The process of creating or acquiring knowledge that is in the form of tacit and explicit knowledge within the project activities in order to reach out to the target goal.

Project Knowledge Conversion

It is an oriented process towards transforming and converting the knowledge for un-useful knowledge to useful and applicable knowledge, from tacit knowledge to explicit knowledge within the project environment.

Project Knowledge Application

A process of sharing, using and exchanging project knowledge during the project activities among the project members for project effective improvement, avoiding failure, getting benefits and sharing outcomes of lessons learned.

Project Knowledge Protection

The process of protecting project knowledge that is in the form of tacit and explicit knowledge from non-authorized access/use within the project environment in the organization.

## 1.8 Thesis Organization

The thesis consists of five chapters and they are organized according to the research flow as follows:

Chapter 1 is an introduction to the thesis, which outlines and includes the primary elements of this study. It discusses the research problem and identifies the research gap, followed by the research questions, objectives and finally ends with the significance of the study and the operational definitions of the key terms in the thesis.

In Chapter 2, a comprehensive literature research was carried out, focusing on the definition of project management, project management maturity, project management maturity models, and knowledge management capabilities. The second part of the chapter details the integration of knowledge management capabilities with project management. It also discusses the proposed model, its structure, levels and assessment elements.

Chapter 3 discusses the research methodology, elucidates the survey design and proposes a survey questionnaire template along with outlining the inclusive study and analysis approaches.

Chapter 4 presents the data analysis, the statistical analysis and the testing of the research hypotheses, and discusses the result of the data analysis.

Chapter 5 is a summation of conclusions drawn, recommendations for using the developed model by the higher education institutions in using their knowledge management capabilities to gain project management maturity, and identifies the contribution to knowledge with further research recommendations.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Introduction

Organizations operating in today's world are facing an increasingly intensified global competition, technological advances and a knowledge-based economy. To grow and survive in such a world, with high competition and a need to be at the top of the pyramid, organizations need to continually learn and transform their knowledge into improved and innovative products and services. This chapter covers a depth of literature on the two main domains of the study: PM and KM. It discusses each domain and its relationship to each other, followed by emphasizing the applied theory and illustrates the theoretical framework. Part of the chapter covers the project management progress in current higher institutions. Finally, the chapter ends with the proposed model that can be used to assess PM maturity in higher education institutions in Yemen via their knowledge management capabilities.

## 2.2 Overview of Project Management

Commonly, it is considered that man has been using actions that mimic the practices of project management since the beginning of time. It also conceived that some important monuments created throughout the history of modern man were built under the precepts of project management although these were not formalized at the time. Valle et al. (2010) showed historical analyses that considered that the concept of project management can be older than it looks. In the contemporary era, it is verified, as Valle et al. (2010) mentioned, that several works were done under the management of big monetary amounts and the work force of thousands of workers, which generated the need to implement project management practices. Mustaro and Rogério (2013) wrote about Taylor, who was a pioneer in the science of project management, and Gantt was another

student of these sciences. Both scientists contributed greatly to the practices of modern project management. Although great events of the past suggested the theories of project management, it was only in the early twentieth century that the theories, frameworks and methodologies aimed at project management were in fact established.

One timeline, according to Carvalho and Rabechini (2011), presents great landmarks of project management from the last few decades. This presents the evolution of project management practices and represents milestones in this setting, as shown in Table 2.1.

Table 2.1 Project management evolution

| Period | Period Event |
|---|---|
| Postwar | Creation of PERT/CPM net |
| 1960's | Significant associations arise as IPMA and PMI |
| 1970's | Stagnation. Software for Project Management are featured |
| 1980's | Growing practice of Project Management in the world |
| 1990's | Exponential growth in the number of certified professionals and publications |
| 2000's | Emphasis on settling the practice of Project Management. |
| 2008 | 4th Edition of PMBOK Guide Released. |
| 2009 | Major PRINCE2 Revision by Office of Government Commerce (OGC) |
| 2012 | ISO 21500 Standard for project management Released |
| 2013 | 5th Edition of PMBOK Guide Released. |
| 2017 | 6th Edition of PMBOK Guide Released. |

In general, and from the research history, project management practices bring many managerial and financial benefits. These in turn cannot be easily measured, because the same metrics that are established for project management often do not have historical data as a reference. Since the projects are unique, enterprises and organizations sometimes do not allow comparisons among these projects (Mustaro & Rogério, 2013). In case of carrying out comparative efforts, a number of variables, including project-related technology, project-based organizational structure and project-oriented organizational culture, which interfere excessively in the comparisons, should be taken into consideration. However, benefits are tangible and intangible, and independent of it is tangible; some are highlighted as evident in PM (Valle et al., 2010), such as:

- Increased commitment to the objectives and organization outcomes.
- Availability of information to the top management for decision-making.
- Quality improvement in results frequently assessed and evaluated.

- Increased integration between departments within the organization.
- Increased organization user satisfaction internally and externally.

As mentioned and highlighted in Table 2.1, some entities or institutions were identified in the early twentieth century who were responsible for creating and distributing methodologies and frameworks aimed at project management in order to maximize the benefits aforementioned of organizations in different segments. Without being restricted to the reasons why these structures have been defined, it is possible to see in Table 2.2 some of these institutions and the frameworks defined and distributed by them.

Table 2.2 Frameworks and institutions for project management

| Framework | Institution |
|---|---|
| Project Management Body of Knowledge (PMBoK) – PMI | Project Management Institute |
| IPMA Competence Baseline (ICB) | International Project Management Association |
| Prince 2 – OGC | Office of Government Commerce |
| ENAA Model Form – JPMF | Japan Project Management Forum |
| RegPM Standards – AIPM | Australian International Project Management |
| APM Body of Knowledge | Association for Project Management |

Project management has been practiced for as long as humanity has inhabited earth. There are many examples in history of challenging projects that were successfully completed, despite all the complexities and uncertainties that could have rendered the project a failure (T. Seymour & Hussein, 2014). Kwak (2003) noted that the modern project management era started at middle of the last century with the development of CPM/PERT. Morris and Hough (1987) argued that the origin of project management came from the chemical industry just before the start of World War II. They further noted that project management was clearly defined as a separate discipline in the Atlas missile program, especially in the Polaris project. Some literatures and researchers attributed the origin of project management creation to Henri Fayol's five functions of a manager, namely to plan, organize, coordinate, control, and direct or command. Kerzner (1998) observed that project management was an outgrowth of systems management.

### 2.2.1 Project Management Definition

Many leading writers and project management institutions have attempted to define project management. Oisen (1971), referencing views from the1950's, may have contributed one of the early attempts.

*"Project Management is the application of a collection of tools and techniques (such as the CPM and matrix organization) to direct the use of diverse resources toward the accomplishment of a unique, complex, one-time task within time, cost and quality constraints. Each task requires a particular mix of these tools and techniques structured to fit the task environment and life cycle (from conception to completion) of the task"* (p.12).

Seymour et al., (1992) defined project management as:

*"A central strategy in the changes that many organizations are undergoing as they adapt from a stable, machine like model to a more dynamic one in face of environmental turbulence and change. Project managers face difficult task of both fostering flexibility, adaptability and the acceptance of change as a permanent state, and providing support for team members to enable them to live with a process they may experience as stressful and disorientating"* (p. 487).

Reiss (2007) suggested that a project is a human activity that achieves a clear objective against a time scale and achieving. He also suggested that project management is a combination of management and planning and the management of change.

Willis (1995) narrated the definition of project management according to the UK Association of Project Management (APM) as the planning, organization, monitoring and control of all aspects of a project and the motivation of all involved to achieve the project objectives safely and within an agreed time, cost and performance criteria. The project manager is the single point of responsibility for achieving this.

British Standards Board (1996) defined project management as the planning, monitoring and control of all aspects of a project and the motivation of all those involved

in it to achieve the project objectives on time and to the specified cost, quality and performance.

Lock (2003) defined project management as a specialized branch of management which has evolved in order to co-ordinate and control some of the complex activities of the modern industry. The changing business environment of the 21st century increased the range of activities coming under the periphery of project management techniques and the way projects are managed.

Kerzner (2009) defined project management in his book as the planning, organizing, directing, and controlling of company resources for a relatively short-term objective that has been established to complete specific goals and objectives.

According to PMI (2013), project management involves applying knowledge, skills, tools, and techniques to project activities in order to meet or exceed stakeholder needs and expectations. It is the art of directing and coordinating human and material resources throughout the life of a project to achieve project objectives within specified constraints.

Bredillet (2004) stated that project management as knowledge field is both an art and a science. Table 2.3 provides the major project management definitions from the writers'/institutions' perspective and thought.

Table 2.3 Major project management definitions

| Writers/Institutions | Project Management Definition |
|---|---|
| (Oisen, 1971) | The application of a collection of tools and techniques (such as the CPM and matrix organization) to direct the use of diverse resources toward the accomplishment of a unique, complex, one-time task within time, cost and quality constraints. Each task requires a particular mix of these tools and techniques structured to fit the task environment and life cycle (from conception to completion) of the task. |
| (D. E. Seymour et al., 1992) | A central strategy in the changes that many organizations are undergoing as they adapt from a stable, machine like model to a more dynamic one in face of environmental turbulence and change. Project managers face the difficult task of both fostering flexibility, adaptability and the acceptance of change as a permanent state, and provide support for team members to enable them to live with a process they may experience as stressful and disorientating. |

Table 2.3 continued.

| Writers/Institutions | Project Management Definition |
|---|---|
| (Reiss, 2007) | Project management is a combination of management and planning and the management of change. |
| (Willis, 1995) | The planning, organization, monitoring and control of all aspects of a project and the motivation of all involved to achieve the project objectives safely and within the agreed time, cost and performance criteria. The project manager is the single point of responsibility for achieving this. |
| (British Standards Board, 1996) | The planning, monitoring and control of all aspects of a project and the motivation of all those involved in it to achieve the project objectives on time and to the specified cost, quality and performance. |
| (Lock, 2003) | A specialized branch of management that has evolved in order to co-ordinate and control some of the complex activities of the modern industry. |
| (Bredillet, 2004) | Project management as knowledge field is both an art and a science. |
| (Kerzner, 2004) (Kerzner, 2009) | The planning, organizing, directing, and controlling of company resources for a relatively short-term objective that has been established to complete specific goals and objectives. |
| (Petersen, 2013) | The application of knowledge, skills, tools and technology to project activities to meet the project requirements. |
| (PMI, 2013) | Project management involves applying knowledge, skills, tools, and techniques to project activities in order to meet or exceed stakeholder needs and expectations. It is the art of directing and coordinating human and material resources throughout the life of a project to achieve project objectives within specified constraints. |
| (Rouse, 2015) | Project management is the discipline of using established principles, procedures and policies to manage a project from conception to completion. |

The term project management is sometimes used to describe an organizational approach to the management of ongoing operations, also referred to as management by projects (Prabhakar, 2008). Project management involves numerous differentiated activities that must focus on one final target.

As a summary from the previous definitions, they all agreed that project management concerns how to manage a project's activities in order to meet the organization's goals and meet project requirements using the organization's resources from tools, techniques and project knowledge application within a period and deadline for this outcome. Project management is accomplished through the use of five processes: initiating, planning, executing, controlling, and closing (Richardson, 2014).

## 2.3 Project Management Maturity (PMM)

### 2.3.1 Concept of Maturity

The concept of maturity, in general, has been the subject of a tremendous number of studies, and this concept evolved into what is now known as maturity today (Ofori & Deffor, 2013). In Webster's dictionary, the word 'maturity' is defined as the state or conditions of being mature, fully developed, ripe and approaching perfection. Therefore, the maturity defined in this study is the quality or state of being mature in doing something in order to gain a brilliant outcome. Based on the definition, therefore, the concept of maturity to an organization may refer to a state where the organization is in the perfect condition to achieve its objectives and reach its planned and desired perfection (Walker, 1995). The definition of maturity will help define the path and the direction that an organization should take to achieve levels of excellence in terms of project management (Pereira & Ferreira, 2015).

The PMI defined organization project management maturity as the degree to which an organization practices organizational project management, whereas it was defined in OPM3 as the existence of best practices, where best practice refers to an optimal way currently recognized by the industry to achieve a stated goal or objective (PMI, 2013). It can be viewed as a progressive and continuous development of the project management approach, methodology, strategy, and decision-making process; for instance, an organization's level of achievement with consistent methods and reproduction of project management deliverables and outcomes. The concept of maturity indicates that there may be a development from one level of capability to a higher one (Backlund, Chronéer, & Sundqvist, 2014).

On the other hand, practitioners and researchers in project management like Kerzner (2004) defined maturity in project management as the development of systems and processes that are repetitive in nature and provide a high probability that each project will be a success. Ibbs, Reginato and Kwak (2004) explained it as the sophistication level of an organization's current project management practices and processes. These definitions not withstanding Ofori and Deffor (2013) indicate that in the real world, one cannot find a fully matured organization, in that no one has reached the stage of maximum development and no one ever will. The higher the maturity levels of an organization, the

better its performance in all observed areas (Grant & Pennypacker, 2006). Their study suggests that 30% of mature organizations showed more than 25% improvement when compared to less mature organizations.

### 2.3.2 Development of PMM

Knowing the development history of project management maturity will help elaborate how this term was innovated and developed. The concept of process maturity was first initiated in the total quality management movement, where it showed that improving the maturity of any technical process leads to two things: reduction in the variability inherent in the process and an improvement in the mean performance of the process (Cooke-Davies, Schlichter, & Bredillet, 2001). Therefore, project management must unite with this process to determine its ongoing progress, weaknesses and strengths with the assistance of maturity models. This study used PM maturity as the dependent variable. Maturity leads to better performance of processes and of the organization as a whole. However, there is an increasing awareness that, whether a higher level of maturity leads to better performance, may depend on certain properties of that organization (Dijkman, Lammers, & de Jong, 2016). In general and historically, the project management maturity model has its origin from the capability maturity model (CMM), which was developed at Carnegie Mellon University in the USA between 1986 and 1993 (Pereira & Ferreira, 2015).

Backlund, Chronéer and Sundqvist (2014) stated that there are different kinds of project management maturity models that exist today, most of them inspired by the CMM which was originally intended to measure the maturity capability in software development projects. Researchers have indicated that organizations with higher project management maturity levels expect to be successful in terms of efficiency and project effectiveness, and from that, they gain a competitive advantage in the marketplace. However, despite several models developed over 20 years, knowledge about how these models are being applied and used in organizations is sparse within the project management literature. For the last period, papers and research were explored and maturity models were developed in order to improve the project management practices. In other words, maturity models can also serve as a point of reference for organizations in the context of project management practices. Table 2.4 presents a list of project management maturity (PMM) models developed previously.

Table 2.4 Major PMM models in the market

| Name | Review | Representations | Levels | Years |
|---|---|---|---|---|
| Capability Maturity Model | The full representation of the Capability Maturity Model as a set of defined process areas and practices at each of the five maturity levels, initiated in 1986 | Staged | 5 Levels | 1986 |
| Capability Maturity Model Integration | A process improvement maturity model for the development of products and services | Staged and continuous. | 5 Levels. | 1988 |
| Organizational Project Management Maturity Model (OPM3) | In 1998, the PMI launched this model to pursue the accreditation of the maturity model as a PMI standard to be used globally. | Staged | 4 Levels | 1998 |
| Berkeley PM Process Maturity Model | The Berkeley Project Management Process Maturity Model was developed that uses statistical techniques to assess the maturity of PM processes and practices among different industries | Staged | 5 Levels. | 2000 |
| Capacity Management Maturity Model | Identifies different levels of IT management competency. | Staged | 5 Levels (0-4) | 2001 |
| PM Solutions Project Management Maturity Model | This model is fully aligned with the Software Engineering Institute's Capability Maturity Model featuring 5 levels of maturity | Staged | 5 Levels. | 2002 |
| Project in Controlled Environments (PRINCE2) | Developed by the UK's Office of Government Commerce (OGC) for the Project-driven organizations | Process-based | 7 | 2002 |
| Organizational Change Maturity Model | This Organizational Change Maturity Model is based on the same five-level, multi-dimensional approach used for project, software and process capability maturity. | Staged | 5 Levels | 2004 |
| Change Management Maturity Model | Prosci developed the Change Management Maturity Model in 2004. It describes different levels of organizational maturity related to managing the people's side of change on projects and initiatives | Staged | 5 Levels | 2004 |

Table 2.4 continued.

| Name | Review | Representations | Levels | Years |
|---|---|---|---|---|
| Portfolio, Programme & Project Management Maturity Model (P3M3) | The OGC has introduced a government standard (P3M3) which is an enhanced version of the existing Project Management Maturity Model (PMMM), which it officially replaces, but will nest within it. | Staged | 5 Levels | 2006 |
| Project Management Maturity Model | Allows organizations to systematically and efficiently develop and measure their project management capabilities. | Staged | 5 Levels | 2006 |
| Business IT Integration Maturity Model | The Business IT Integration Maturity Model is first introduced in the summer of 2006. It was created to use in a discussion with an IT department to define the level of organizational maturity needed (based on Nolan's Maturity Model). | Staged | 5 Levels | 2006 |
| Maturity Increments IN Controlled Environments (MINCE) | Maturity Increments in Controlled Environments Model (MINCE) was presented by the MINCE2 Foundation in 2007. The focus of MINCE maturity model is towards an organization's ability to adapt to environmental and market changes. | Staged | 5 Levels | 2007 |
| Business-IT Maturity Model (BIMM) | Developed in the early 1990s and has evolved based upon extensive multi-company research and application through IT management consulting engagements. Maturity Models as Management Tools Maturity models are invaluable management tools. | Staged | 5 Levels | 2009 |

Zaied (2012) stated in their research that all the existing maturity models provide a framework in the field of project management improvements and they are a point of reference for organizations to understand its current position of the overall organizational competency and realize the aims for the future. According to Pankowska (2010), all models illustrate the combination of steps to help an organization to improve processes and practices in the field of project management. Based on the importance of PMM in the development of project management within the organisational context, it is vital to

introduce a project management maturity model (PMMM) in order to improve project management performance (Alzahrani, 2015).

As in the feedback of experience of software practitioners, i.e. (Grant & Pennypacker, 2006; Neverauskas & Railaite, 2013), it is estimated that there are more than 30 models available in the market. While presenting existing maturity models, the greatest attention should be paid to the five maturity models, of which are considered as the main reference to the rest of the maturity models.

Explaining all the existing maturity models would be difficult because it is a highly interdisciplinary field of study that attracts scholars and practitioners from various fields (philosophy, information science, library science, economics, management, sociology, and engineering among others). This means each model has its own structure and characteristics, which distinguishes itself from another model, and the variety and measurements scales require a detailed and comprehensive explanation. Due to the mentioned reason, the following section covers almost all the assessment models with the five famous models chosen for further elaboration, of which is the primary reference of all maturity models.

### 2.3.3 Project Management Maturity Models (PMMM)

Maturity models are a type of framework that are used to transform and move an organization from being less mature, less standardized, less organized and less documented into an organization that achieves higher standards with a well-recognized reputation and greater consistency. They are used as a framework to guide the improvement efforts of an organization (Cleland & Ireland, 2002). To ensure organizational success in global business surroundings, it is necessary that organizations attain a high standard of maturity. The use of maturity models in the diagnosis of a project management culture in organizations especially aims to identify weaknesses and strengths in their project management processes (Pereira & Ferreira, 2015).

Historically, maturity and performance capability measurements were first introduced in production facilities as measures of total quality and continuous improvement. A careful study of these maturity models reveals that the models vary from one another in terms of the concepts they embody as well as the suggestions they pose as to what the path of maturity looks like. It is worth indicating that these different maturity

models for project management may define maturity differently and measure different things to determine maturity (Man, 2007). Broadly speaking, there exists two categories of PMMMs in terms of the way they deal with maturity – one assumes the staged-representation of maturity such as CMM, P3M3, PRINCE 2 and ProMMM and the other one assumes the non-staged representation of maturity such as OPM3 (Farrokh & Mansur, 2013). It is remarkable that the most common PMMMs do not address knowledge management as a separate entity for maturity assessment (Spalek, 2014).

#### 2.3.3.1 Organizational Project Management Maturity Model (OPM3)

OPM3 is an acronym for Organizational Project Management Maturity model and this standard was developed under the supervision of the Project Management Institute. The purpose of this standard is to provide a way for measuring their maturity against a comprehensive and broad-based set of organizational project management best practices. OPM3 also helps an organization that wishes to increase their organizational PMM to plan for improvement (PMI, 2013). Desai, Crnkovic and Ross (2007) stated that OPM3 comprised of three interlocking elements: knowledge, assessment and improvement.

The **Knowledge** element includes an executive summary; the narrative explanations required by the user to understand organizational project management, its definition and its application toward organizational PMM; an explanation of terms specific to the OPM3 standard; the explanation of the OPM3 steps and an example of application, the appropriate appendices; the OPM3 Glossary; and the OPM3 Index.

The **Assessment** element includes the OPM3 self-assessment, which is an interactive database application. After completion of the self-assessment, the results include various graphs (spider diagrams) that visually depict an organization's attainment of best practices against the domains of Project, Program and Portfolio (PPP) management and the maturity stages of process improvement:

- Standardize.
- Measure.
- Control.
- Continuously Improve.

When combined, these values of maturity stages of process improvement produce a percentage point representative of the organization's organizational PMM placement on a continuum of maturity.

The **Improvement** element is comprised of the OPM3 components of best practices, capabilities, outcomes, key performance indicators and the relationships across and among the best practices which are warehoused within a database. This database includes each component's unique identifier, name, and description. Because different organizations might apply OPM3 in different ways, this database will allow the user to filter specific criteria and parameters important to their organization to obtain various lists of best practices and/or capabilities (Desai et al., 2007).

Thus, OPM3 provides answers to very important questions related to the organization's current PMM and allow organizations to further improve on the same. OPM3 is a roadmap; a well-structured and detailed guide to the best practices that the organization needs to implement to achieve its strategic goals through projects while conserving organizational resources. It promotes organizational maturity awareness among senior management and attributes organizational success to project management (Farrokh & Mansur, 2013). Based on a large number of best practice examples, organizations can evaluate their project management capabilities and identify areas that need improvement, which are then dealt with by designing and implementing an appropriate action plan (Seelhofer & Graf, 2018).

#### 2.3.3.2 Portfolio, Programme & Project Management Maturity Model (P3M3)

The portfolio, programme and project management maturity model (P3M3) is a reference guide for structured best practice. It breaks down the broad disciplines of portfolio, programme and project management into a hierarchy of key process areas (KPAs). According to Vasili (2010), the Office of Government Commerce (OGC) developed the P3M3, which is a department within the UK Government. The goal and purpose were to help the public sector improve its efficiency, gain better value for money and deliver improved success from programs and projects.

P3M3 does not only recognize the PMM level of an organization; rather, it also take into consideration the activities that build and maintain a program and the activities that select and prioritize the projects and programs to be carried out (Vasili, 2010). This

will help organizations to decide what maturity level they need to achieve to meet their business needs. Like the SEI's Capability Maturity Model, a five-level maturity framework describes P3M3. These levels constitute the structural components that comprise P3M3.

- Awareness of process: At this level, an organization does not recognize projects and run them differently from its ongoing business. Projects at this level may be running informally with no standard process or tracking system for the project activities and processes.
- Repeatable process: Consistency or coordination between projects may be limited in this level, as an organization does not ensure that each project is run with its own processes and procedures to a minimum specified standard.
- Defined process: At this level, the organization has its own central controlled project processes, and can individually project flex within these processes to suit the particular project.
- Managed process: This level is to ensure the organization obtains and retains specific measurements on its PMM and runs a quality management organization to better predict future enhancement.
- Optimized process: The organization runs continuous process improvement with proactive problem and technology management for projects in order to improve its ability to depict performance over time and optimize processes.

The Portfolio, Programme and Project Management Maturity Model (P3M3) has become a key standard amongst maturity models in the market, providing a framework for an assessment with which organizations can assess their current performance and put in place improvement plans with measurable outcomes based on their industry's best practice. This study adopted a part of this model, which is the PjM3. It covers project management as an individual model for its assessment results. The PjM3 covers for its assessment areas such as management control, benefits management, financial management, stakeholder management, risk management, organizational governance and resource management.

PjM3 in particular has become an essential tool in assessing organizations' current capabilities and helpthem to implement change and improvements in a structured way (Rod Sowden, 2006). According to Lefevre (2015), one of the reasons for choosing this

model is that PjM3 can easily assess the organization's current capabilities, identify where they want to be in the future and implement the necessary improvements in a clear and structured way, with measurable results. Another reason is that it defines project management as a unique set of co-ordinated activities, with definite start and finishing points, undertaken by an individual or team to meet specific objectives within a defined time, cost and performance parameters as specified in the business case (Lefevre, 2015). This model was chosen to measure the dependent variable due to its international spread, participation of researchers in the development process, access to the assessment tool, and transparency of the evaluation criteria/process (Christoph Albrecht & Spang, 2014).

#### 2.3.3.3 Project in Controlled Environments (PRINCE2)

Formally, PRINCE (Projects in Controlled Environments) is a project management methodology developed under the direction of the UK government Office of Government Commerce OGC. Several updates have been developed since then, and the latest PRINCE2 update was released in 2002. Although it was first created for IT organizations, it has evolved into a more generic, best practice approach for the management of all projects (Pincemaille, 2008). It defines a model for project management best practices, including the project management activities needed to fulfil a project according to the triangle, ensuring quality in an agreed time, scope and cost (Hänninen, 2016). However, it is actually the standard project management methodology in the UK and many other European countries while it is rarely used outside the European continent.

Organizations are aware of the benefits that a structured approach to projects can bring, and the widespread use of PRINCE2 shows the growing interest for a structured project management approach. PRINCE2 is a flexible project management method and can be easily tailored to all varieties of projects and organizations; it is a public domain methodology, which is free to use. According to Pincemaille and Brien (2008), PRINCE2 is a process-driven project management method; this methodology breaks projects into stages and each stage is managed separately. There are seven processes for managing the project and project stages:

- Starting up a project: The project team is assembled, the project approach is decided and business justification is documented.

- Initiating a project: Project planning work is continued, the project plan, business case, risks, project controls are documented, and the next stage of the project is planned.
- Directing a project: The project board (project sponsors) controls the project, where it involves a series of authorizations, giving ad-hoc direction and confirming project closure.
- Controlling a stage: The project is broken down into stages and each stage is controlled separately.
- Managing stage boundaries: This includes end of stage activities and planning for the next stage. It also decides what should be done for stages that have exceeded tolerance levels.
- Managing product delivery: Managing the acceptance, execution and delivery of project work. Ensures that the work products are delivered to meet expectations and is within tolerance.
- Closing a project: Project wrap up, formally de-commission the project, project evaluation, identify follow up actions.

#### 2.3.3.4 Capability Maturity Model (CMM)

Larson and Gray (2011) claimed that the PMM concept has been presented for the first time in the late 1980s, when the United States government and Software Engineering Institute (SEI) was trying to find a tool for successful software development. The result of these efforts was the CMM, which concentrates on implementation of best practice during the management of an organization's software development projects. It is necessary to say that the CMM model takes a very important place since this model was invented and has spread across various industries. As of today, the CMM model is considered as a predecessor of other existing PMM models in the market.

The CMM is a benchmark for measuring the maturity of an organization's software process and project management maturity (Mateen, 2015). It is a methodology used to develop and refine an organization's software development and project management process. CMM can be used to assess an organization against a scale of five process maturity levels based on certain Key Process Areas (KPA) (Larson & Gray, 2011). It describes the maturity of the organization based upon the project the organization is dealing with and the clients. Each level ranks the organization according to its standardization of processes in the subject area being assessed (Keith, Vitasek,

Manrodt, & Kling, 2015). This model is composed of five maturity levels and they are listed as below:

- Initial level: processes are disorganized, even chaotic. Success is likely to depend on individual efforts and is not considered to be repeatable because processes would not be sufficiently defined and documented to allow them to be replicated.
- Repeatable level: basic project management techniques are established, and successes could be repeated because the requisite processes would have been made established, defined, and documented.
- Defined level: an organization has developed its own standard project management process through greater attention to documentation, standardization, and integration.
- Managed level: an organization monitors and controls its own processes through data collection and analysis after implementing its standardization procedures.
- Optimizing level: processes are constantly being improved through monitoring feedback from current processes and introducing innovative processes to better serve the organization's particular needs.

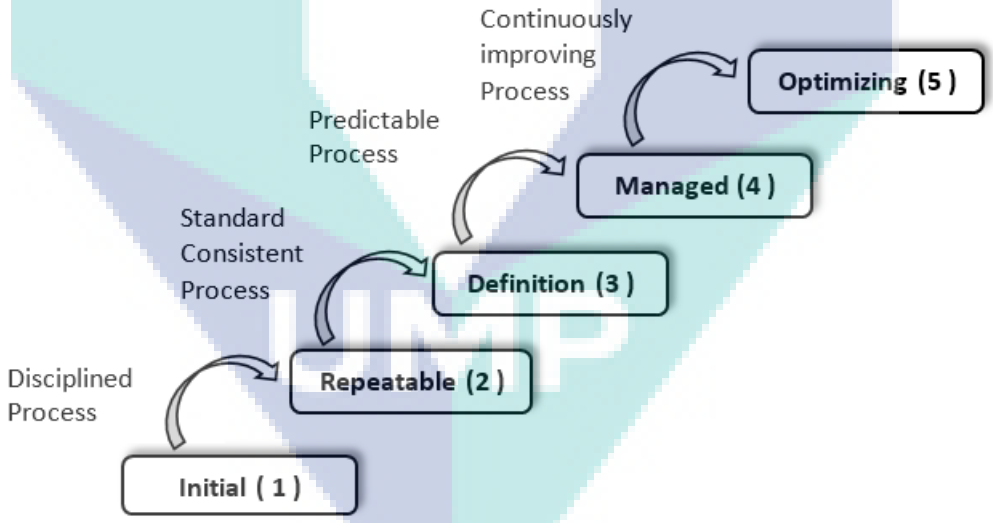


Figure 2.1 The Five Levels of CMM Maturity Model.
Source: Paulk et al., (1993).

Gaál, Szabó, Obermayer-Kovács, Kovács and Csepregi (2011) stated that the maturity models are the result of the application of the life-cycle approach. Each entity develops through the levels over time until it reaches perfection up to the highest level. Two types of maturity models are known –staged and continuous (Farrokh & Mansur, 2013). The CMM is categorized under the staged model. Each key process area indicates

what organizations should focus on in order to improve its process. The maturity model serves as a comparative purpose of use if it allows for internal or external benchmarking (Pöppelbuß & Röglinger, 2011).

#### 2.3.3.5 Project Management Maturity Model (ProMMM)

The Project Management Maturity Model (ProMMM) was developed by PM Professional Solutions Limited, a UK-based project management organization. It is intended for organizations to evaluate their project management process adequacy and compare them to best practices. The model structure originates from concepts from other existing models such as CMM, measuring PMM according to a scale but also emphasizes the importance of organizational culture (Hillson, 2001). It was developed to meet the needs for understanding and determining an organization's project management processes. The basis for ProMMM is practical and pragmatic, based on the empirical experience of its developers in providing project management consultancy across a wide range of industries over many years. More importantly, all of the organizational PMMMs except the ProMMM define a varying number of so-called knowledge areas, i.e. specific areas that the organization must know about in order to gauge maturity (Seelhofer & Graf, 2018).

This model acts as a benchmark for organizational project management capability, describing four increasing levels (naïve, novice, normalized and natural) with defined stages along the way against which organization can benchmark themselves. Many organizations use ProMMM since its original development to introduce effective project management, (Hillson, 2001). ProMMM used a perception-based questionnaire to explore respondents' perception of the degree to which their organization manages projects effectively. There are four attributes i.e., culture, process, experience, and application, to describe each level of ProMMM (Seelhofer & Graf, 2018). By using these attributes, organizations can assess their current maturity level and set a target to achieve next maturity level (Seelhofer & Graf, 2014).

- Naïve: project management is unstructured, repetitive and reactive; experiences are not used to enhance future projects.
- Novice: early adopter to project management knowledge; aware of the benefit of project management although the PM process has not been implemented well.

- Normalized: management of projects and formalization of project management process is widely implemented, but not all cases have excellent results.
- Natural: project management has been internalized in all aspects of the business; the organization adapts project management best practices to gain competitive advantage.

The current PMMMs are an enhanced version based on the process maturity framework that evolved from the Software Engineering Institute's SEI Capability Maturity Model (Backlund et al., 2014; Warrilow, 2009). The SEI experience between 1986 and 1991 indicated that maturity questionnaires provide a simple tool to identify areas where an organization's process may need improvement, but unfortunately, the questionnaire was often regarded as the model rather than a way of exploring process maturity issues. PMM researches indicated that the contribution of PMMMs to organizational improvement and development is somewhat unclear. Therefore, a literature review highlights different aspects regarding PMMM specifically their purpose, advantages, and disadvantages (Backlund et al., 2014).

Based on a literature review, Yazici (2009) emphasized the need for further research on PMM and how this relates to project success. She also stated that organizations should continue investing in PMMMs to improve their maturity levels. Also, the role of project management as a strategic enabler in organizations needs to be further explored (Mullaly, 2006) and there is a need for future longitudinal research to monitor the evolution of PMM (Grant & Pennypacker, 2006). Kwak and Ibbs (2002) stated that future research should continue to focus on increasing the understanding of the PMM and its benefits of project management knowledge areas and processes. This indicates that the status of PMM has not reached its expected perfection level, and that current studies conducted recommend more research on the maturity in project management.

Every developed model has its own advantages and disadvantages to the organizations that will adopt these models. Table 2.5 highlights some of the strengths and weaknesses of the five focused models.

Table 2.5 PMMMs advantages and disadvantages

| Maturity Model | Advantages | Disadvantages |
|---|---|---|
| Organizational Project Management Maturity Model (OPM3) | - Capable to assess organizational maturity at any level.<br>- Multidimensional: can assess project, program and portfolio management maturity of any organization.<br>- Does not have a definite number of KPIs/KPAs.<br>- Does not follow the orthodox notion of staged-representation. | - Not directly designed for IT project management domain.<br>- Not very effective to address IT domain specific issues.<br>- The exact points of transition between its levels are not clear as it tends to be hierarchical. |
| Portfolio, Programme & Project Management Maturity Model (P3M3) | - Creates a reliable P3M (portfolio, programme and project management) capability baseline.<br>- Recognize achievements from previous investments in capability improvement<br>- Compares the organization against accepted maturity levels that can be certified<br>- Enables comparison of capabilities between organizations.<br>- Provides plans for continual progression.<br>- Provides an objective assessment of strengths and weaknesses.<br>- Provides validation of an organization's maturity | - P3M3 does not differentiate between project management success and project success.<br>- P3M3 uses a single number to represent maturity at the project, programme and portfolio level.<br>- The P3M3 model is based mainly on the OGC Project Management Maturity Model. This is a significant weakness because project management focuses on project management success. |
| Project in Controlled Environments (PRINCE2) | - Provides specific roles and responsibilities of the management.<br>- Well-defined path that covers the start, middle, and end of a project.<br>- Well-known approach in private and public sectors.<br>- Serves as a common language to all participants. | - Does not cover people management and contact management assessment.<br>- Heavily document-driven and too bureaucratic.<br>- Not an adaptive method, so is incapable to manage changes and uncertainties easily. |

Table 2.5 continued.

| Maturity Model | Advantages | Disadvantages |
|---|---|---|
| Software Capability Maturity Model (CMM) | - Provides more detailed coverage of the product life cycle.<br>- Provides an opportunity to eliminate stovepipes and barriers.<br>- Valuable to organizations that produce software-only solutions. | - Determines what a process should address instead of how it should be implemented<br>- Does not explain every possibility of software process improvement.<br>- Concentrates on software issues but does not consider strategic business planning, adopting technologies, establishing product line and managing human resources<br>- Does not tell what kind of business an organization should be in.<br>- Will not be useful in a project having crisis right now. |
| Project Management Maturity Model (ProMMM) | - Acts as a benchmark for organizational project management capability.<br>- Allows diagnosis of the current organization position and presents a well-defined target in the next level. | - Less maturity levels compare to other maturity models.<br>- Classification is system-based, not process-based. |

The existing PMM models have been designed as an auxiliary tool to help organizations improve their PMM situation, however, some authors are critical. According to Vergopia (2008), PMM models are often considered as impractical and inflexible, and are increasingly burdensome for the organization's creative decision-making. Some researchers (Neverauskas & Railaite, 2013; Young, Young, & Zapata, 2011) present a critical view to existing maturity models. According to them, the majority of PMMMs are incomplete; they lack a more detailed description of certain elements. Authors writing on maturity models state that their models include all of the processes necessary for successful projects, but contradict by saying that these models lack empirical evidence and, in some cases, a deeper theoretical justification.

Many models are considered disciplinary, impractical and rigid (Farrokh & Mansur, 2013; Vergopia, 2008). Furthermore, models are often viewed as inflexible because of the disciplinary steps they embrace for improvement. They are feared to add to an organization's routine red-tape, making it difficult for an organization to find creative solutions to technical problems (Vergopia, 2008). They further add that by becoming mature, some organizations fear that they will become risk-adverse entities,

afraid to take risky endeavours because they may lose their high maturity rating. In addition, such models are often criticized for their lack of implementation guidance; many organizations are reluctant to start a project management improvement program without mentoring assistance.

This criticism is at the core of many models in the market and especially the five mentioned models. These models do not offer a cognitive means to improve knowledge throughout the organization in order to improve its project management processes and reach higher PMM levels. The models focus on acquiring the "know-what" (what processes need to be acquired and at what level of mastery they need to be at) versus the "know-how" (how the organization learns the new processes, implements them, learns from them, and changes them if necessary to continuously improve their quality) (Vergopia, 2008). Another common criticism of these models is that they are implemented for project management process improvement, and the positive results are often too difficult to measure financially in the overall organizational bottom line. Furthermore, because the results take time to be witnessed and the models can be expensive to implement, some organizations may not perceive their benefits. Besides that, some industry practitioners view these models as additional routine red-tape to their management, reducing flexibility and creativity necessary with many projects by forcing the project execution through a set of predetermined procedural steps (Neverauskas & Railaite, 2013).

Vergopia (2008) stated that this shows the potential for misuse of formal project management systems that are used to impose unrealistic controls and penalties for variances from the pre-planned execution, instead of a means to help improve project management processes. In addition, they also pointed out that implementing such project management process improvement also requires the involvement of different parties, which is not always feasible. Other authors (Andersen & Jessen, 2002) pointed out that the PMMMs are too narrow and strict in nature, and somewhat limited in their scope because their main focus is to categorize organizations versus helping to understand what PMM means for them. Specifically, there seems to be little learning activities based on the results from the PMM assessment, with most focus on information than communication (Fredrik Backlund, Chonéer, & Sundqvist, 2013).

Lastly, if an organization wants to improve its project management processes in order to improve PMM, it can use a PMMM as a guiding tool for what it needs to accomplish, but unless it continuously seeks to learn from its past experience through efficient retrospective project reviews, it will keep on "reinventing the wheel". The lack of emphasis in PMMMs, one of their major weaknesses, is paralleled by the limited amount of research in this area.

To sum up, most of the models discuss improvements in the product development process and the use of technology to facilitate the development process. Some of these models also cover the organizational environment to support the development process. Most of the models mentioned above are still under development, but some of them are being used on a commercial basis and are being evaluated. All the models are easy to use, are user-friendly and how they work can be easily understood. The PMMMs presented above are generally constructed on 5-level maturity system. The Software Engineering Institute (SEI)'s Capability Maturity Model is one of the pioneer reference points for the models. The SEI by developing the CMM stated the 5-level maturity model for the first time. This adds to the reason by Yeong and Lim (2010) for PM-KM integration for more project success. The study proposes an integrated model that combines knowledge management with project management to improve its maturity and thus contribute towards competitiveness and sustainability in higher education institutions in Yemen. However, in order for the organization to transform further, knowledge management must be integrated with project management to respond rapidly to gather information to solve specific problems and share knowledge assets effectively and efficiently (Yeong & Lim, 2010). Another reason for this integration is to come out with new standard measurement tools that assist managers to evaluate the PMM through existing knowledge management capabilities in the institutions. Levin (2010) argued that knowledge management must become an integral part of each project professional's daily project work.

## 2.4 Project Management Body of Knowledge (PMBOK)

The PMI has published its standard for project management practice in a document entitled "A Guide to the Project Management Body of Knowledge". There are several PMBOK editions that have been produced by the PMI. This study focuses on the fifth version of PMBOK, which was published at the end of 2013. Unfortunately, the sixth edition could not be used for this study as the majority of the study and questionnaire was

distributed and collected before the sixth edition was published. The knowledge in this section refers to the operation area covered during project management. PMBOK defines the project management life cycle in terms of five phases or five process groups to use their terminology, which are initiating processes, planning processes, executing processes, controlling processes and closing. Spread across these five process groups are 47 process areas grouped into ten knowledge areas. This edition of PMBOK was chosen among the existing editions as it was the latest one at the time of conducting the research. In addition, this Body of Knowledge edition has also been used in some maturity models like P3M3 and CMM. Table 2.6 shows the list of the 10 project management areas and the 47 processes.

Table 2.6 Overview of project management knowledge areas and processes

| Project Management Areas | Processes |
|---|---|
| Project Integration Management | • The project Charter<br>• Develop Project management Plan<br>• Direct and Manage Project Work<br>• Monitor and Control Project Work<br>• Perform Integrated Change Control<br>• Close Project / Phase |
| Project Scope Management | • Plan Scope Management<br>• Collect Requirements<br>• Define Scope<br>• Create WBS<br>• Validate Scope<br>• Control Scope |
| Project Time Management | • Plan Schedule Management<br>• Define Activities<br>• Estimate Activity Resources<br>• Estimate Activity Durations<br>• Develop Schedule<br>• Control Schedule |
| Project Cost Management | • Plan Cost Management<br>• Estimate Costs<br>• Determine Budget<br>• Control Costs |
| Project Quality Management | • Plan Quality Management<br>• Perform Quality Assurance(QA)<br>• Perform Quality Control(QC) |
| Project Human Resource Management | • Plan Human Resource Management<br>• Acquire Project Team<br>• Develop Project Team<br>• Manage Project Team |
| Project Communications Management | • Plan Communications Management<br>• Manage Communications<br>• Control Communications |

Table 2.6 continued.

| Project Management Areas | Processes |
|---|---|
| Project Risk Management | • Plan Risk Management<br>• Identify Risks<br>• Perform Qualitative Risk Analysis<br>• Perform Quantitative Risk Analysis<br>• Plan Risk Responses<br>• Control Risks |
| Project Procurement Management | • Plan Procurement Management<br>• Conduct Procurements<br>• Control Procurements<br>• Close Procurements |
| Project Stakeholders Management | • Identify Stakeholders<br>• Plan Stakeholder Management<br>• Manage Stakeholder Engagement<br>• Control Stakeholder Engagement |

Source: PMBOK Guide fifth edition (2013).

## 2.5 Knowledge Management (KM)

Knowledge is often defined as a justified personal belief (William, 2009). According to Omotayo (2015), knowledge is the insights, understandings, and practical know-how that people possess. There are many taxonomies that specify various kinds of knowledge. Over the centuries, many attempts have been made to classify knowledge, and different fields have focused on different dimensions. This has resulted in numerous classifications and distinctions based on philosophy.

Knowledge management (KM) is based on the premise that just as human beings are unable to draw on the full potential of their brains, organizations are generally not able to fully utilize the knowledge that they possess (William, 2009). Through KM, organizations seek to acquire and create potentially useful knowledge and to make it available to those who can use it at a time and place that is appropriate for them to achieve maximum effective usage in order to positively influence organizational performance. Before elaborating on KM in-depth, the following section starts with understanding what knowledge is.

Understanding the different forms that knowledge can exist in, and thereby being able to distinguish between various types of knowledge, is an essential step for KM (Frost & Yosuke, 2010). For instance, it should be evident that the knowledge captured in a document would need to be managed (i.e. stored, retrieved, shared, changed, etc.).

Organizations focus their efforts in managing knowledge, which has two major types: tacit knowledge and explicit knowledge.

*Tacit knowledge* tends to reside within the heads of people who have the knowledge and it is difficult to articulate and difficult to put into words, text, or drawings. It is being the most valuable source of knowledge that is most likely to lead to breakthroughs in the organization. It includes cultural beliefs, values, attitudes, mental models as well as skills, capabilities and expertise (Omotayo, 2015).

*Explicit knowledge* represents content that has been captured in some tangible form such as words, audio recordings, or images (Omotayo, 2015). This is the type of knowledge that is most easily handled by a KM system as it forms in databases, memos, notes, documents and others. It is usually contained within a tangible or concrete media. Table 2.7 displays the differences between these types of knowledge.

Table 2.7 Tacit and explicit knowledge

| Tacit knowledge | Explicit knowledge |
|---|---|
| • Knowledge to adapt, to deal with new and exceptional situations.<br>• Expertise, know-how, know-why, and care-why.<br>• Ability to collaborate, to share a vision, to transmit a culture.<br>• Coaching and mentoring to transfer experiential knowledge on a one-to-one, face-to-face basis. | • Knowledge to disseminate, to reproduce, to access and re-apply throughout the organization.<br>• Ability to teach, to train.<br>• Ability to organize, to systematize, to translate a vision into a mission statement or operational guidelines<br>• Transfer knowledge via products, services and documented processes. |

Over the last twenty years, KM-related issues have been widely studied and published regarding knowledge, knowledge management, KM enabler and the processes of the KM, etc. According to Grey (1996), KM is a collaborative and integrated approach to the creation, capture, organization, access, and use of an enterprise's intellectual assets. Brooking (1999) refers to KM as the process by which we manage human centred assets. The function of KM is to guard and grow knowledge owned by individuals, and where possible, transfer the asset into a form where it can be more readily shared by other employees in the company. However, Stankosky (2008) defined KM as the leveraging intellectual assets to enhance organizational performance. In another definition by William (2009), KM is the planning, organizing, motivating, and controlling of people, processes and systems in the organization to ensure that its knowledge-related assets are improved and effectively employed.

Hislop (2013) referred to KM as any deliberate efforts to manage the knowledge of an organization's workforce, where can be achieved via a wide range of methods including directly, through the use of particular types of ICT, or more indirectly through the management of social processes, the structuring of organization in particular ways or via the use of particular culture and people management practices. Organizations which decide to significantly invest in project KM can gain a competitive advantage in their branch (Spalek, 2014). However, efficient KM maximizes internal efficiency, profitability and ensures competitive advantage to the organization (Terzieva, 2014).

### 2.5.1 Knowledge Management Capabilities (KMC)

To compete effectively, organizations must leverage their existing knowledge and create new knowledge that favourably positions them in their chosen markets. In order to accomplish this, absorptive capacity must be developed in the organizations for the ability to use prior knowledge to recognize the value of new information, assimilate it, and apply it to create new knowledge and capabilities.

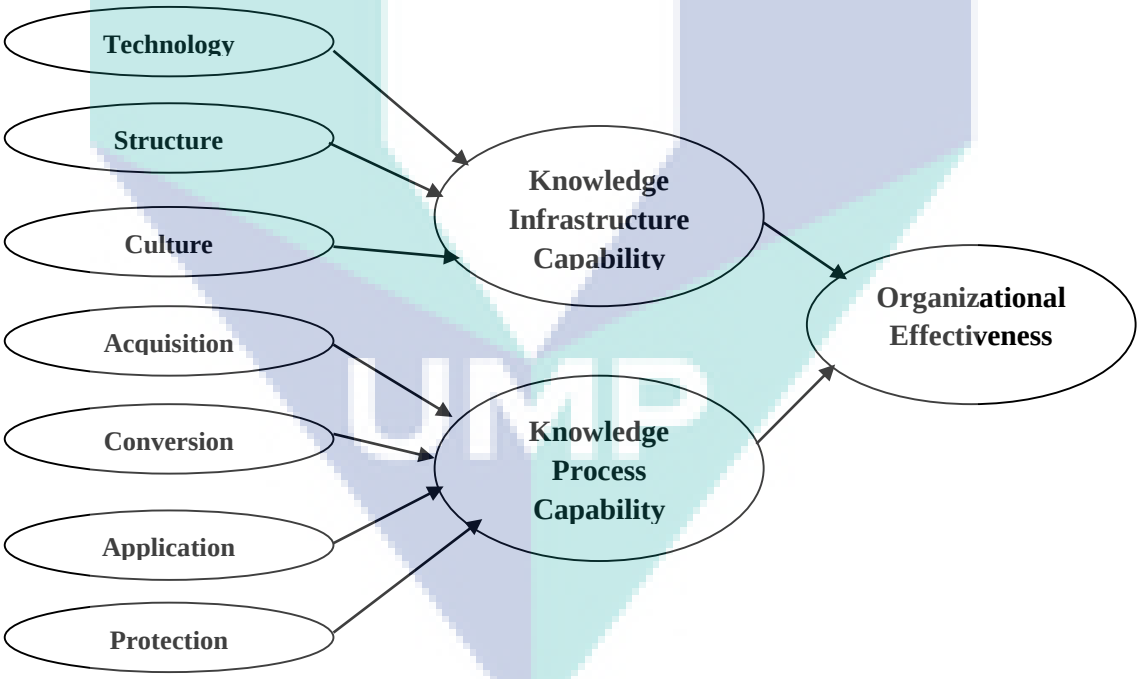


Figure 2.2 Knowledge management capabilities model

Source: Gold et al. (2001)

Gold et al. (2001) developed a model of KM based on the capabilities perspective. They refer to three key infrastructure capabilities, i.e. technology, structure, and culture, which enable the maximization of social capital, or the so-called intangible capital. In

order to leverage infrastructure, KM processes must also be present in order to create, store, transform, and transport knowledge throughout the organization.

These processes enable the organization to capture, reconcile, and transfer knowledge in an efficient and protected manner. Together, the perspectives of infrastructure and processes provide a useful theoretical foundation for defining important aspects of knowledge effectiveness in organizations (Zaied, Hussein, & Hassan, 2012).

The justification of choosing these capabilities was based on Paisittan, Digman and Lee (2009) who stated these two kinds of knowledge capabilities are explored and interrelated and are recognized elements for an organization's competencies. The first type is the knowledge process capabilities (KPC), which is the capability of a process to transform knowledge that is stored in the form of standard operating procedures and routines throughout the organization into valuable organizational knowledge, experience, and expertise. The second type is the knowledge infrastructure capabilities (KIC), which is the capability to manage infrastructures like the technology, structure and culture in the organization to support and facilitate organizational activities and maket use of the knowledge. According to Paisittan, Digman and Lee (2009) and Zaied, Hussein and Hassan (2012), these two capabilities constructs as the main elements of KM are believed to contribute to strategy implementation effectiveness, which could also include the implementation of project management strategy as of the importance of this study.

#### 2.5.1.1 Knowledge Process Capabilities

This section elaborates the actual knowledge management processes that are related to assess PMM and lead to organizations success (Gold et al., 2001). So far, these processes are knowledge discovery/detection, knowledge organization and assessment, knowledge sharing, knowledge reuse, knowledge creation and knowledge acquisition. According to Forst and Yosuke (2010), these form the backbone of knowledge management processes as they outline all aspects involved in the actual management of knowledge. Rahman and Hassani (2011) mentioned four knowledge processes (i.e. acquisition, conversion, application, protection) that could result in a successful organization's performance if they are managed efficiently. Isaac, Kapkiyai and Joywin (2015) found that the four selected knowledge processes had a positive and significant

effect on organizational performance, and this could be the justification for this study to choose these processes to attempt integration with project management.

Thus, KM processes help organizations build knowledge as a strategic resource, which along with infrastructure capabilities will drive knowledge effectiveness, organizational performance and reach the highest project management maturity level. The processes of the KM lifecycle approach relate to the fact that organizations utilize internal and external sources of knowledge. This knowledge must be made available to the people concerned in the organization.

The main focus of the knowledge processes is to facilitate the flow of knowledge between individuals and consequently teams, and the major challenge for any KM initiative is to facilitate these flows so that the maximum amount of transfer occurs (Singh Sandhawalia & Dalcher, 2011). The KM cycle starts with creation and/or acquisition of knowledge, which has to be organized, mapped, and/or formalized to transform it into a reusable form. It has to be made accessible to people, or disseminated and/or shared with everyone in the organization. Finally, it has to be applied, used, reused, and/or exploited to achieve organizational benefits and make sure it is protected. Gold et al. (2001) have grouped them into four broad dimensions of process capability: acquiring knowledge, converting it into a useful form, applying or using it, and protecting it. Acquisition, conversion, application and protection are identified as the dimensions of process capability.

**Knowledge Acquisition:** The acquisition process is oriented towards obtaining knowledge for the project's purpose. However, prior to acquisition, an organization must know the knowledge it has within it in some form or other, along with the knowledge gaps. Along with knowing the current position, an organization should make efforts to acquire knowledge and create new knowledge by using processes and tools for the same knowledge (Bharadwaj, Chauhan, & Raman, 2015). Many terms have been used to describe these processes: acquire, create, capture, and collaborate. All these terms have a common theme of the accumulation of knowledge. Innovation, another aspect of acquisition, is the creation of new knowledge from the application of existing knowledge during the project life cycle. However, improved use of existing knowledge and more effective acquisition of new knowledge is also a key aspect of knowledge creation (Brix, 2017). These processes take place simultaneously rather than in a sequential manner.

Creating organizational knowledge requires collaboration of personal experiences working there; it involves many instances where critical information must be accurately communicated (O'Daniel & Rosenstein, 2015). The collaboration takes place at two levels within the organization: between individuals themselves and between the organization and its network of business partners. Collaboration between individuals brings together individual differences like cognitive style, preferred tools, and backgrounds and experiences to create knowledge in the organization during their project interactions. The interaction between the individuals will promote learning and collaboration between individuals (White & Cicmil, 2016). However, the ability to acquire knowledge is partly based on an organization's absorptive capacity.

**Knowledge Conversion:** The conversion process is oriented towards making raw knowledge convertible into a usable shape and can be used by the project team members available at a central location and is easily accessible by everyone in the organization. Some of the processes that enable knowledge conversion are the organization's ability to organize, integrate, combine, structure, coordinate and store knowledge. The knowledge conversion process was accelerated, and the team members utilized their personal knowledge to stimulate group/team discussions (Brix, 2017). An organization must develop a framework for organizing or structuring its knowledge. Without common representation standards, consistency or common dialogue of knowledge would not exist. This would make it difficult to manage the asset effectively. Knowledge about a particular subject may reside in different parts of the organization or in different systems within the organization. Combining or integrating this knowledge reduces redundancy, enhances consistent representation, and improves efficiency by eliminating excess volume.

Thus, it is important for organizations to store and convert knowledge in a user-friendly, easily accessible form. Explicit knowledge can be stored as best practices or lessons learned. For tacit knowledge, the conversion process makes available corporate portals to access the expertise locator system (Nawab, Nazir, Zahid, & Fawad, 2015).

**Knowledge Application:** The project knowledge application process refers to the process of application among the employees in an organization and can be considered as the core task of KM (Rabbi, Zandi, & Farrukh, 2015). Many organizations may just hoard the knowledge, thinking that people will access the same and use it. For quick and easy access and sharing of knowledge, there should be effective retrieval mechanisms. For

explicit knowledge, the web portals and organization intranet can play a crucial role to share the latest and updated knowledge regarding the project's progress. Knowledge is effectively applied during the developmental processes of an organization through rules and directives, routines and self-organized teams (Singh Sandhawalia & Dalcher, 2011).

Using text mining techniques to mine relevant knowledge is characteristic of project knowledge application of unstructured knowledge. Using intelligent agents to actively build user profiles and push appropriate lessons learned and material to the user is another way of project knowledge application. Chat rooms, bulletin boards, online communications, communities of practices, etc., on the organization's intranet also facilitate knowledge sharing (Bharadwaj et al., 2015). However, for tacit knowledge sharing, the project knowledge application process makes available corporate to access the expertise.

**Knowledge Protection:** The knowledge protection process is oriented towards the protection of knowledge in the organization. Ghosh and Scott (2007) stated that knowledge must be protected from inappropriate use inside the organization by using logins and authentication to access systems. However, knowledge is protected from inappropriate use outside the organization when sensitive information is requested from other parties in the organization (Bharadwaj et al., 2015). As knowledge can be created and shared easily in decentralized ways on the Web, the question of securing knowledge and protecting knowledge from "spilling over" needs to be considered (Razmerita, Phillips-Wren, & Jain, 2016), such as restricting access for organizations' employees to maintain knowledge confidentiality, protect employees' identities in order to sustain sharing of embedded knowledge and to establish the importance of protecting knowledge within the organization from any authorized access. Therefore, it would be pointless for organisations to innovate and create new and unique knowledge, yet fail to protect this knowledge (Tshuma, Steyn, & Van Waveren, 2018).

#### 2.5.1.2 Knowledge Infrastructure Capabilities

**Technology:** According to Gold et al. (2001), technology as an infrastructure component comprises a crucial element of the structural dimension needed to mobilize social capital for the creation of new knowledge. Project-related technology is able to overcome the barriers of time and space that would otherwise be limiting factors in KM

activities. It also serves as a repository in which knowledge can be reliably stored and efficiently retrieved. Information technologies like e-mail, repositories, intranet portal, teleconferencing, and the activities of mentoring, collaboration and training play a key role in transferring knowledge (Singh Sandhawalia & Dalcher, 2011).

The entire technology infrastructure used in organizational knowledge management systems (OKMS) is tangible and acts as an enabler to facilitate KM initiatives in the organization. According to Bharadwaj, Chauhan and Raman (2015), the technology infrastructure comprises the hardware, software, middleware and protocols that allow for the encoding and electronic exchange of knowledge.

Project-related technology infrastructure provides the base or platform upon which KM solutions are built. It consists of the repositories for unstructured data (document and content management) and structured data (data warehousing, generation, and management). According to Yeh, Lai and Ho (2006), IT that supports and coordinates project are databases, knowledge platforms, performance evaluation management system, and integrated performance support system. They believe that IT plays four different roles in KM: i) Obtaining knowledge; ii) Defining, storing, categorizing, indexing, and linking knowledge-related digital items; iii) Seeking and identifying related contents; and iv) Flexibly expressing the content based on the various utilization backgrounds.

The organizational knowledge management systems (OKMS) today employ one technology or a combination of several key technologies like groupware, messaging, web browsers, document management, search and retrieval, data and text mining, visualization, push technology, group decision support, and intelligent agents. Knowledge portals like the internet and intranet are the most common infrastructure and play an important role in KM and project management (Rabbi et al., 2015).

**Organizational Structure:** The organizational structure plays an important role in the day-to-day functioning of the organization. The structure supports projects as the dominant form of business. Each project is treated as a separate and relatively independent unit within the organization. (Nahod & Radujkovic, 2019). Gold et al. (2001) defined the project organizational structure as the rules, policies, procedures, and processes, hierarchy of reporting relationships, incentive systems, and departmental boundaries that organize designs within the organization.

Organizations most frequently group their employees based on knowledge and skills, work process and function, time, output, client, or place. An organization's structure is largely determined by the variety one finds in its environment. The project-based organizational structure's capability for facilitating the flow of knowledge is shaped by an organization's policies, processes, and system of rewards and incentives, which determine the channels from which knowledge is accessed and how it flows (Singh Sandhawalia & Dalcher, 2011).

Project-based organizational structure has several definitions; here, it is the specification of jobs to be done within an organization and the ways in which those jobs relate to one another. According to Gold et al. (2001), project-based organizational structure is the second most critical factor for successful KM implementation. Hasanali (2002) highlights structure as one among five critical success factors for knowledge management. Organization structure is an important infrastructure to teamwork, which plays a facilitating and steering role in developing the culture of knowledge (Pandey & Khare, 2012). If the organization structure is matrix-based as opposed to a bureaucratic hierarchical base, it encourages teamwork. A flexible structure would allow the formation of ad hoc cross-functional teams in which experts from different departments can be gathered to ease the flow of ideas across departments or provide venues for employees to communicate informally.

**Organizational Culture:** In general, culture is defined as a complex whole which includes knowledge, belief, art, morals, law, custom, and any other capabilities and habits acquired by humans as a member of society (Bharadwaj et al., 2015). Since then, many authors have defined organizational culture as the combination of value, core belief, behaviour model, and emblem. It represents the value system of the company and will become the employees' behaviour norm. Every organization's culture is an independent entity, different from any other organization (Yeh et al., 2006). Culture plays a vital role in the success or failure of project management (Nguyen & Watanabe, 2017).

The organizational culture is very important in leveraging PM with KM. It has been considered both as a facilitator and a hurdle/barrier for effective PM/KM. The culture of an organization has a key influence on both domains, more specifically on the effectiveness of knowledge in an organization. In addition, for knowledge culture, it is only specific for its own where it is defined as a type of organizational culture that

influences the KM processes. Rabbi, Zandi and Farrukh (2015) stated that it is the culture that determines which knowledge to be shared, with whom it could be shared and when it should be shared.

In the KM literature, a wide array of factors and concepts are cited as influencing elements for the creation and development of knowledge culture. Employee interactions should be encouraged, both formally and informally. This type of interaction and collaboration is important in shaping organizational culture conducive for PM. Instances like sharing information freely, working closely with others, and developing friends at work relate to interaction and collaboration. Many authors have defined a form of interaction where experienced workers or managers transfer knowledge to new or less experienced workers as part of their organization's culture. Al-Alawi, Al-Marzooqi and Mohammed (2007) refer to the communication between staff measured by a high level of face-to-face interaction, use of common language, and teamwork discussion and collaboration as constituents of a knowledge enhancing culture. After reviewing and discussing the KM capabilities in general, the next section will cover how the project management took place with knowledge management in the higher education institutions in Yemen.

## 2.6 PM and KM in Higher Education Institutions

While an acceptance of more structured KM and project management principles is becoming more of the norm than the exception in the organizational environment, formal project management methodologies and KM procedures are just beginning to gain a foot-hold within higher education institutions. Austin, Browne, Haas, Kenyatta, & Zulueta (2013) stated that the project management methodology currently has widespread and successful utilization in the construction industry and health care environments. The use of formal, structured project management is lacking in higher education as well as how project management and successful leadership will benefit the field and higher education institutions.

Creating an academic institution using both KM and project management can then lead to academic depth and breadth far beyond the imagination of a professional organization. Thus, Austin et al. (2013) in their study recommended for future research to further prove the importance of implementing project management in higher education

institutions and that would contribute to effective, efficient and timely delivery of product and services to their users – the faculty, staffs and students.

It is apparent that large sums are being spent by institutions of higher education on many varied project management initiatives in an effort to meet the many challenges they face during their ongoing project development. According to Johnston and Wierschem (2007), all these "projects" must be managed, but how they are managed is not clear and project teams manage these projects without any prior scope planning. They all stated in their study that a review of existing literature fails to show whether the institutions of higher education and especially their IT project departments have responded as enthusiastically as businesses to the call for the application of sound project management practices to new projects. Somehow, Austin et al. (2013) added that there appears to be a dearth of research that specifically addresses the lack of formal project management in HEIs. Overwhelmingly, researchers have chosen to discuss project management as it relates to IT departments and IT functions within universities and no other departments in the universities. This indicates that the current research in project management is not fully covered by the higher education itself; it is only covered by department.

Johnston and Wierschem (2007) simply stated that the current status of project management activities in the institutions of higher education is largely unknown, especially on the IT department that is responsible for major IT projects in these institutions. Therefore, it is useful to determine PM practices in academic environments in order to understand the current situation and to make recommendations for appliance and as well for additional research. Puzziferro (2012) recommends higher education leaders to have an excellent understanding in regulatory rules, legal interpretations and compliance, and this understanding must be on project management and how it will help institutions achieve and deliver the projects. The higher education institution leaders will need to be knowledgeable in project management practices as they are related and responsible for the institution projects.

From the previous sections, researches (Austin et al., 2013) show that there is a lack of project management use in higher education institutions compared to other industries like healthcare and construction. It is a new term, and leaders of these institutions are not fully knowledgeable on how project management will increase the

project sufficiency if it was supported or integrated with KM in the institution, especially in Yemen.

KM is a fairly new field, and experiments are just beginning in higher education. There is tremendous value to higher education institutions that develop initiatives to share knowledge to achieve business objectives (Laal, 2011). KM principles recognize that it is important for higher education institutions to know what they know in order to achieve what they want. All institutions inherently store, access, and deliver knowledge in some manner, and educational institutions are no exception. Effective KM identify and leverage the know-how embedded in an institution's projects, with a focus on how it will be applied. The challenge in KM is to make the right knowledge available to the right people at the right time (Kidwell, Vander Linde, & Johnson, 2000).

In current higher learning institutions, research and conducting proper project management practices are the key for knowledge creation and knowledge dissemination. The higher learning institutions are no longer just providing knowledge to the students from lectures, but are also starting to manage and collaborate the existing knowledge for future reference and project management enhancement. According to Bhusry and Ranjan (2011), KM in higher educational institutions aims at integrating the knowledge produced at all levels and using it towards the institute's goals and targets. They also stated that this would have the implications of improving the operational quality, capacity development and effectiveness of the organization, leading to enhanced productivity and performance. KM in educational institutions makes good sense and a good combination of intellectual output of the academic organization if preserved well using technology (Dhamdhere, 2015).

The present complex knowledge environment in these institutions requires constant evolvement, innovation, investigation, analysis, prediction and response to opportunities and threats, which may harm or improve the project management in these institutions. All institutions store, access, and deliver knowledge in a unique manner; the differing factor is the way that value is added to the products and services they deliver by the effective use of the knowledge capital. According to Nawaz and Gomes (2014), universities have to avoid unrelated activities of knowledge, and their staff have to recognize and respond to their changing role in a knowledge-based society. In addition, they have to understand how KM can support and enhance project management. They

even urge that the universities need to consciously and explicitly manage the processes associated with the creation of their knowledge assets, and to recognize the value of their intellectual capital to their continuing role in society, and in a wider global marketplace for higher education. However, higher education institutions have started the implementation of KM to create effective learning atmosphere as well as support the institutions with their current and future projects. It enhances their knowledge to support their mission (Nawaz & Gomes, 2014).

## 2.7 The Theoretical Foundation

Once it comes to integrating KM into PM, knowledge management is a multifaceted, emerging discipline that can be examined from many perspectives. This study intends to assess PMM through KM capabilities in higher education institutions in Yemen in the context of knowledge-integration (Grant, 1997; Grant, 1996a), organizational capability (Gold et al., 2001), and social capital (Nahapiet & Ghoshal, 1998). These disciplines evolved from early economic-based theories of the firm, which later developed into a resource-based view of the firm. A more focused view stemming from the resource-based view is the knowledge-based view of the firm.

The research model adopted for this study is the organizational-capabilities-perspective theory developed by Gold et al. (2001), which is the theory of knowledge management effectiveness from the perspective of organizational capability. This theory is grounded in social-capital theory, knowledge-integration, and the knowledge-based view of the firm. However, the theory is built on two fundamental concepts of social-capital (its role in creating intellectual assets) and knowledge-integration (its role in creating knowledge synthesis). Gold et al. (2001) provided a definition and empirical context for assessing knowledge management from the perspective of organizational capabilities that lead to improved business performance, as measured by organizational effectiveness. This study measures the level of project management maturity.

### Social Capital

For an organization to use knowledge as a resource or capability, it must develop an absorptive capacity —a concept introduced by Cohen and Levinthal (1990), meaning the ability to value, assimilate, and apply knowledge to create new knowledge. Creating new knowledge requires the presence of social capital (Gold et al., 2001; Grant, 1997;

Nahapiet & Ghoshal, 1998). In the context of knowledge management and project management, the idea of the social-capital theory is that the social interactions of people become a resource for creating and storing collective knowledge (Nahapiet & Ghoshal, 1998), especially during PM processes and activities. Social capital is the collective sum of resources that are held in, accessible through, and derived from a network of social relationships (Nahapiet & Ghoshal, 1998). From the perspective of the social capital theory, Grant (1996b) argued that the firm's collective knowledge resources that are networked, linked, and transferred to the organization define organizational capability. The seminal work of Grant provided the framework for defining the process of knowledge integration (Anderson, 2009).

**Knowledge Integration**

According to Spender (1996), knowledge can be held by individuals as well as collectively by the organization. Collective knowledge exists when the efforts of people with complementary skills are combined (Anderson, 2009), and through the process of knowledge integration, that collective knowledge is transformed to the organization (Grant, 1996b; Nahapiet & Ghoshal, 1998). Organizations with better knowledge-integration processes will have stronger knowledge management capability (Grant, 1997; Huang & Newell, 2003), making them better equipped to sustain competitiveness (Chuang, 2004; Grant, 1997). Thus, using this theory for integrating knowledge can be considered as a usable asset to the organization.

**The Knowledge-Based Theory (KBT)**

The knowledge-based theory of the organizations considers knowledge as the most strategically significant and important resource of the organization. Its proponents argue that because knowledge-based resources are usually difficult to imitate and socially complex, heterogeneous knowledge bases and capabilities among organizations are the major determinants of sustained competitive advantage and superior corporate performance (Decarolis & Deeds, 2006).

The knowledge is embedded, carried and transferable through multiple capabilities including organizational culture, structure, information technology and employees. In the knowledge-based view, the knowledge infrastructure capabilities are treated as a finite traditional stock and investment, which must be replenished after it is

depleted and which contributes to achieving competitive advantage and getting higher project management maturity, primarily by depriving other institutions that have the same knowledge they have. Grant (1996b) in one of his articles took strong steps towards KBT, suggesting the following four points:

- Organizations apply knowledge to the production of goods and services.
- Knowledge represents the most strategically valuable resource of an organization.
- Individuals create and hold knowledge, not organizations.
- Organizations exist because of the high costs involved with markets attempting to coordinate the knowledge of an individual specialist.

From the overview of several researchers (Decarolis & Deeds, 2006; Grant, 1996b; Spender, 1996) on the knowledge-based theory of the organizations, sustained competitive advantage and superior corporate performance were seen to be realized if the organization has specific assets (knowledge-based resources and capabilities) which are usually difficult to imitate.

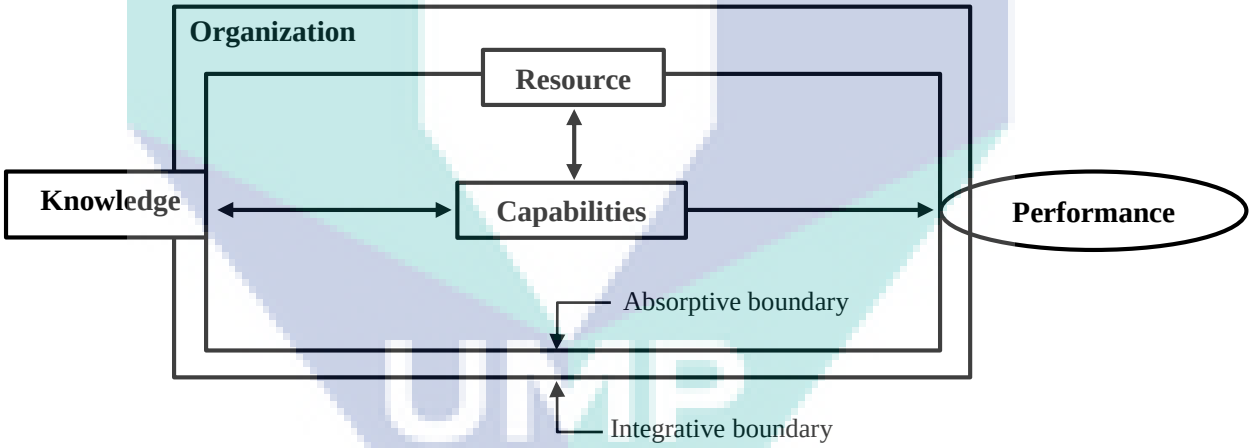


Figure 2.3 Knowledge-based view of the organization
Adopted from Kaplan et al. (2001)

However, the knowledge-based view of the organization designed by Kaplan, Schenkel, Von Krogh and Weber (2001) is an adequate approach to understand the relationship between its capabilities and performance; in this case, it can be applied to its project management maturity. Figure 2.3 indicates that the knowledge-based view proposes that an organization's unique knowledge is the key source of competitive advantage, allowing it to combine conventional resources in distinctive ways and provide

superior value to stakeholders. After identifying the theory of this research, the next section will address how KM and PM are integrated from different authors' perspectives, leading to the theoretical framework and proposed model integration for this research.

## 2.8 Integrating Knowledge Management with Project Management

### 2.8.1 KM & PM Integration Model by Yeong and Lim (2010)

This model has introduced the intervening factors that may influence KM and project management which are culture, process and technology. Yeong and Lim suggested that these factors may affect both KM and project management, which have a direct influence on the enhancement of a project's success. In a study undertaken by Yeong and Lim (2010), it was found that organizational culture, KM process and technology provide strong support for effective knowledge sharing in organizations. The main components of KM including technology, processes and organizational culture were covered in this model.

From their developed model, culture, technology and process may influence project management practices in the organization, which in turn affects the chance of project success. They furthermore focused on organizational culture and the use of new technology as well as the process that focuses on the quality of the project's deliverables. In the model, the culture factor is the most significant problem in international projects. The dimensions of cultural difference according to Yeong and Lim (2010) are as follows:

- Uncertainty avoidance.
- Power distance.
- Individualism.
- Masculinity.
- Role of time.
- Consideration of detail.

It was suggested that appropriate project team members and project managers should be selected to accommodate cultural differences in not just the local conducted project and the international projects. Yeong and Lim gave full attention to culture as it is important to most project environments and not just international projects. They mentioned the process in their model as the process in a project environment known as a

structured set of activities designed to accomplish a specific organization's objective. A process has several defined inputs to turn them into defined outputs which are the deliverables of a project (Office of Government Commerce, 2010b). There are two versions of the process (Liebler & McConnell, 2011; PMI, 2013; Turner, 2009):

- Processes derived from the work of Henri Fayol (1841-1925): Plan, organize, implement and control.
- Processes according to the PMBOK Guide 2013: Initiate, plan, organize, execute, control and close.

The notion of processes is similar to the phases in a project lifecycle, and the management of process has a significant effect on a project's success. Thus, process is one of the three key factors that affect the project environment and in turn project success in their model.

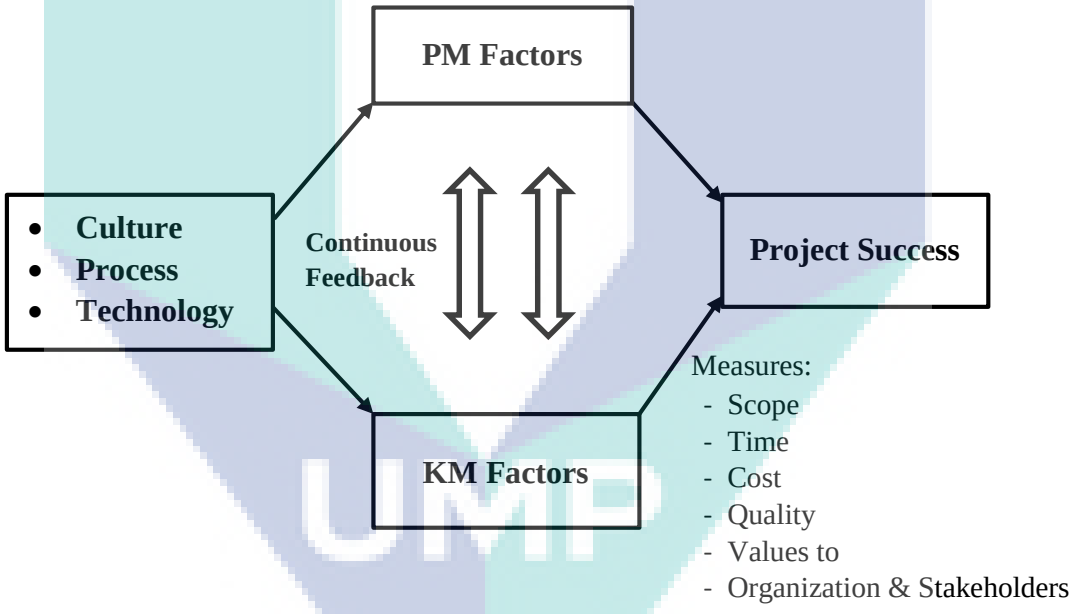


Figure 2.4 Yeong and Lim proposed KM/PM integration model
Source: Yeong & Lim (2010)

They also suggested that project managers should continuously provide feedback that align with the existing knowledge in the repository and newly created knowledge from the projects to enhance project success. This could be done by building the process of the project lifecycle and holding regular discussions to share knowledge with all project members and stakeholders.

The purpose of their study and proposed model is to understand the integration of KM with project management to enhance project success in organizations. It is important to understand how knowledge could be created via projects and how the knowledge is transferred to other project team members in the form of tacit and explicit knowledge. It is assumed that continuous feedback and alignment of knowledge in the project lifecycle as well as knowledge sharing among the project team members is essential for enhancing the success of a project.

### 2.8.2 KM & PM Integration Model by Handzic and Durmic (2015)

Handzic and Durmic (2015) developed a new conceptual model that introduced the combined factors from both KM and PM in a way that can increase the rate of project success in an organization. Their proposed model is presented in Figure **2.5**.

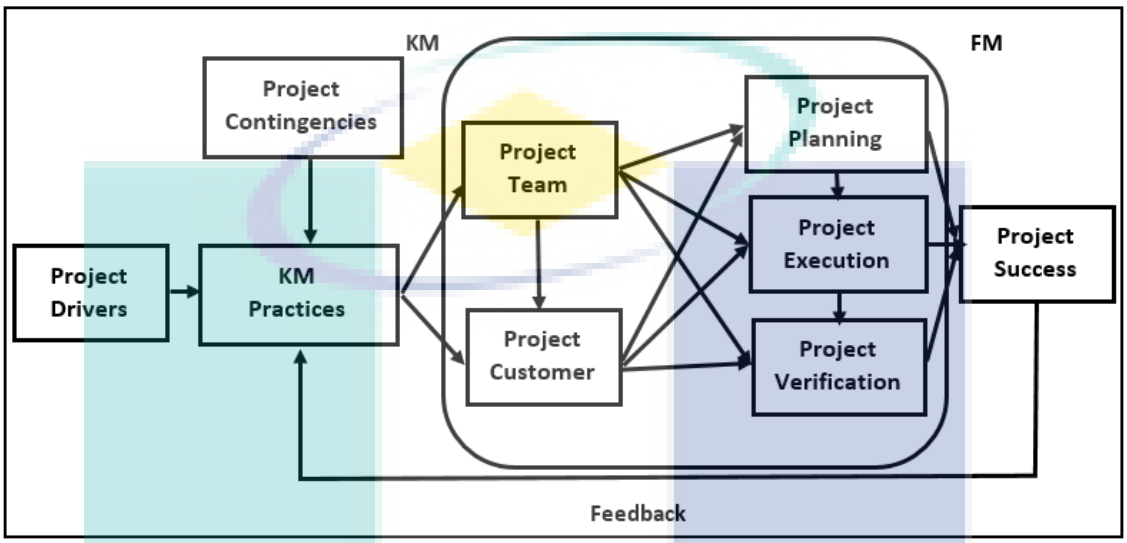


Figure 2.5 Handzic and Durmic proposed KM/PM integration model.
Source: Handzic & Durmic (2015)

Ten interrelated model components derived from KM and PM frameworks were included in the model. From KM, the proposed model adopted contextual contingencies and drivers of KM, as well as socio-technical knowledge enablers and processes. From PM, the model adopted people (project team and user), processes (project planning, execution, verification) and outcome (project success) elements. They suggested that the knowledge stock element from KM is merged with people elements from PM. Similarly, outcome elements from KM and PM were merged into one and the same outcome for a project's success. Their proposed model recognizes that various motivational forces and contextual contingencies drive and influence the choice and application of KM practices in PM, thus indirectly influencing the project's process. Transfer of tacit knowledge via mentoring and explicit knowledge via documenting are the most two frequent practices. The model further proposed that KM practices in terms of various socio-technical knowledge enablers and knowledge processes foster the development of the project team's competencies and relationships with project users.

Next, the model proposes that the project team and project customer jointly influence the project's processes. Thus, in the proposed model, the project process (as a

structural capital) represents a key factor that can enhance project quality and success. Finally, the model proposes a feedback loop to indicate the need for continuous development of both tacit and explicit knowledge assessed in the project environment. As these models discussed and explained how KM is merged with project management, below is a table that indicates the weaknesses and strengths of each model.

Table 2.8 Models strengths and weaknesses

| KM and PM Integrated Models | Strengths | Weaknesses |
|---|---|---|
| Young & Lim Model | - Integration of knowledge management with project management to enhance project success in organizations.<br>- Project managers should continuously give feedback and align existing knowledge from the repository and newly created knowledge from the projects to enhance project success.<br>- Emphasizes the need for continuous feedback and alignment of knowledge in the project environment. | - Future research could include a study of the capture and sharing of existing knowledge and new knowledge in all phases of the project lifecycle.<br>- Did not focus on all the knowledge processes and the knowledge infrastructure. |
| Handzic & Durmic Model | - Model adopted contextual contingencies and drivers of KM, as well as socio-technical knowledge enablers and processes.<br>- Outcome elements from KM and PM are merged into one and the same outcome (project success).<br>- Model proposes that the project team and project customer jointly influence the project processes.<br>- Model proposes a feedback loop to indicate the need for continuous development of both tacit and explicit knowledge assesses in the project environment. | - Did not focus on all the knowledge processes and the knowledge infrastructure.<br>- Driven from a developed model in integrating KM, PM and Intellectual Capital. |

Both models have the same target and scope that show the ideology of integrating KM with project management. Both models only mentioned some of the knowledge enablers in the organization and not all of the enablers or knowledge management capabilities. Some researchers (Handzic & Bassi, 2017; Yeong & Lim, 2010) suggested that a research could be conducted in the future to study the capturing and sharing of existing knowledge and new knowledge in all phases of the project lifecycle. This means they did not include the knowledge process capabilities in their research.

The two models proposed a feedback loop to indicate the need for continuous development of both tacit and explicit knowledge assessed in the project environment and in order to evaluate the improvements. This is a strength for the two models. Handzic and Durmic's model was not developed purely to integrate the KM with PM, but it was structured to integrate knowledge management, intellectual capital and project management. In general, these two models contributed to both KM and PM disciplines. They provided a foundation to conduct further research to understand how project success might be achieved via integrating knowledge management and project management, so the proposed model in this thesis will cover the existing gap in these models that integrate KM with PM through knowledge management capabilities.

The following explores the contemporary literature on integrating KM and PM to improve its maturity in the organization and bridge the literature gaps that integrate and merge KM with PM in order to gain the highest PM maturity level based on measuring the organization's KM capabilities.

### 2.8.3 KM and PM research gap analysis

According to Ismail, Nor and Marjani (2009), despite the extensive literature on knowledge sharing, little is known about how individuals in the organizations create, share and protect knowledge, especially in a project environment. They proposed a theoretical framework as shown in Figure 2.8, which indicates that providing appropriate motivators and removing relevant inhibitors to share knowledge and experience would result in more efficient and effective sharing of knowledge in projects, which in turn would lead to an increased probability of project success. Their model suggests that there are significant relationships between effective project knowledge sharing practice and project success. Their study and model focused abundantly on the socialization of tacit knowledge in the organization and how this knowledge can be applied and used in PM and especially in higher education institutions, which is currently a gap in most project environments in these institutions. The authors concluded that ensuring when and how tacit and explicit knowledge is shared during the processes of the project management is an essential demand to enhance project success (Ismail et al., 2009). Also, using KM processes and infrastructure capabilities is one of the most effective reasons for project success in the higher education institutions.

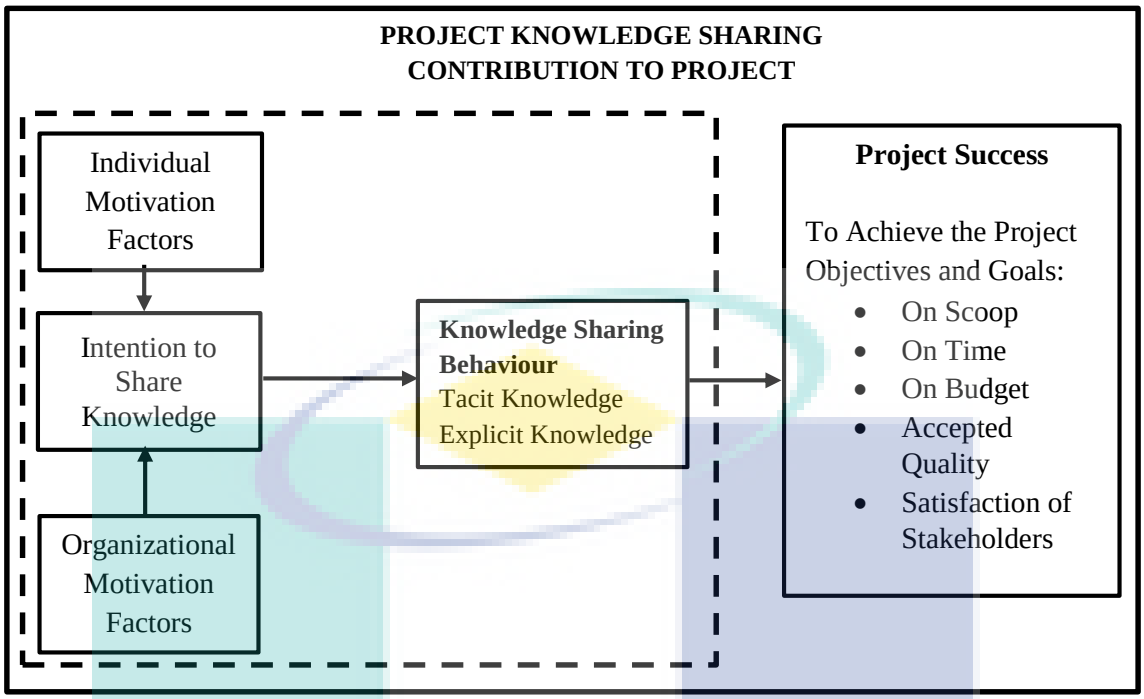


Figure 2.6 Proposed theoretical framework for project knowledge sharing contribution to project
Source: Ismail et al., (2009).

Cope III, Cope and Hotard (2006) also suggested that KM is a practice that makes sense to improve project management. They state that if the knowledge in both tacit and explicit forms could be captured and shared within the project management community, organizations would benefit a lot. If higher education institutions take this into consideration, they could fill in the existing research gap by improving their project management activities using their limited and available KM capabilities, especially the higher education institutions in Yemen.

From the conducted research gap analysis, it was noted as was stated by Lierni and Ribière (2008) that very few academic publications focused on the role of using KM to improve the management of projects. Also there are a very few academic researches covering the involvement of KM on PM in higher education institutions. Lierni and Ribière (2008) concluded that it is reasonably certain that project managers perceive the use of knowledge management practices as a positive influence on the management of projects. The most frequently adopted knowledge management practices to help project managers are: sharing repository of project artefacts, lessons learned and best practices repositories, and document and content management systems. Lierni and Ribière (2008) proposed that in the project environment, knowledge comes primarily from explicit

knowledge sources but project managers could strongly benefit from sharing and codifying tacit knowledge associated with the management of former projects.

Owen (2008) in her study proposed a model that knowledge is created, transferred, captured and reused within a project, and as a result will increase project management maturity. She provided a structure to link project/program management to knowledge management and mutually exploited both in Figure 2.7. For the projects in higher education institutions, she stated that a project could be defined as a task where knowledge is created as the result of the activities that are carried out by project teams. Project team members create, transfer, and reuse knowledge created from the tasks and phases of the ongoing projects. Her framework suggested that project team members will be able to conceptualize the task, and reuse and apply past knowledge and experiences for using them in current projects, especially the projects, which are planned and managed by the project management team in the higher education institution. This framework is considered as an immense model, which may assist higher education institutions to fill in the gap by involving KM in PM in their projects.

Owen's framework shows how knowledge is developed at the task level, which is embedded into the project methodology in the project environment and eventually improves the capability of an organization as well as higher education institutions. She suggests that both tacit and explicit knowledge is embedded throughout the project lifecycle and phases. Tacit knowledge is captured and reused at the project level in the form of personal knowledge contributed by the project team members. Tacit knowledge is transferred and reused via mentoring from project members with more experience. Explicit knowledge is reused in terms of project documentation captured during the project lifecycle (Yeong & Lim, 2010).

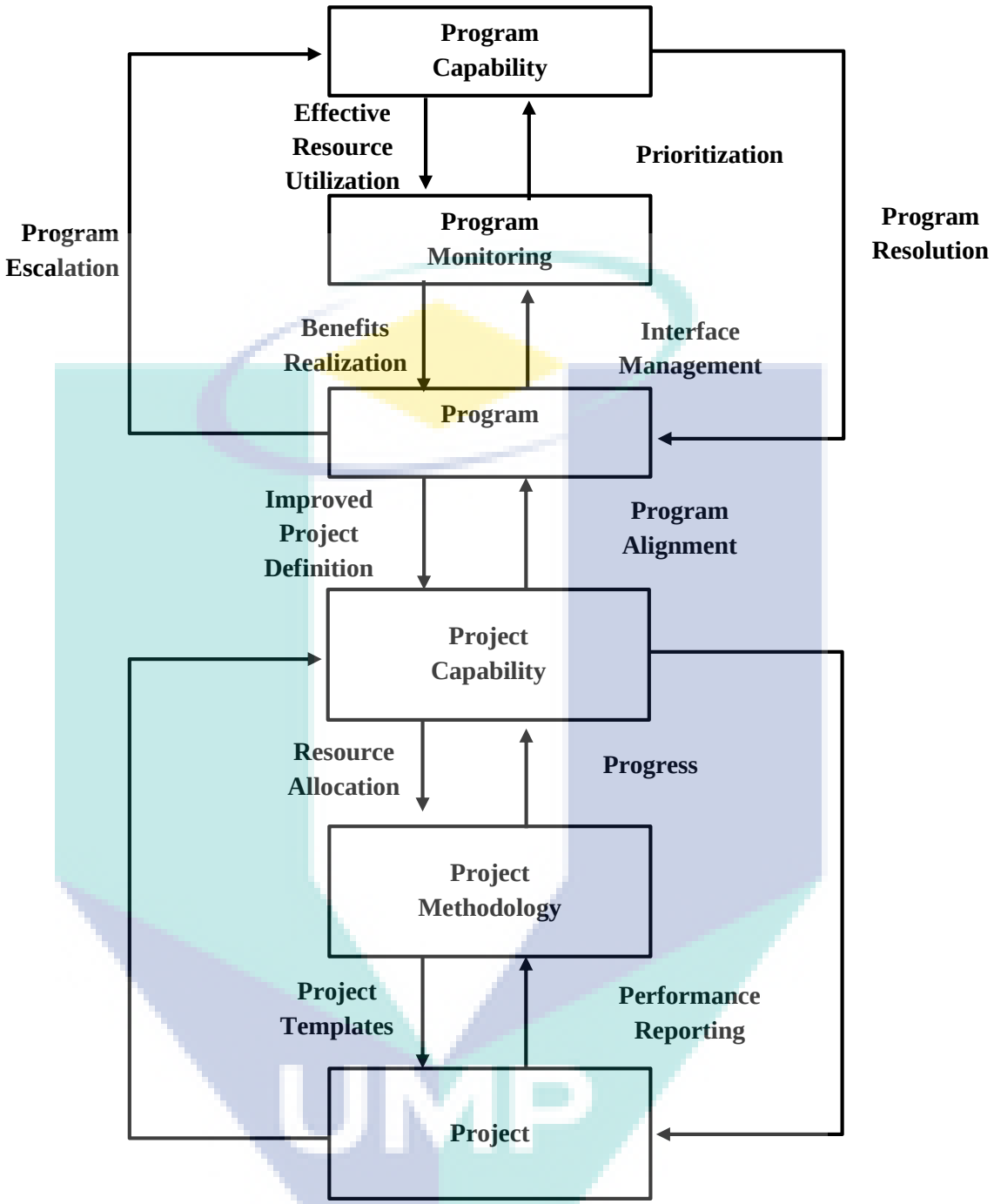


Figure 2.7 KM and project/program management linked

Source: Owen (2008).

The framework proposed by Owen uses the concept of recursiveness and extends the project to the program level, where the program is a group of projects managed together, allowing added benefit and control which would not normally be achieved from managing the projects individually (PMI, 2008 & Owen, 2008). Owen concluded that in order for an organization and especially higher education institutions to deliver successful projects, continuous learning needs to occur to improve its KM capabilities. Continuous

learning can be derived in terms of developing guidelines for creating, sharing, and reusing knowledge in a project management environment, thus integrating knowledge management practices with project/program management.

As described by Levin (2010), every organization wants to make use of project management to deliver its products and services with superior outcomes and benefits that can be sustained for its stakeholders. If the organization implements KM effectively, it may be successful in project management and will transform the organization to excellence. Organizations are becoming project-based, and management-by-project is a defined strategy (Biørn & Saeed, 2014). However, in order for the organization to transform further, KM must be integrated with PM to respond rapidly to gather information to solve specific problems and share knowledge assets effectively and efficiently (Yeong & Lim, 2010). Levin argued that KM must become an integral part of each project professional's daily project work. She suggested that it is necessary to integrate knowledge bases to projects so the people involved in the project could combine individual contributions to those of the project's objectives and align with the organization's strategic objectives. Handzic and Bassi (2017) concluded by stating that a powerful combination of KM and PM can create a synergy effect in order to deliver successful projects.

However, the gap between these areas can generate numerous studies that could be widely used for many economically viable businesses, and in the utilisation of knowledge-based systems for better integration and usability between KM and PM (Michels, Eduardo, Grijó, Machado, & Selig, 2012). Filling the existing research gap, Levin (2010) ensured that KM must be integrated with PM to respond rapidly to gather information to solve specific problems and share knowledge assets effectively and efficiently. She suggested that it is necessary to integrate knowledge bases to projects so that the people involved in the project could combine individual contributions to those of the project's objectives and align with the organization's strategic objectives.

For an integration of KM with PM, Levin (2010) proposed nine guidelines for organizations to have successful implementation of these two terms. The guidelines are as listed below:

- Define knowledge management so that everyone in the organization can understand it.
- Make knowledge management be a work package in the work breakdown structure of every project.
- Establish a point of contact for the knowledge management on each program and project work with the Enterprise Project Management Office.
- Use a responsibility accountability matrix to define roles, responsibilities, and accountabilities for knowledge management.
- Communicate the importance of knowledge management to all stakeholders throughout the organization.
- Provide knowledge management orientation and training to all stakeholders.
- Establish a practical knowledge management reward and recognition system.
- Track the usefulness of knowledge management by using metrics.
- Organizations should focus on continuous improvement.

Understanding the integration of knowledge management with project management would enhance project success and the project management maturity level in higher education institutions. It is important to understand how knowledge could be created and captured via projects and how the knowledge is transferred and reused to other project team members in the form of tacit and explicit knowledge. Having an effective knowledge management strategy to identify how the organizations create, value, preserve and transfer knowledge is critical to their operations through implementing intellectual capital from organizational memory. Organizational learning is a significant component in the organization that plays a crucial role in maintaining and improving performance based on experience via its capacity within the organization. Form that improvement, the knowledge could be explicit or tacit and difficult to articulate (Linda Argote & Hora, 2017).

As a result of the KM and PM research gap analysis, it was observed that there is a significant gap in the integration of the KM and PM in organizations, particularly the higher education institutions. Authors have recommended and suggested some frameworks and guidelines on how to ensure a proper integration and that totally focuses on KM, not its capabilities. The gap is still exists and has not been covered nor filled once it has come to the integration of the KM capabilities into the PM. The proposed

framework by (Owen, 2008) indicates how knowledge is used to manage project management, and how knowledge management processes that create, capture, reuse and transfer could have significant influence on a project's success (Sokhanvar et al., 2014). Therefore, to get a successful implementation of integration of knowledge management with project management, the organization must take into account the nine guidelines proposed by Levin (2010). As a summarized sentence of the pervious mentioned paragraphs, as long as the research gap is filled, "the integration of knowledge management capabilities into project management, information and knowledge can be easily created, shared, applied and protected throughout the project as well as with the entire higher education institution".

## 2.9 The Theoretical Framework

In the previous section, the literature on project management and knowledge management was reviewed with regards to the KM/PM integration to improve project performance, ensure project success and gain project management maturity. A theoretical framework was proposed based on the knowledge gathered from the literature discussed in the previous section of the chapter, which introduced the factors that influence project management maturity.

The factors proposed in this chapter are project-related technology, project-based organizational structure, project-oriented organizational culture, project knowledge acquisition, project knowledge conversion, project knowledge application and project knowledge protection. It suggested that these factors have an effect on knowledge management and project management, which in return influence the enhancement of project success in the organizations.

In a study undertaken by Rabbi et al. (2015), project-related technology was the most common infrastructure and played an important role in knowledge management and project management involving the creation, sharing, use and protection of knowledge with the organization's vicinity. The second factor is the project-based organizational structure, which as Pandey and Khare (2012) stated in their study is the importance given to teamwork which plays a facilitating and steering role in developing the culture of knowledge. A flexible structure would allow the information of ad hoc cross-functional teams in which experts from different departments can be gathered to ease the flow of

ideas across departments or provide venues for employees to communicate informally. The last factor from the knowledge infrastructure capabilities is the project-oriented organizational culture, and this factor is very important in leveraging KM. It has been considered both as a facilitator and a hurdle/barrier for effective KM in PM. Culture of an organization is a key influence on KM, more specifically on the effectiveness of knowledge in an organization. KM's success can be achieved by modifying an organisation's culture in ways that encourage and support desired knowledge attitudes and behaviours (Olubunmi, 2015).

The second part of the factor is the knowledge processes capabilities. The process of project knowledge acquisition plays a significant role in influencing the project's success and reach maturity in project management. The creation of knowledge requires collaboration of personal experiences within the organization, and this can be between individuals themselves and between the organization and its network of business partners. However, it starts with people sharing their internal tacit knowledge by socialising with others or by capturing it in digital or analogue form (Olubunmi, 2015). Once the knowledge is created, the next factor is to convert the knowledge and make it available and exist at a central location, which is then easily accessible by everyone in the organization. Some of the processes that enable project knowledge conversion are the organization's ability to organize, integrate, combine, structure, coordinate and store knowledge.

Nawab et al. (2015) recommended in their study that it is important for organizations to store and convert knowledge in a user-friendly, easily accessible form. Therefore, when the employees in the organization understand and access the converted knowledge easily, it will increase their knowledge on the project's background, information and activities that affect the chance of project success and reach a desirable PM maturity level. Project knowledge application is the third factor that refers to the process of sharing among the employees in an organization. Miguel, Saavedra and Lindemann, (2016) believed that the success of KM is determined by the application of knowledge; companies may not want to invest in KM because of the few support and evidence regarding knowledge application. Essentially, it involves fostering the development of project team and customer knowledge and relationships through suitable KM practices and their application in the project life cycle (Handzic & Durmic, 2015).

The last factor is the project knowledge protection. Ghosh and Scott (2007) stated that project knowledge must be protected from inappropriate use inside the organization by using logins and authentication to access systems to protect knowledge from inappropriate use outside the organization when sensitive information is requested from another party in the organization. Failure to fulfil this factor may lead the organizations to lose its project management maturity and project success. Levin (2010) emphasized that knowledge management must be embedded throughout the project management lifecycle. Knowledge assets are continuously developed in the organization and each project should build on these and share the knowledge (Levin, 2010).

In the proposed theoretical framework for this study, it is suggested that project-related technology, project-based organizational structure, project-oriented organizational culture, project knowledge acquisition, project knowledge conversion, project knowledge application and project knowledge protection as a knowledge management capability may influence project management in the organization which in turn affects the chance of project management maturity. Table 2.9 shows the integration between KM capabilities and PMBOK (2013) processes for the ten project management areas (PMI, 2013).

Table 2.9 Integration of KM into the PMBOK Areas

| **Project Integration Management** | |
|---|---|
| Project-related Technology | Integrating and coordinating all project plans to create a consistent, coherent document with the support of technology, also to carry out the project plan, activities and coordinating changes across the project. |
| Project-based Organizational Structure | Project-based Organizational Structure has to be flexible to fit the project integration management processes, project plan development, project plan execution and integrated change control. |
| Project-oriented Organizational Culture | Integrating and coordinating all project plans inside a manageable organizational culture that assists the organization members to run a smooth project plan execution and allow for an integrated change control in order to coordinate changes across the project. |
| Project Knowledge Acquisition | For the project knowledge acquisition factor, knowledge must be acquired from existing knowledge during project plan development, project plan execution and integrated change control processes. |
| Project Knowledge Conversion | Tacit and explicit knowledge in project plan development, project plan execution and integrated change control are converted through socialization, externalization, internalization and combination, (Kloppenborg & Petrick, 2002), and this is the project knowledge conversion. |

Table 2.9 continued.

| | |
|---|---|
| **Project Integration Management** | |
| Project Knowledge Application | Project knowledge application is applying the knowledge in a project plan development for the project plan execution in order to carry out a successful project plan according to the useful project knowledge application in the organization and coordinating changes across the project. |
| Knowledge Protection | Protecting the knowledge during integration and coordination of all projects which ensures a secured project plan execution. Knowledge has to be protected from unauthorized access in the integrated change control. |
| **Project Scope Management** | |
| Project-related Technology | Integrating technology in this area will facilitate to collect requirements, help in documenting and define the project scope with technology. The work break structure can be designed and it supports the tools to verify the project scope. |
| Project-based Organizational Structure | Project-based Organizational Structure has to be a flexible to fit the project scope management processes in PMBOK (2013), which are to collect the scope requirements, define the scope, create the work breakdown structure and verify the scope. |
| Project-oriented Organizational Culture | As a project-oriented organizational culture, culture is free to collect the project scope requirements as well as define scope and facilitate creating the work breakdown structure with an open organizational culture. Finally, its cultural environment supports scope verification and scope control. |
| Project Knowledge Acquisition | For the project knowledge acquisition factor in this area, knowledge must be acquired from the existing knowledge during the scope collection requirements, scope defining, WBS creating, verifying and closing of the scope processes. |
| Project Knowledge Conversion | Tacit and explicit knowledge in project scope management are converted through socialization, externalization, internalization and combination (Kloppenborg & Petrick, 2002). |
| Project Knowledge Application | Project knowledge application is applying the knowledge in collecting the scope requirement processes, defining the scope during the WBS creation and verifying the scope in order to have a successful project scope control. |
| Project Knowledge Protection | Protecting the knowledge during collecting and defining the project scope in order to create the WBS and to make a sufficient project scope verification and control. |
| **Project Time Management** | |
| Project-related Technology | Project-related technology as a factor plays a significant role in project time management by using scheduling software to define and sequence activities. Organizations use software to estimate the project activities duration, and develop and control the project scheduling activities. |
| Project-based Organizational Structure | PMBOK (2013) listed the project time management processes, which are define activities, sequence activities, estimate activities resources, estimate activity durations, develop schedule and control schedule. The Project-based Organizational Structure must be designed to suit these processes and act as the Project-based Organizational Structure factor. |
| Project-oriented Organizational Culture | As the project-oriented organizational culture, culture is open and free in the organization to perform these processes and define and sequence project activities. Lastly, culture should not be a barrier in developing and controlling the project's activities schedule. |

Table 2.9 continued.

| | |
|---|---|
| **Project Time Management** | |
| Project Knowledge Acquisition | Knowledge is created and acquired. This project area acquisition can be done from the existing knowledge and get benefit from lessons learned. Knowledge is needed to define the project schedule, sequence schedule and to have enough knowledge for developing and controlling the schedule. This integration can reform the project knowledge acquisition factor. |
| Project Knowledge Conversion | Tacit and explicit knowledge in project time management are converted through socialization, externalization, internalization and combination, (Kloppenborg & Petrick, 2002). This reforms the project knowledge conversion factor. |
| Project Knowledge Application | The factor for project knowledge application applies the knowledge in defining and sequencing the project activities and ensures the knowledge is used while developing and controlling the scheduling processes in the organization. |
| Project Knowledge Protection | Knowledge protection process and project time management processes are integrated to form project knowledge protection that aims to protect the knowledge which are used to define and sequence the project activities. In addition, the knowledge used in developing and controlling the activities are protected from the authorized party, which may lead to project time management failure. |
| **Project Cost Management** | |
| Project-related Technology | Wiezel and Badger (2015) stated that knowledge and skills related to the involvement or use of technology for estimating costs, determining budget and controlling costs processes is up to date on project-related technology and uses it effectively to lead and enable team members to work efficiently in the project cost management. |
| Project-based Organizational Structure | Project based project-based organizational structure supports innovation and effective project leadership, and members across the functions run the project cost management processes (Biørn & Saeed, 2014). |
| Project-oriented Organizational Culture | Project oriented organizational culture should evolve to manage knowledge effectively and to better manage the relationship with the organizational environment in order to run the project cost management (Sznajder, 2011). |
| Project Knowledge Acquisition | For the project knowledge acquisition factor in this area, knowledge must be acquired from the existing knowledge prior to estimating project costs and determining budget and control costs. |
| Project Knowledge Conversion | In the project, estimating costs and determining budget and project controlling costs processes, tacit and explicit knowledge are converted through four conversion processes (socialization, externalization, internalization and combination), (Kloppenborg & Petrick, 2002). |
| Project Knowledge Application | Project knowledge application is applying the knowledge that is needed in estimating the project costs, determining the cost and controlling the cost for each activity in order to have a successful project cost control. |
| Knowledge Protection | Protecting the knowledge during estimating project costs, determining budget and controlling costs for a secured and successful project cost management. |
| **Project Quality Management** | |
| Project-related Technology | Project-related technology as a factor plays a significant role in project quality management by using quality software/program to plan quality, perform quality assurance and perform quality control. |

Table 2.9 continued.

| | |
|---|---|
| **Project Quality Management** | |
| Project-based Organizational Structure | The project based project-based organizational structure supports innovation and effective project leadership and members across the functions of this area, (Biørn & Saeed, 2014). In addition, it is to ensure it is designed to support the project quality processes. |
| Project-oriented Organizational Culture | As the project-oriented organizational culture, culture is free to conduct quality assurance and quality control and support the quality plan in the organization. |
| Project Knowledge Acquisition | For the project knowledge acquisition factor in this area, knowledge must be acquired from the existing knowledge prior to developing the HR plan and acquiring the project team members. |
| Project Knowledge Conversion | (Kloppenborg & Petrick, 2002) stated the project knowledge conversion's four processes are socialization, externalization, internalization and combination. Therefore, the tacit and explicit knowledge in this area are converted to be used by the team members in the project quality management. |
| Project Knowledge Application | Project knowledge application is applying the knowledge in the organization that is needed in creating a quality plan and perform an effective quality assurance and quality control for the purpose of monitoring the project quality standard. |
| Project Knowledge Protection | Creating the quality plan, quality assurance and quality control requires knowledge protection for a secured and successful project quality management. |
| **Project Human Resource Management** | |
| Project-related Technology | Integrating the technology in this area will facilitate the development of a human resource plan to acquire, develop and manage the project team. With technology, the human resource system can be created to facilitate and support these processes in the organization. |
| Project-based Organizational Structure | (Biørn & Saeed, 2014), mentioned that the project-based organizational structure supports innovation and effective project leadership and members across the functions of the project management. The project-based organizational structure must be structured to ensure the human resource management processes are achieved in the organization without barriers or difficulties. |
| Project-oriented Organizational Culture | Project oriented organizational culture should evolve to manage knowledge effectively and to better manage the relationship with organization environment (Sznajder, 2011). So, organizational culture should assist in developing the HR plan, and acquire and develop the project team members with a supportive culture. |
| Project Knowledge Acquisition | Knowledge should be created or acquired from the existing knowledge on how to plan the human resource in the project and acquire the project team members. |
| Project Knowledge Conversion | (Kloppenborg & Petrick, 2002) stated that the project knowledge conversion's four processes are socialization, externalization, internalization and combination. So, the tacit and explicit knowledge in this area are converted to be used by the team members in human resource management. |

Table 2.9 continued.

| | |
|---|---|
| **Project Human Resource Management** | |
| Project Knowledge Application | The factor for project knowledge application is applying the knowledge while developing the human resource plan, acquiring the project plan, developing project team and ensuring the knowledge is applied to manage the project human resource management team in the organization. |
| Project Knowledge Protection | Knowledge protection process and project human resource management processes are integrated to form project knowledge protection that aims to protect the knowledge, which are used for the HR plan development. Knowledge must be protected with regards to acquiring the project team members. |
| **Project Communication Management** | |
| Project-related Technology | Integrate and coordinate all project plans to identify stakeholders, plan communications and manage stakeholders' expectations with the support of technology. Also, technology in the form of software/programs helps to distribute information on the project and prepare the performance report. |
| Project-based Organizational Structure | PMBOK (2013) listed the project communication management processes, identified project stakeholders, communicated the plan and distributed information. The project-based organizational structure must be designed to suit these processes and to manage the stakeholders' expectations to act as a project-based organizational structure factor. |
| Project-oriented Organizational Culture | As a project-oriented organizational culture, culture is free to identify the stakeholders, plan, communicate and distribute the information as well as support in managing the stakeholders' expectations with an open organizational culture. Finally, it is cultural environment that supports communication report performance. |
| Project Knowledge Acquisition | Project knowledge acquisition for an individual occurs when information or ideas from other people are accessed, captured, processed, and retained, adding to that individual's tacit knowledge (Chivonne, 2014). Knowledge must be acquired to have a successful project communication management. |
| Project Knowledge Conversion | In the project communication management, tacit and explicit knowledge are converted through four conversion processes (socialization, externalization, internalization and combination), (Kloppenborg & Petrick, 2002) in order to use the existing knowledge and reform it into useful knowledge for this area. |
| Project Knowledge Application | Project knowledge application is applying the knowledge that is needed in identifying the stakeholders, distributing the information and preparing the project performance report in order to have a successful project communication management. |
| Project Knowledge Protection | Protecting the knowledge during project communication management in order to ensure the knowledge is kept secure and is unreachable by the unauthorized people, especially in distributing information and preparing the performance report. |
| **Project Risk Management** | |
| Project-related Technology | Knowledge and skills related to the involvement or use of technology is up to date on project-related technology and uses it effectively to lead and enable team members to work efficiently with project risk management processes (Wiezel & Badger, 2015). |

Table 2.9 continued.

| | |
|---|---|
| **Project Risk Management** | |
| Project-based Organizational Structure | Project-based organizational structure has to be flexible to fit the project risk management processes in PMBOK (2013), which are planning risk management, identifying the project risk as well as performing qualitative and quantitative risk analysis. Project-based organizational structure should be structured to fit the monitoring and controlling risks. |
| Project-oriented Organizational Culture | Project oriented organizational culture should evolve to manage knowledge effectively and to better manage the relationship with organization environment (Sznajder, 2011). Therefore, organizational culture should assist in planning the risk management and other project risk management processes. |
| Project Knowledge Acquisition | Knowledge is created and acquired during this project area. Acquisition can be done from the existing knowledge and get benefit from the lessons learned. Knowledge is needed to plan risk management and identify the project's risks and to have enough knowledge for monitoring and controlling risks. This integration can reform the project knowledge acquisition factor. |
| Project Knowledge Conversion | In the project risk management, tacit and explicit knowledge are converted through four conversion processes (socialization, externalization, internalization and combination) (Kloppenborg & Petrick, 2002) in order to get use of the existing knowledge and reform it into useful knowledge for this area. |
| Project Knowledge Application | Project knowledge application applies knowledge in the organization that is needed in planning risk management and identify the risk to the project to perform quantitative risks analysis and plan risk responses. |
| Project Knowledge Protection | Knowledge related to project risk should be protected in the organization, as this knowledge is vulnerable. Failure to protect this knowledge may lead to project failure |
| **Project Procurement Management** | |
| Project-related Technology | Project-related technology as a factor plays a significant role in project procurement management by using procurement software to plan procurement for conducting and administrating the project procurement processes and contracts. |
| Project-based Organizational Structure | The project based project-based organizational structure supports innovation and effective project leadership and members across the functions of this area (Biørn & Saeed, 2014) and to ensure it is designed to support the project procurement processes. |
| Project-oriented Organizational Culture | Sznajder (2011) stated that project oriented organizational culture should evolve to manage knowledge effectively to run project procurement management processes and to better manage the relationship with organization environment. |
| Project Knowledge Acquisition | Knowledge should be created or acquired from the existing knowledge on how to plan the procurement in the project and for conducting and administrating a sufficient procurement. |
| Project Knowledge Conversion | In project procurement management tacit and explicit knowledge are converted through four conversion processes (socialization, externalization, internalization and combination) (Kloppenborg & Petrick, 2002) in order to use the existing knowledge in the procurement plan and procurement processes. This is to reform the project knowledge conversion factor. |
| Project Knowledge Application | The factor for project knowledge application is applying the knowledge while planning procurement, administrating and conducting the procurement for successful project procurement closure. |

Table 2.9 continued.

| | |
|---|---|
| **Project Procurement Management** | |
| Project Knowledge Protection | Protecting the knowledge during procurement plan, which ensures secured and administrated procurement procedures. Knowledge has to be protected from unauthorized access, which intends to affect the project success of the organization. |
| **Project Stakeholders Management** | |
| Project-related Technology | Project-related technology as a factor plays a significant role in project stakeholders management by using a software to identify stakeholders, plan stakeholder management, manage stakeholder engagement, and control stakeholder engagement. |
| Project-based Organizational Structure | The project-based organizational structure supports innovation and effective project leadership and members across the functions of this area (Biørn & Saeed, 2014). In addition, it is designed to support the project stakeholder processes. |
| Project-oriented Organizational Culture | Sznajder (2011) stated that project oriented organizational culture should evolve to manage knowledge effectively to run project stakeholder management processes, better manage their relationship with organization environment and ensure the right stakeholders are chosen for the project based on cultural policies. |
| Project Knowledge Acquisition | Knowledge should be created or acquired from existing knowledge on how to plan the stakeholder in the project and for conducting and administrating sufficient stakeholder selection. |
| Project Knowledge Conversion | In the project stakeholder management, tacit and explicit knowledge are converted through four conversion processes (socialization, externalization, internalization and combination) (Kloppenborg & Petrick, 2002) in order to use the existing knowledge in the stakeholder management processes. |
| Project Knowledge Application | The factor for project knowledge application is applying the knowledge when identifying stakeholders, planning stakeholder management, managing stakeholder engagement and controlling stakeholder engagement. |
| Project Knowledge Protection | Protect the knowledge during stakeholder plan to ensure secured and administrated stakeholders' procedures. Knowledge has to be protected from unauthorized access which intends to affect the project's success in the organization. |

This was a summary of integrating KM with PM and highlights one of the research objectives of redefining these capabilities in terms of how they integrate with project management. KM capabilities can be redefined in PM, and the following is the definition of each capability based on its integration with PM:

*Project-related Technology:* A combination of hardware, software and network infrastructure that ensure and support a project's success in the organization.

*Project-based Organizational Structure:* A group of rules, policies, procedures, and processes, hierarchy of reporting relationships and incentive systems which organize the project's activities within the organizational boundaries for meeting a planned goal.

*Project-Oriented Organizational Culture:* The knowledge, belief, art, morals, law, custom, and any other capabilities and habits acquired by the employee as a member of the organization, which is a key influence in project activities.

*Project Knowledge Acquisition*: The process of creating or acquiring knowledge that is in the form of tacit and explicit knowledge within the project's activities to reach the target goal.

*Project Knowledge Conversion:* An oriented process towards transforming and converting the knowledge from un-useful knowledge to useful and applicable knowledge, and from tacit knowledge to explicit knowledge within the project environment.

*Project Knowledge Application:* A process of sharing and using the project knowledge during the project activities among the project stakeholders to achieve project improvement, avoid failure, gain benefits and share the lessons learned.

*Project Knowledge Protection:* The process of protecting project knowledge that is in the form of tacit and explicit knowledge from non-authorized access/use within the project environment in the organization.

During the development of the model to assess the maturity level of project management through knowledge management capabilities, a five-level system is used for the assessment in Figure 2.8. This study uses the PMBOK 5th edition guide as a primary reference for instructing and consulting all areas of PM and is closely aligned with the seven KM capabilities. The Knowledge Management Capabilities/Project Management Maturity Model (KMC-PMMM) is developed to assess the maturity level in project management by analysing and evaluating the previous maturity models such as CMM, ProMM, P3M3 and PM3 (Kent Crawford, 2006; Kwak & Ibbs, 2002) where all of these models were inspired by the capability maturity model (CMM) (Backlund et al., 2014).

All the previous maturity models were considered useful, however, models may need some upgrading and enhancement in order to be utilized by organizations for success and project management maturity. This is because of their concerned areas, different practices and processes, different cultures and organizational structures, differences in their production processes and the product itself.

This study considers the importance of other maturity models and their maturity levelling systems, but because of the previously mentioned reasons, this study modifies and develops the previous maturity levels for project management by focusing on

knowledge management capabilities. The maturity level of project management measures an organization's effectiveness in delivering projects. It sizes up how far an organization has progressed toward incorporating project management as an effective way of work (Demir & Kocabaş, 2010).

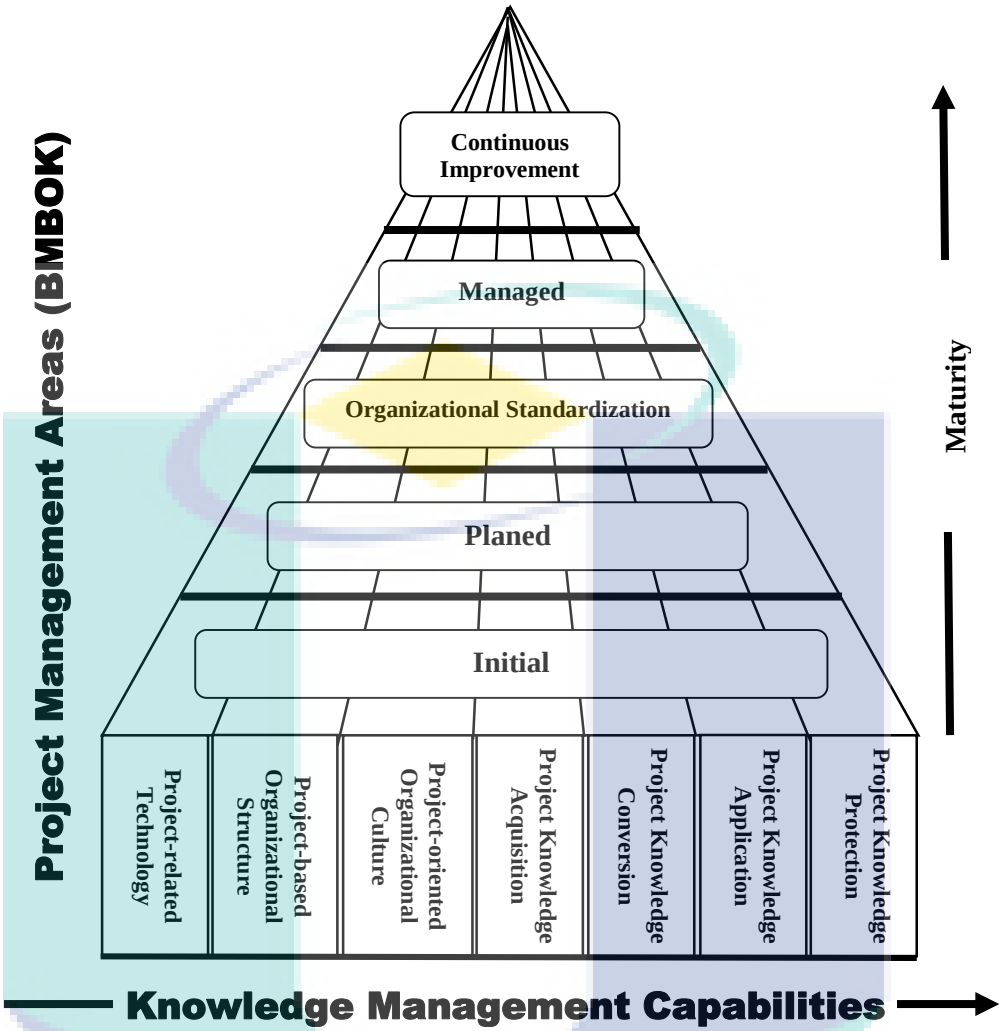


Figure 2.8 The proposed KMC-PMM model

For the second objective of the research, the developed model uses a 5-level maturity scale to measure the maturity in project management through the seven knowledge management capabilities. According to Backlund, Chronéer and Sundqvist (2014), these five levels define an ordinal scale to measure the maturity of an organization's process and to evaluate its process and capability and they are listed in Appendix E.

**Level 1: Initial**

There is a lack of awareness about knowledge management capabilities in project management and there are no formal practices or standards for using these capabilities in organizations. Project-related technology, project-based organizational structure, project-oriented organizational culture, project knowledge acquisition, project knowledge conversion, project knowledge application and project knowledge protection are very

lacking in use and could be unavailable. The initial level of maturity means that projects are, in fact, not organized in the organization (Spalek, 2014). Managers are in need of knowledge management capabilities for project management. All the activities during this process are ad-hoc.

- Ad-hoc capabilities and processes.
- Managers heard about knowledge management capabilities and its importance for project management.

**Level 2: Planned**

At this level, knowledge management capabilities are being used and applied to many different project management processes, but there is no standardization or proper guidelines of using such capabilities in the organizations. The implementation and documentation of each capability is basic, but the links are not formed between the implementation of knowledge management activities (Swietoniowska, 2013). The organizations recognize that common processes need to be defined and developed, such that the success of the project can be repeated on other projects. In addition, the recognition of the application and support of the project management principles to other methodologies employed by the organization is included (Demir & Kocabaş, 2010). Managers initially plan to apply these capabilities to all project management processes. Project-based organizational structure at this level is partially built with an unintended structure between all members of consequence of inhibiting collaboration and sharing of knowledge across internal organizational boundaries.

Mainly, the success is dependent on managers' experience on how to use knowledge and integrate it with project management process, tacit and explicit knowledge. When the scale of the project gets larger, the managers give higher importance to knowledge management capabilities and project management activities. In general, there is no systematic process to organize and manage using knowledge in the organizations, and it is already planned to be systematic.

- Project management is supported by knowledge management capabilities.
- There is no systematic process.
- Success of project management depends on managers' experience in knowledge management capabilities.

**Level 3: Organizational Standardization**

At this level, all knowledge management capabilities are in place and are established as project management processes' own organizational standards. All the other stakeholders of these processes like employees, organization environment, contractor and the managers act as one project team that understand how knowledge management infrastructure and knowledge management processes play a significant role in organizational standardization. Swietoniowska (2013) stated that the processes of project management are well understood and described in the guidelines, procedures, standards and tools. Procedures and standards are more detailed than at level 2. The organization realizes that a singular methodology could be more effective than multiple methodologies.

Organizations in this stage establish their own processes and standards with formal implementation of these capabilities and documents it in a standardized method. Managers are involved in key decisions and the approval of knowledge management capabilities implementation within the project life cycle. Each project is evaluated through these capabilities and the results are compared with other project outcomes. At this level, organizations cannot blindly apply all capabilities equally to all projects. According to Hyttinen (2017), the project implementation must be planned, decided and agreed upon with ethical principles. The capabilities should be implemented according to the ongoing project and for future planned project. The modification of the standardized processes according to the ongoing project is another process. Therefore, consideration must be given to the differences between projects in implementing these capabilities.

- Standardization of knowledge management capabilities for organizations and their project management.
- All the stakeholders of the process act as one project team using all knowledge management capabilities.
- Each project is evaluated and managed in light of other projects based on the knowledge management capabilities.

**Level 4: Managed**

Project management processes are managed in the light of plans of using the knowledge management capabilities. While doing this, the consideration of the previous processes of using these capabilities is not neglected as it was in the previous levels. This level contains the recognition that process improvement is necessary to maintain a competitive advantage (Demir & Kocabaş, 2010). Projects managers use efficiency and effectiveness metrics to make decisions regarding the current project and realize the impact on other projects in terms of managing project-related technology, project-based organizational structure, project-oriented organizational culture, project knowledge acquisition, project knowledge conversion, project knowledge application and project knowledge protection. Effectively managing knowledge in projects is the key factor in the company gaining a decisive advantage (Spalek, 2014). All projects, changes and other issues are evaluated based on how far these capabilities are being used to reach project management maturity.

The project management team continues at this level more efficiently. All project knowledge and information are distributed and integrated into the project team. All the processes and standards are managed and documented for the project. These documents support the usage of knowledge management capabilities at this level. Project managers understand each knowledge management capabilities' roles in the process and execute it clearly and effectively, and they understand their role against each capability.

- Knowledge management capabilities are managed.
- Project managers use the metrics for the project decisions.
- Project managers brilliantly understand each knowledge management capabilities' role against the project's success.

**Level 5: Continuous Improvement**

Processes are actively used by the project managers for the improvement of the project management activities in terms of knowledge management capabilities. Lessons learned are used to improve project management processes, standards and documentations. The staff of the organization focuses not only on the current project activities from the knowledge management capabilities perspective, but also on continuous improvement. This level is the highest one that indicates the company's

awareness of the role that knowledge management plays in project management. Therefore, the organization runs those processes which should help to identify areas for improvement (Spalek, 2014). All the collected metrics during the execution of the project processes are also used for future decisions and improvement (Demir & Kocabaş, 2010).

- Processes used for the improvement of project management activities.
- All the staff of the organization focus on the improvement of project management based on its KM capabilities.
- All collected metrics are used for future decisions.

## 2.10 Levelling of KMC-PMM Model in PM Knowledge Areas

### 2.10.1 Project Integration Management

Project integration management is the knowledge area that is exclusively for the use of project managers. All of us know that the project managers are also called integrators. The project integration includes the processes and activities needed to identify, define, combine, unify, and coordinate the various processes and project management activities within the project management process groups (Jainendrakumar, 2015). It also aims to integrate, analyse and report the project results in carrying out the project management plan and control changes to the baseline (Richardson, 2014). It ends by closing the project or phase in an orderly and disciplined requirement.

The main processes of project integration according to the PMBOK (2013) is initiating the project charter and developing the project management plan which deals with the formal authorization of a project and defines the project charter, assumptions and constraints. Another process is directing and managing project work, which identifies all the documents and jobs delivered at the end of the project. Then, the project work of monitoring and controlling the process helps to carry out the project. The next process is the change control, which is responsible for all the changes during the project development in assessing and identifying the project changes and their distribution to all related parties in the organization (Richardson, 2014). The last process is the project closure which deals with controlling and checking the decisions, assumptions, scopes and project deliverables. As these processes were mentioned, now it can be assessed and valued by the KMC-PMM model through the seven knowledge management capabilities.

**Level 1 -** At this level of project management, there is no established technology, project-based organizational structure, organizational culture and no usage of knowledge processes. Knowledge management capabilities are ad hoc and integration project management teams follow informal organizational practices.

**Level 2 -** Technology exists in the organization and is being used in some of the project integration management processes, but these are still informal practices that do not use a technology infrastructure. The requirement for the technology evolves as the various PM processes change as they move through the levels of maturity (Mieritz, Fitzgerald, Gomolski, & Light, 2007). Members of the organization use the project-based organizational structure, which eases the sharing of knowledge across internal organizational boundaries. Members share their knowledge and experiences, but not all things that must be shared. The organization wants its employees to share what they know with the organization (Thanmoli & Abu Mansor, 2008). Culture is an important view of organization toward its goal knowledge, and members will encounter problems from lack of knowledge distribution within the organization. Knowledge is protected through these processes.

**Level 3 -** There is an organizational standard for the knowledge management capabilities for the preparation of the contract and initiation of the project. The detailed scope statements, assumptions and constraints are managed by checking, monitoring and documenting throughout the project integration management. Technology, project-based organizational structure and culture infrastructure are standardized, are now utilized by most project integration management teams in the organization, and are fully used to integrate knowledge into project. There is knowledge creation and use of the existing knowledge to support the project integration processes like execution and control Knowledge creation is enabled by the processes and activities of interaction, feedback, innovation, brainstorming, and benchmarking (Singh Sandhawalia & Dalcher, 2011). Sometimes, the team is not active, and authorized processes, activities, and behaviours are being conducted wrongly, so there must be organizational standards to protect the knowledge with the organization.

**Level 4 -** At this level, project integration management has technology which can deliver relevant requested knowledge by users to support the project charter, develop the project management plan, direct and manage project work, monitor and control project

work, perform integrated change control and close project/phase processes by facilitating the information technology. This is done within a flexible project-based organizational structure for sharing with collaboration across boundaries within the organizational culture. The structure of organizations is an essential factor that will influence the availability of resources and thereby can affect how the projects will be managed (de Souzaa & Gomesb, 2015). Members of an organization make full use of existing knowledge and interact between tacit and explicit knowledge. Organizations have training programs to educate their employees on protecting the knowledge and information of the project integration management.

**Level 5 -** All the processes done for the project integration management such as initiation, scope definition, deliverables identification, execution and controlling are all for process improvement. KM capabilities, namely infrastructure and processes, provide the support structure required to share knowledge within the context in which it is required (Singh Sandhawalia & Dalcher, 2011). All data and information gained during these processes are used for the improvement of this area to ensure documentation of the learned lesson.

### 2.10.2 Project Scope Management

The main purpose of project scope management in the organization is ensuring the project includes all the work required to complete the project successfully. However, the accuracy of defining the project scope strongly influences the overall project performance (Corvello, Javernick-Will, & La Ratta, 2017).

The main processes of project scope are the plan scope management processes that relate to how the project scope is defined (PMBOK, 2013). It assesses and develops the processes, procedures and standards relating to the collection of the business related requirements of the project. Another process is defining the project scope. It aims to find and determine the organization's project scope. Then comes the work breakdown structure or the project charter process, which is a fundamental project management technique to define and organize the total scope of the organization's project using a hierarchical tree structure. This process aims to help the organization to assign any project activity easily. Finally is the scope validation and scope change control processes, which

covers the regularity of the use and overall evaluation of the proposed changes in the organization (Richardson, 2014).

**Level 1 -** At this level of project management, there is no established technology, project-based organizational structure, organizational culture and no usage of knowledge processes. Knowledge management capabilities are ad hoc and integration project management teams follow informal organizational practices in handling the project scope management processes.

**Level 2 -** Technology exists in the organization and is being used in some of the project integration management processes, but these are still informal practices that do not use a technology infrastructure. The project-based organizational structure does not set all of its members and organizational culture, according to de Souzaa and Gomesb (2015). Rather, the structure and culture of the organization affects the way it manages its projects. Knowledge is created at the scope planning and management process and the existing knowledge is shared across internal organizational boundaries regarding the project scope. In addition, members share their knowledge and experiences, but not all things that must be shared. Knowledge starts to be protected through these processes and the scope change especially controls the process.

**Level 3 -** There is an organizational standard for the knowledge management capabilities of the project scope planning and management process, technical requirements definition and the breakdown structure. Technology, project-based organizational structure and culture infrastructure are standardized and utilized by most project scope management teams in the organization, and are being used to integrate knowledge into the project. Knowledge embedded in organizational structures, tools, and processes can buffer the organizations from the negative effects of member turnover (Argote & Miron-Spektor, 2011).

Technology like project software is used for technical requirements. Structure is set up to suit the transfer of knowledge as well as the culture. There is knowledge creation and use of existing knowledge to support the project scope management processes**.** Sometimes, a team is not active, and the authorized processes, activities, and behaviours are conducted wrongly, so there must be organizational standards to protect the knowledge with the organization.

**Level 4 -** At this level, project scope management has the technology which can deliver the relevant requested knowledge to support all the processes in this area. This is done within a flexible project-based organizational structure to share and collaborate across boundaries within the organization's culture, which is manageable at this level. Members of the organization make full use of existing knowledge and interact between tacit and explicit knowledge. Organizations have training programs to educate their employees on protecting the knowledge and information of the project scope management protection and sensitize them on how this knowledge could affect the organization in case it is lost. KM capabilities, namely infrastructure and processes, provide the support structure required to share knowledge within the context in which it is required (Singh Sandhawalia & Dalcher, 2011).

**Level 5 -** All the processes done for the project scope management such as scope planning and management process, business requirements definition, technical requirements definition, and scope change support the process of improvement at this level. All data and knowledge gained during these processes are used for the improvement of this area and documents the learned lessons on each process.

### 2.10.3 Project Cost Management

The main purpose of project cost management to the organization is determining the total cost of the projects, estimating the cost of identified resources, and ensuring the project is completed within the approved budget (Scotto, 1994). In addition, it is involved in developing the project baseline by comparing its progress against the baseline and controlling costs.

According to the PMI (2013), the main processes of project cost management are cost estimation, which includes an analytical process using factors, relationships, and expert knowledge to develop the cost of the project. Another process is the cost budgeting for developing a project cost baseline by allocating the cost estimates to individual elements in the WBS. Then, the performance measurement process measures the project performance to determine whether the organization's project activities have been accomplished in accordance with the plan. The last process is cost control, which manages the cost baseline to ensure the organization project is completed within the approved

budget and determines the changes to the cost baseline, manages the authorized changes, informs stakeholders and takes corrective action.

**Level 1 -** Knowledge management capabilities are ad hoc and project cost management teams follow informal organizational practices in handling the project cost management processes. There is no established technology, project-based organizational structure, organizational culture or usage of knowledge processes.

**Level 2 –** The technology is existed in the organizations and is being used in some of the project cost management processes, for instance, using software cost estimating and budgeting processes. However, these are still informal practices and does not use a technology infrastructure. Project-based organizational structure sometimes support all members in terms of using the project cost management processes as well as the organizational culture but is not wide open for the same members to exchange knowledge and information. The project-based organizational structure of the companies is a component that influences the availability of resources and could also affect the way of the project is managed (de Souzaa & Gomesb, 2015). Thus, the structure has to be planned to be managed. Knowledge is less created or used in cost estimating, budgeting, performance measurement and cost control.

It is rare to share existing knowledge across internal organizational boundaries to manage the project cost. Members share their knowledge and experiences, but not all things that must be shared. Knowledge starts to be protected through these processes, especially in performance measurement and cost control.

**Level 3 -** At this level, there is an organizational standard for cost estimating, cost budgeting, performance measurement and cost control processes. Technology, project-based organizational structure and culture infrastructure is standardized and utilized by most project cost management teams in the organization and are fully used to integrate knowledge into project in terms of costing and managing the budget of the project. Structure is set up to suit the transfer of knowledge as well as the culture that is now managed and is widely open to team members.

Knowledge creation is enabled by the processes and activities of interaction, feedback, innovation, brainstorming, and benchmarking (Singh Sandhawalia & Dalcher, 2011). There is knowledge creation and use of existing knowledge to support the project

cost management processes, like costing and financial information**.** At this level, the team may not often be active, and authorization of processes, activities, and behaviours are conducted wrongly. Thus, there must be organizational standards to protect the knowledge with the organization's vicinity.

**Level 4 -** At this level, project cost management has fully introduced the technology which can deliver the relevant requested knowledge by users to support all the processes in this area. This is done within a flexible project-based organizational structure to share and collaborate across all the boundaries within the organizational culture, which is manageable at this level and everyone is familiar with its cultural customs. Culture plays a particular role during the early phases of a project, while in later phases, the established cultural basis allows a higher degree of impersonal communication (Lindner & Wald, 2011).

Members of organization make full use of existing knowledge and interact between tacit and explicit knowledge in supporting and measuring the cost performance in order to gain maturity level. Organizations have training programs to educate their employees to protect knowledge and information of the project cost management protection and sensitize them on how could this affects the organization in case it is lost.

**Level 5 -** All the processes are done for the project cost management such as cost estimation, cost budgeting, performance measurement and cost control to support the process of improvement at this level. All data and knowledge gained during these processes are used for the improvement of this area for the next project and ensure documentation of the lessons learned for each process.

### 2.10.4 Project Time Management

The main purpose of project time management to the organization is to develop and manage the project schedule and ensure the project is completed within the approved time frame by defining the project activities and executing the schedule. Moreover, it controls the plans during project execution. Therefore, the less time required to complete such projects the better for satisfying social needs (Solis & Corona-Suárez, 2016).

According to the PMI (2013), the main processes of project time management are the activities and resources definition process, which identifies and documents the

project's activities and what resources are needed to carry out the project in the organization. The second process is activities sequencing, which is responsible for sequencing the project's activities and considers the relations and relativity between them. Another process is the schedule development to identify dependencies between project activities, assign resources and identify the start and end dates for each project's activities.

The schedule integration is another process that deals with the integration of major components of the organization's schedules. These schedules are integrated accurately to understand the change that occurs in the organization. The last process in time management is the schedule control, which aims to manage the project's activities within the planned time frame through establishing a schedule control system, publishing schedule status reports, analysing schedule performance metrics, determining changes to the schedule baseline and informing the project stakeholders of the change in the organization.

**Level 1 -** In general, at this level, the knowledge management capabilities are ad hoc and project management teams follow informal organizational practices in handling the project time management processes. There is no established technology, project-based organizational structure, organizational culture and or usage of knowledge processes as the organization is at the beginning stage.

**Level 2 –** The technology is existed in the organization and is being used in the some of the project's time management processes, for instance, using software to design and construct time schedules like the MS Project software. However, this is still an informal practice of using a technology infrastructure. The requirement for the technology evolves as the various PM processes change as they move through the levels of maturity (Mieritz et al., 2007). Sometimes, the project-based organizational structure does not support all members in terms of using the project time management processes as well as the organizational culture as it is not wide open for the same members to exchange their knowledge and information.

Knowledge is less created and used in activities sequencing, schedule development schedule integration and schedule control processes. It is rare to share existing knowledge across internal organizational boundaries regarding managing the project's time. In addition, members share their knowledge and experiences, but not all

things that must be shared. The knowledge is not totally protected through these processes and especially in the activities of sequencing, schedule development, schedule integration and schedule control.

**Level 3 -** At this level, there is an organizational standard established for the activities and resources definition, activities sequencing, schedule development, schedule integration, and schedule control processes. Technology, project-based organizational structure and culture infrastructure is standardized and utilized by most project time management teams in the organization, and are fully used to integrate knowledge into the project in terms of scheduling the time of the project.

Technology such as the time scheduling software is used for the organization's processes at this level. Structure is set up to suit the transfer of knowledge and the culture is now managed and widely open to the team members. There is knowledge creation and use of the existing knowledge to support project time management processes, such as schedule sequence and schedule integration and control, while knowledge sharing is considered a key contributor (Akram, Shen, Haider, & Hussain, 2018). At this level, sometimes the team is not active and the authorized processes, activities, and behaviours are being conducted wrongly, so there must be organizational standards on how to protect the knowledge with the organization.

**Level 4 -** At this level, project time management has fully introduced the technology, which can deliver relevant requested knowledge by users to support all the processes in this area. A flexible project-based organizational structure encourages knowledge sharing and collaboration across boundaries within the organization, while a rigid structure often has an unintended consequence of inhibiting such practices (Singh Sandhawalia & Dalcher, 2011). Members of the organization make full use of the existing knowledge and interact between tacit and explicit knowledge to support activities sequencing, schedule development, schedule integration and schedule control processes in order to gain maturity level. Organizations have training programs to educate their employees on protecting knowledge and information regarding project time management protection and sensitize them on how this knowledge affects the organization in case it is not protected.

**Level 5 -** All the processes are done successfully for project time management such as activities sequencing, schedule development, schedule integration, schedule control processes and support of the improvement process at this level. All data and knowledge obtained during these processes are used for the improvement of this area for the next project and lesson learned are documented at each process. At this level, knowledge is found to be the main building block for the innovative processes (Akram et al., 2018).

### 2.10.5 Project Quality Management

The purpose of project time management is to meet client satisfaction, conform to requirements, and ensure fitness to project requirements. According to the PMBOK (2013), the main process of project quality management is quality planning which is responsible for identifying the quality standards, practices and associated quality activities. Another process is performing quality assurance (QA) that comes after the quality planning as it deals with developing processes, procedures and standards to assure the organization's project work meet relevant quality standards. There must be a quality control process to monitor the actual project results to see if they comply with relevant quality standards and identify ways to eliminate the causes of unsatisfactory results. The last process is by performing quality control (QC) which aims to understand, support and be involved in project management activities through awareness, support and involvement in the project.

**Level 1 -** In general, at this level, knowledge management capabilities are ad hoc and project quality management teams follow informal organizational practices in handling project quality management processes. There is no established technology, project-based organizational structure, organizational culture and no usage of knowledge processes, as the organization is at the beginning stage.

**Level 2 -** At this level, technology exists in the organization and is being used in some of the project quality management processes. For instance, using software for quality planning and monitoring the quality assurance control within the organization, but this is still an informal practice of using a technology infrastructure. At this level, project-based organizational structure often supports all members in terms of using the project quality management processes and the organizational culture is not wide open for the

same members to exchange their knowledge and information. Therefore, the project quality level is not high due to the shortage of infrastructure and strict structure and culture. According to de Souzaa and Gomesb (2015), the culture of the organization is nothing more than the result of the experience lived by the organization members with the ability to influence and make decisions.

Knowledge is less created and used in quality planning, quality assurance, and quality controlling processes. Knowledge creation is enabled by the processes and activities of interaction, feedback, innovation, brainstorming and benchmarking (Singh Sandhawalia & Dalcher, 2011). It is rare to share the existing knowledge across internal organizational boundaries when managing the project's quality. In addition, members share their knowledge and experiences, but not all things that must be shared and used. Knowledge at this level is protected through these processes and especially in the activities of sequencing, schedule development, schedule integration and schedule control. Finally, knowledge sharing plays a positive role in generating innovative work behaviour in employees (Akram et al., 2018).

**Level 3 -** At this level, there is an organizational standard established for quality planning, quality assurance and quality control processes. Technology, project-based organizational structure and culture infrastructure are standardized, are utilized by most project quality management teams in the organization, and are fully used to integrate knowledge into the project in terms of project quality and managing and controlling the quality assurance and oversight management. A flexible project-based organizational structure encourages knowledge sharing and collaboration across boundaries within the organization (Singh Sandhawalia & Dalcher, 2011). Technology such as project quality software is used for the processes of this area. Structure is set up to suit the transfer of knowledge and the culture is now managed and widely open to the team members. There is knowledge creation and use of existing knowledge to support the project quality management processes, especially quality assurance and oversight management**.** At this level, sometimes the team is not active, and authorized processes, activities and behaviours are conducted wrongly, so there must be organizational standards to protect the knowledge within the organization.

**Level 4 -** At this level, project quality management was fully introduced and manages the technology that can deliver relevant requested knowledge by users to support

all the processes in this area. Information technologies like e-mail, repositories, intranet portal, teleconferencing, and the activities of mentoring, collaboration and training play a key role in transferring knowledge (Singh Sandhawalia & Dalcher, 2011).

This is done within a flexible project-based organizational structure to share and collaborate across boundaries within the organization's culture, whether internally or internationally. Culture is manageable at this level and everyone is familiar with cultural customs and activities. Members of the organization make full use of the existing knowledge and interact between tacit and explicit knowledge to support quality activities in order to gain the maturity level. In this project knowledge area, knowledge sharing contributes value to existing knowledge within the organization and leads to innovativeness (Akram et al., 2018). Organizations provide training programs to educate their employees to protect the knowledge of project quality management processes and sensitize them on how it could affect the organization in case it was not protected. Project quality management is considered the more important area in the project management; whenever the quality is high, the maturity level is high too.

**Level 5 -** At this level, all the project quality management processes are completed successfully with full support by the knowledge management capabilities in the organization. Improvement process is required at this level if it observes any insufficiency in the knowledge capabilities in this area. All data and knowledge obtained during these processes are used for the improvement of this area for the next project and ensure documentation of the lessons learned in each process.

### 2.10.6 Project Human Resource Management

The main purpose of project human resource management to the organization is to identify the requisite skills required for specific organization and management activities. It also selects individuals who have those skills, assign roles and responsibilities, manage and ensure high productivity of resources, and forecasts the needed resources for the future (Richardson, 2014).

According to PMBOK (2013), the main processes of resource management are identifying activities, documenting and assigning project roles and responsibilities, and reporting relationships for the project. The next process is staff acquisition to identify, solicit and acquire the necessary resources for the project. It also develops and manages

the project team in the organization to enhance productivity, efficiency and overall project success. Another process is professional development to develop the level of professionalism that exists within the organization and project team members. Development may be achieved through individual project management knowledge (Richardson, 2014). This refers to the knowledge acquired by the individual project management as a degree, a certificate, an awareness of the need for project management education and the individual experience or competence required for the vacant position in the organization.

**Level 1 -** In this level, the knowledge management capabilities are ad hoc and project cost management teams follow informal organizational practices in handling the human resource management processes. The level of maturity means that projects in fact are not organized in the organizations. The knowledge possessed by individuals involved in project-related processes is of a different nature and is not commonly recognized (Spalek, 2014). There is no established technology, project-based organizational structure, organizational culture or usage of knowledge processes.

**Level 2 -** At this level, technology exists in the organization and is being used in some project human resources management processes, for instance using HR software to identify activities, and document and assign project roles, responsibilities, staff acquisition and professional development during the project life. However, this is still an informal practice of using a technology infrastructure. According to Spalek (2014), it is still not a cross-project standard to manage knowledge identification, capture, development, sharing and deployment processes. Sometimes, the project-based organizational structure supports all members in terms of using the project human resource management processes as well as the organizational culture but is not wide open for the same members to exchange their knowledge and information. Therefore, the project human resource management maturity level is not high due to the shortage of infrastructure and strict structure and culture. At this level, culture plays a role during the early phases of a project, while in later phases, the established cultural basis allows a higher degree of impersonal communication (Lindner & Wald, 2011).

Knowledge is less created and used in staff acquisition and professional development processes. It is a rare sharing of existing knowledge across internal organizational boundaries to manage the project's human resource. In addition, members

share their knowledge and experiences, but not all things that must be shared and used to help improve the human resource functions. Knowledge is protected through these processes and especially in the roles, responsibilities, staff acquisition and professional development.

**Level 3 -** At this level, there is an established organizational standard to identify activities, documenting and assign project roles, responsibilities, staff acquisition and professional development processes. Technology, project-based organizational structure and culture infrastructure are standardized and utilized by most project human resource management teams in the organization and are fully used to integrate knowledge into the project in terms of human resource and managing staff acquisition. Technology such as human resources software is used for the whole processes of this area. Structure is set up to suit the transfer of knowledge, and the culture is now managed and is widely open to the team members. Projects can be reported by the organization when the majority of projects are included in the project knowledge management system (Spalek, 2014).

Knowledge creation and existing knowledge are used to support the project human resource management processes, especially in selecting the staff and assigning roles and responsibilities. At this level, sometimes the team is not active, and authorized processes, activities and behaviours are conducted wrongly. There must be organizational standards to protect the knowledge with the organization boundary.

**Level 4 -** At this level, project human resource management has fully introduced the technology which can deliver relevant requested knowledge by users to support the processes in this area. Information technologies like e-mail, repositories, intranet portal, teleconferencing, and the activities of mentoring, collaboration and training play a key role in transferring knowledge (Singh Sandhawalia & Dalcher, 2011).

This is done within a flexible project-based organizational structure to share and collaborate across boundaries within the organizational culture. Culture is manageable at this level and everyone is familiar with the cultural customs and activities. Members of the organization make full use of the existing knowledge and interact between tacit and explicit knowledge in supporting quality activities in order to gain the maturity level. Organization have to be effectively utilized with proper training, knowledge and information provided to the personnel within the organization so that they can carry out

their tasks and functions in a productive manner (Kapur, 2018). Project human resource management is considered as a more important area in the project management. Whenever the right staff is hired and professional development is improved, a high maturity level in the organization is achieved.

**Level 5 -** This is the highest level and indicates the organization's awareness of the role that knowledge management plays in project management (Spalek, 2014). It shows that all the project human resource management processes have been successfully completed with full support by the knowledge management capabilities in the organization. An improved process is required at this level if any insufficiency in the knowledge capabilities toward this area is observed. All data and knowledge obtained during these processes are used for the improvement of this area for the next project and the documentation of the lessons learned on each process is ensured. It is vital to ensure reconciliation of the individual/group goals with those of the organization so that the personnel feel a sense of commitment and loyalty towards it (Kapur, 2018).

### 2.10.7 Project Communications Management

The purpose of project communication management in the organization is to manage the project data process from collection to categorization, dissemination and utilization of the data to support decision-making. According to PMI (2013), the main processes of project communication management is communications planning which determines the information and communications needed of all the project stakeholders inside and outside organization. The next process is managing communications, which deals with the information needed during project execution and progress measurement control and includes status reporting and forecasting data and reports received from project integration and information distribution for making information available and accessible to all stakeholders of the organization (Richardson, 2014). The last process is controlling communications, which is responsible for the control of information for the ongoing project in the organization.

**Level 1 -** In general, at this level, the knowledge management capabilities are ad hoc and project management teams follow informal organizational practices in handling the project communication management processes. There is no established technology, project-based organizational structure, organizational culture and no usage of knowledge

processes as the organization is at the beginning stage of communication management. Therefore, through such knowledge transmission, individuals acquire a new edge to facilitate new actions (Akram et al., 2018).

**Level 2 -** At this level, technology exists in the organizations and is used in some of the project communication management processes. They use some communication software for planning and distribution, following the performance reporting of the communication in the organization to keep track of the issues related to the project. However, this is still an informal practice of using a technology infrastructure. The project-based organizational structure supports all members in terms of using the project communication management processes, but the organizational culture is not wide open for the same members to exchange their knowledge and information and to communicate freely without any restriction. Project-based organizational structure's capability for facilitating the flow of knowledge is shaped by an organization's policies, processes, and system of rewards and incentives, which determine the channels from which knowledge is accessed and how it flows (Singh Sandhawalia & Dalcher, 2011).

Knowledge is less created and used in the planning, managing and controlling of communications processes. It is rare to share existing knowledge across internal organizational boundaries. In addition, members share their knowledge and experiences, but not all things that must be shared. Knowledge is beginning to be protected through these processes and especially in the performance reporting process.

**Level 3 -** At this level, there is an established organizational standard to plan communications management, manage communications and control communications processes. Technology, project-based organizational structure and culture infrastructure is standardized and utilized by most project communication management teams in the organization and are used to integrate knowledge into the project in terms of communication. The team members can also communicate regarding the project and share knowledge and ideas that support the project's success.

Organizations at this level manage to use the technology such a communication software for the processes of this area. Structure is set up to suit the transfer of knowledge and facilitate the communication level, and the culture is now managed and is widely open to the team members. There is knowledge creation and use of existing knowledge

to support the processes of project communication management, like the planning and distribution of information. At this level, sometimes the team is not active with the standards, and the authorized processes, activities, and behaviours are being conducted wrongly, so there organizational standards on how to protect the knowledge inside the organization is required.

**Level 4 -** At this level, project communication management has fully introduced the technology which can deliver relevant requested knowledge by users to support all the processes in this area. This is done within a flexible project-based organizational structure to share and collaborate well across boundaries within the organizational culture, which is manageable at this level and everyone is familiar with the cultural customs (Singh Sandhawalia & Dalcher, 2011).

Members of the organization make full use of the existing knowledge and interact between tacit and explicit knowledge to support communications planning, information distribution, performance reporting and issue tracking processes in order to enrich the communication in the project. Organizations have training programs in project communication management to educate their employees to protect the knowledge and information during their communication regarding the project's needs and issues and sensitize them on how this knowledge could affect the organization in case it is not protected.

**Level 5 -** All the processes are done successfully for the project communication management such as communications planning, information distribution, performance reporting and issue tracking processes to support the process of improvement at this level. All data and knowledge obtained during these processes are used for the improvement of this area for the next project and ensure the lessons learned are documented at each process. Innovation in this level is a result of such knowledge exchange that occurs between employees (Akram et al., 2018).

### 2.10.8 Project Risk Management

The main purpose of project risk management for the organization is by identifying, analysing, responding and controlling risk factors during the project process in the organization. Another benefit is to understand the risk events and determine the

best way to deal with the risks (Richardson, 2014). Lastly, organizations must develop and execute a plan and monitoring progress in the organization.

According to the PMI (2013), the main processes of project risk management is planning risk management and determining which risks are likely to be faced during the execution of the project process activities. The next process would be to identify risks, which is evaluating risks and assessing the potential outcomes in order to prioritize the list of quantified risk events. The qualitative and quantitative risk analysis processes are responsible to define the steps to manage these risks in the organization by determining how best to respond and establish contingency plans, reserves and agreements necessary to contain risks. Another process is risk control, which is controlling risks, making decisions on how to handle each situation, and taking corrective action.

**Level 1 -** In general, at this level, the knowledge management capabilities are ad hoc and project risk management teams follow informal organizational practices in handling project risk management processes. There is no established technology, project-based organizational structure, organizational culture or usage of knowledge processes as the organization is still the beginning stage of the project. Project management challenges are linked to lack of attention to human factor issues in the design and development of new technology (Fossum, Danielsen, & Aarseth, 2018).

**Level 2 -** At this level, technology exists in the organization and is used in the some of the project risk management processes. For instance, the organization uses a software that helps the organization manage its risk management processes, plan risk management, identify risks, perform qualitative risk analysis, perform quantitative risk analysis, plan risk responses and control risks. However, this is still an informal practice of using a technology infrastructure. Sometimes, project-based organizational structure supports all members in terms of using the project risk management processes. The difficult design and structure are an obstruction to locate and determine the risks, and the organizational culture is not wide open for the same members to exchange their knowledge and information. Therefore, the risk level in the project is high due to the shortage of infrastructure and strict structure and culture. According to Lindner and Wald (2011), culture plays a particular role during the early phases of a project, while in later phases, the established cultural basis allows a higher degree of impersonal communication.

The knowledge is less created and used in identification and determining risk, risk quantification, risk response development and risk control and documentation processes. It is rare to share existing knowledge across internal organizational boundaries regarding how to manage risks in the project. In addition, members share their knowledge and experiences, but not all things that are shared are used (Akram et al., 2018). Knowledge starts to be protected through these processes and especially in the activities of sequencing, schedule development, schedule integration and schedule control.

**Level 3 -** At this level, there is an organizational standard established to plan risk management, identify risks, perform qualitative risk analysis, perform quantitative risk analysis, plan risk responses and control risks processes. Technology, project-based organizational structure and culture infrastructure are standardized and utilized by most project risk management teams in the organization. They are also fully used to integrate knowledge into a project in terms of controlling risks, risks quantification and risk response. The organizations use technology such a project risk management software for the processes of this area. Information security is required because the technology applied to information creates risks (Ahlan & Arshad, 2012).

Structure is set up to suit the transfer of knowledge, and culture is now managed and is widely open to team members. There is knowledge creation and use of the existing knowledge to support the project risk management processes, especially risk quantification, risk response development and risk control**.** At this level, sometimes the team is not active and the new standards and authorized processes, activities, and behaviours are being conducted wrongly, so organizational standards to protect the knowledge with the organization boundary is needed.

**Level 4 -** At this level, project risk management has fully introduced the technology, which can deliver relevant requested knowledge about risks by users to support all the processes in this area. This is done within a flexible project-based organizational structure to share and collaborate across boundaries within the organizational culture, whether internally or internationally, and culture is manageable at this level and everyone is familiar with cultural customs and activities. An organization's culture is central to encourage interaction and collaboration between individuals to facilitate knowledge flow, and provides individuals the ability to self-organize their own knowledge and practice networks (Singh Sandhawalia & Dalcher, 2011).

Members of the organization make full use of the existing knowledge and interact between tacit and explicit knowledge to support the risk management activities to gain the maturity level and avoid any risks that may lead to project failure. Organizations have training programs to educate their employees to protect the knowledge and information of the project risk management and sensitize them on how this knowledge could affect the organization in case it was not protected. Project risk management is considered one of more important areas in the project management, and whenever the risks are managed and controlled, the organization can reach a high maturity level.

**Level 5 -** At this level, all the project risk management processes are done and completed successfully with full support by the knowledge management capabilities in the organization. An improvement process is required at this level if any insufficiencies are observed in the knowledge capabilities toward this area. All data and knowledge obtained during these processes are used for the improvement of this area for the next project and the documentation of the lessons learned on each process is ensured. Akram et al. (2018) stated that knowledge sharing with employees leads to innovative work behaviour in the context of knowledge donating and knowledge collecting.

### 2.10.9 Project Procurement Management

There is a purpose for project procurement management in the organization; it deals with all purchases, acquisitions and contracts planning. According to the PMI (2013), the main process of project procurement management is procurement planning, which determines whether to go for procuring or production by the organization. After determining this, the next steps are deciding how to procure, what and how much to procure and when to go for procurement. The next step is conducting the procurement process by filling the gap between identifying requirements and contracting by identifying potential vendors, determining solicitation type, determining type of contract, developing procurement documents and solicitation/source selection. Next comes finding the right vendor, negotiating the contract, getting information, receiving bids and proposals, evaluating the information, negotiating the contract and finalizing the contract. The last processes are controlling procurements and procurement closure, where there must be actions involved with vendor management during contract performance, acceptance by the client, payment for services and close out activities (Richardson, 2014),

and assuring that the seller performance is in accordance with the terms of the contract and receives proper reimbursement.

**Level 1 -** In general, at this level, the knowledge management capabilities are ad hoc and project procurement management teams follow informal organizational practices in handling the project procurement management processes. There is no established technology, project-based organizational structure, organizational culture or usage of knowledge processes as the organization is in the beginning stage. Knowledge assets are intended to be sufficiently generic so that it captures the capabilities of an organization across a wide range of technologies and processes (Freeze & Kulkarni, 2007).

**Level 2 -** At this level, technology exists in the organization and is used in some project procurement management processes. For instance, by using software to help plan the procurement and the requisition process and identify what venders have to go for based on their pro-invoices and services. However, this is still an informal practice of using a technology infrastructure. Sometimes, a project-based organizational structure does support all its members in terms of using the project procurement management processes and the organizational culture is not wide open for the same members to exchange their knowledge and information. Therefore, the procurement process may fail due to the shortage of infrastructure and strict structure and culture. Knowledge is less created about the vendors and about the project needs in the planning, identifying, requisition and contract management processes. It is rare to share existing knowledge across internal organizational boundaries regarding the management of procurement success. In addition, members share their knowledge and experiences, but not all things that are shared are used. Knowledge at this level is beginning to be protected through these processes and especially in the identifying and closing of the procurement.

**Level 3 -** At this level, there is an organizational standard established for project procurement management processes. Technology, project-based organizational structure and culture infrastructure are standardized and utilized by most project procurement management teams in the organization. They are fully used to integrate knowledge into projects in terms of procurement planning, procurement identifying, requisition process, and contract management processes. The project-based organizational structure capability for facilitating the flow of knowledge is shaped by an organization's policies,

processes, and system of rewards and incentives, which determine the channels from which knowledge is accessed and how it flows (Singh Sandhawalia & Dalcher, 2011).

The structure is set up to suit the transfer of knowledge and culture is now managed and is widely opened to the team members. There is knowledge creation and use of existing knowledge to support the project procurement management processes, especially in identifying the procurement and closing the contract. At this level, sometimes the team is not active and the authorized processes, activities, and behaviours are being conducted wrongly. Thus, organizational standards are not well recognized to protect the knowledge with the organization's boundary to have project procurement management maturity.

**Level 4 -** At this level, the project procurement management has fully introduced the technology that can deliver the relevant requested knowledge by users to support all the processes in this area. This occurs within a flexible project-based organizational structure to share and collaborate across boundaries within the organizational culture, whether internally or internationally. Culture is manageable at this level and everyone is familiar with cultural customs and activities (Lindner & Wald, 2011). Members of the organization make full use of the existing knowledge and interact between tacit and explicit knowledge in supporting quality activities to gain the maturity level. Organizations have training programs to educate their employees on protecting the knowledge and information of the project procurement management protection and sensitize them on how this knowledge could affect the organization in case it was not protected.

**Level 5 –** In this level, all the project procurement management processes are done and completed successfully with full support by the knowledge management capabilities in the organization. The improvement process is required at this level if any insufficiencies are observed in knowledge capabilities in this area. All data and knowledge obtained during these processes are used for the improvement of this area for the next project and documentation of the lessons learned for each process is ensured.

### 2.10.10Project Stakeholders Management

Project stakeholder's management's purpose in the organization is managing and planning the project's stakeholders by identifying each stakeholder engagement and manage and control their engagement and contribution to the project's decision making.

According to the PMI (2013), the main process of project stakeholders management is identifying the project stakeholders which are the names and responsibilities of these stakeholders to the project from inside and outside the organization. The next process is planning stakeholder management, which deals with the planning of and managing of the stakeholders' decision toward the project's progress and activities. Next is to handle their engagements, involvement and contributions to the project's improvement. The last process in this area is controlling the stakeholders' engagement. They need to be engaged with ongoing and future projects, but these engagements should be controlled, guided and documented in order to have positive engagements and avoid negative ones.

**Level 1 -** In general, at this level, the knowledge management capabilities are ad hoc and project stakeholders' management teams follow informal organizational practices in handling the project stakeholders' management processes, especially in identifying the project stakeholders. There is no established technology, project-based organizational structure, organizational culture or usage of knowledge processes as the organization is at the beginning stage of stakeholder's management. This is a new knowledge area in project management.

**Level 2 -** At this level, technology exists in the organization and is being used in some of the project stakeholder's management processes. They use software to identify and plan the project stakeholders, as well as managing and controlling stakeholder engagement. However, this is still an informal practice of using a technology infrastructure. The project-based organizational structure supports all members in terms of using the project stakeholder's management processes and the organizational culture is not wide open for the same members to exchange their knowledge and information and communicate freely without any restriction. The project-based organizational structure's capability to facilitate the flow of knowledge is shaped by an organization's policies. Knowledge about the stakeholder is less created, and they do not have enough knowledge

in managing and controlling the stakeholder's engagement processes. It is rare to share existing knowledge across internal organizational boundaries. In addition, members share their knowledge and experiences, but not all things that must be shared. Knowledge is beginning to be protected through these processes and especially in the controlling process.

**Level 3 -** At this level, there is an organizational standard established to identify stakeholders, plan stakeholder management, manage stakeholder engagement, and control stakeholder engagement. Technology, project-based organizational structure and cultural infrastructure are standardized and utilized by most project management teams in the organization and are being used to integrate knowledge into the project in terms of identifying stakeholders. The project managers can communicate concerning the project and share knowledge and ideas that support the project's success by identifying and planning the right project stakeholders.

Organizations at this level are managing to use technology such using software for the processes of this area. Structure is set up to suit the transfer of knowledge and facilitate communication. Also, culture is now managed and is widely open to the team members. There is knowledge creation and use of existing knowledge to support the project stakeholder management's processes, like identifying stakeholders, planning stakeholder management, managing stakeholder engagement and controlling stakeholder engagement. The project may have succeeded on the product side, but many fail on the process side by not keeping stakeholders informed about what is going on within the project (Baker, 2012). At this level, the team is not active with these needed standards and authorized processes, activities, and behaviours are being conducted wrongly, so organizational standards to protect the knowledge inside the organization is needed.

**Level 4 -** At this level, project stakeholder management has fully introduced technology which can deliver relevant requested knowledge by users to support all the processes in this area. This is done within a flexible project-based organizational structure for to share and collaborate across boundaries within the organization's culture, which is manageable at this level and everyone is familiar with its cultural customs (Singh Sandhawalia & Dalcher, 2011).

Members of the organization make full use of the existing knowledge and interact between tacit and explicit knowledge such as identifying stakeholders, planning stakeholder management, managing stakeholder engagement and controlling stakeholder engagement in order to enrich stakeholder selection in the project. Organizations have training programs in project stakeholder management to educate their employees on protecting the knowledge and information during their communication in this area regarding the project's needs and issues, and to sensitize them on how this knowledge could affect the organization in case it was not protected.

**Level 5 -** All the processes are done successfully for the project stakeholder management such as identifying stakeholders, planning stakeholder management, managing stakeholder engagement and controlling stakeholder engagement processes which support the process of improvement at this level. All data and knowledge obtained during these processes are used for the improvement of this area for the next project and documentation of lessons learned at each process is ensured.

## 2.11 Hypotheses development

**Hypothesis 1**

The project-related technology infrastructure in the organization includes communication technologies and systems, data processing, storage, and management of information. The effectiveness and efficiency of this infrastructure that supports project management implementation are essential conditions at the initial stage and across all the stages of the project management maturity. According to de Souzaa and Gomesb (2015), information technology is the area upon which project management maturity studies are mostly focused on. It has an important role in the strategic function of the leading organizations in competitive markets (Carvalho & Rabechini, 2011).

One possible way to systematically view the technology infrastructure is to consider the capabilities provided in four aspects (reach, depth, richness and aggregation). Turner (2009) argued that good project management can be achieved by achieving a balance between the different areas of technology as well as between cultures. Yeong and Lim (2010) suggested that technology as a factor may have an effect on project management, which in turn influences the enhancement of a project's success. Tissayakorn, Akagi and Song (2013) added that organizations always work to develop

and improve their technology infrastructure. They will manage to change from a closed system or workflow system to an enterprise-wide knowledge sharing system with more intelligent technologies and can add value to the organization's performance and increase its project management maturity level. Based on the above, the study hypothesized that:

*"Project-related technology has a significant positive effect on project management maturity."*

**Hypothesis 2**

The way an organization is structured is fundamental to the outcome of its project management performance (PricewaterhouseCoopers, 2012). The alignment of the project-based organizational structure to the degree of importance of project management within the organization is decisive in the overall project performance and leads to project management maturity. Schwalbe (2008) stated that project-based organizational structure has a big influence on overall project performance; the higher the alignment between structure and business requirements, the higher the overall project performance. This infrastructure is underestimated and completely ignored by the top management. Organizations have not evolved or adapted themselves as quickly as the business has, hence, large proportions of projects fail. Rasula, Vuksic and Stemberger (2012) stated that project-based organizational structure can improve social interaction, and in turn results in a higher degree of knowledge sharing and application for the purpose of achieving a high maturity level in project management. According to Souzaa and Gomesb (2015), the project-based organizational structure of organizations is an essential factor that will influence the availability of resources and can thereby affect how the projects will be managed and how the organization can gain the highest level of project management maturity. Based on the above, the study hypothesized that:

*"Project-based organizational structure has a significant positive effect on project management maturity."*

**Hypothesis 3**

In general, culture incorporates a set of shared values, norms, beliefs and thinking that the members of an organization possess. Some people find a positive relationship

between organizational culture determined by trust, learning and collaboration. The culture of the organization is nothing more than the result of the experience lived by the organization's members with the ability to influence and make decisions (de Souzaa & Gomesb, 2015). An organization's cultural infrastructure is key to the ability of the organization to manage knowledge effectively in order to increase the organization's performance (Tissayakorn et al., 2013). Therefore, organizations should seek to promote and build the types of cultural values that support their project management, which will lead to varying outcomes in terms of maturity, good cultural values such as sharing and openness, and trust that will lead to positive project management maturity, innovation and efficiency, whereas bad values will lead to undesirable outcomes such as inefficiency. Pretorius, Steyn and Jordaan (2012) identified organizational culture as one of the major factors behind a project's success. Organizational culture affects the way a company internally transfers the knowledge it generates from projects (Ajmal & Koskinen, 2008).

Yeong and Lim (2010) suggested that culture influences project management practices in the organization, which in turn affects the chance of a project's success. Therefore, an organization's culture should provide support and incentives, and encourage knowledge-related activities by creating environments for knowledge exchange and accessibility in order to facilitate the project management maturity for the organization (Tissayakorn et al., 2013). Based on the above, the study hypothesized that:

*"Project-oriented organizational culture has a significant positive effect on project management maturity."*

**Hypothesis 4**

Project knowledge acquisition can be done by using existing knowledge and effectively produce new knowledge through active conversation among the organization's members, by externalization and distribution as new knowledge. Project knowledge acquisition methods include conducting an external survey, acquiring a knowledge rich firm, sending employees to external training, hiring an employee, purchasing a dataset, monitoring technological advances, and purchasing a patented process. It is enabled by the processes and activities of interaction, feedback, innovation, brainstorming, and benchmarking (Wang, 2015).

This process has a significant effect on project management as long as it's conducted in a sufficient manner and knowledge is acquired correctly from existing knowledge that will lead the organization to project management maturity. According to Isaac, Kapkiyai and Joywin (2015), knowledge is captured by six factors: valuing employees' attitudes and opinions and encouraging employees to up-skill; being market focused by actively obtaining user and industry information; having a well-developed financial reporting system; being sensitive to information about changes in the marketplace; employing and retaining a large number of people trained in science, engineering or math; working in partnership with international users; and getting information from market surveys. Handling these factors in this process can ensure an excellent organization performance. According to Yeong and Lim (2010), knowledge that is created, transferred, captured and reused within a project will result in improving project management maturity. Based on the above, the study hypothesized that:

*"Project knowledge acquisition has a significant positive effect on project management maturity."*

**Hypothesis 5**

Making current knowledge useful in the organization is called project knowledge conversion and is made possible through the processes and activities of synthesis, refinement, integration, combination, coordination, distribution, and restructuring of knowledge. This process enables an organization to make individual knowledge useful to the organization by converting individual knowledge into usable knowledge. One of the mechanisms is through the four phases that have been proposed by (Nonaka, 1994) which are socialization, externalization, combination, and internalization. These processes also allow the organizations to replace knowledge that has become outdated. Some of the processes that enable project knowledge conversion are the organization's ability to organize, integrate, combine, structure, coordinate, or distribute knowledge. According to Owen (2008) as cited by (Yeong & Lim, 2010), knowledge that is created, transferred, captured and reused within a project will result in improved project management maturity. An organization must develop a framework to organize and structure its knowledge since without common representation standards, no consistency or common dialogue of knowledge would exist. Thus, this process affects the organization's project management maturity if it was mismanaged (Kimaiyo et al., 2015). According to Gold et

al. (2001), a primary goal of any organization should be to integrate specialized knowledge of many individuals to achieve organizational performance. Based on the above, the study hypothesized that:

*"Project knowledge conversion has a significant positive effect on project management maturity."*

**Hypothesis 6**

The degree of which the organization applies the knowledge resources that is shared across functional boundaries in the organization is referred to as project knowledge application. Project knowledge application concerns how knowledge is utilized to produce commercial value since knowledge can only be realized when it is applied to solve problems.

Project knowledge application involves storage, retrieval, application and sharing. Effective storage and retrieval mechanisms enable organizations to quickly access knowledge during the project's processes. Davenport and Klahr (1998) noted that an effective application of knowledge has helped organizations to improve their efficiency and reduce project costs. This process helps an organization to enhance its business performance by having the latest information and knowledge. For knowledge to influence organizational performance, it must be used to support the organization's processes. Hence, it is through knowledge utilization that acquired knowledge can be transformed from being a potential capability into a realized and dynamic capability that affects organizational performance (Kimaiyo et al., 2015). According to Owen (2008) as cited by (Yeong & Lim, 2010), knowledge that is created, transferred, captured and reused within a project will result in improving project management maturity. In addition, this is an essential process to the organization for applying the existing knowledge for the goal of achieving the highest project management maturity level. Based on the above, the study hypothesized that:

*"Project knowledge application has a significant positive effect on project management maturity."*

**Hypothesis 7**

It is an essential task in the organization to protect the knowledge asset from internal authorized access or external attacks. Security is always the major concern in any organization's management information system. Protecting corporate knowledge requires clear but detailed policies to ensure the knowledge asset is in a safe state at all times. Knowledge protection is necessary for effective functioning and control within organizations. According to Lee and Yang (2000), this would typically include the use of copyright and patents along with information technology systems that allow knowledge to be secured by a filename, user name, password and file-sharing protocols that ascribe rights to authorized users.

For a resource to confer competitiveness to an organization and result in superior performance in project management, it has to be valuable, rare, inimitable and non-substitutable. This resource must be protected, and organizations need to assure their organizational knowledge is kept safe and accessed only by authorized personnel. However, knowledge protection is often challenging in part because the copyright laws that are intended to protect knowledge are limited in their treatment of the knowledge environment. Yeong and Lim (2010) stated that knowledge captured and reused within a project would result in improving project management maturity. The knowledge protection process should not be abandoned or marginalized (Gold et al., 2001) as it is one of the main processes that can ensure project management maturity to the organization if it is handled properly and the knowledge is secure. Moreover, protecting knowledge from illegal and inappropriate use is essential for an organization to establish and maintain a competitive advantage in project management (Kimaiyo et al., 2015). Based on the above, the study hypothesized that:

*"Project knowledge protection has a significant positive effect on project management maturity."*

Finally, the proposed model in Figure 2.8 shows that the knowledge management infrastructure capabilities and knowledge management processes capabilities are the main factors that can measure and assess project management maturity following the capability maturity model levelling scale. All the ideas and thoughts mentioned above explain how to integrate knowledge management with project management and how knowledge

management plays a significant role in organizations to achieve their project management to its highest maturity level, which is the optimal level. Overall, the findings conform to the literature and lend credibility to the theory by Gold et al. (2001) that effective knowledge management, as measured by its influence on organizational performance, leads to successful project management. This theory is adopted with a slight change to its domain to the project management maturity, as it is dependent on the organization's knowledge infrastructure capability and knowledge process capability. Exploratory research is being conducted for this thesis in order to implement the adopted theory in higher institutions in Yemen. The adopted measurement items from the P3M3 assessment model measures project management maturity as a dependent factor.

## 2.12 Summary

Assessments of an organization's project management maturity is dependent upon the ability of the assessors to use an appropriate assessment model to extract meaningful information, gain valuable knowledge from members of the subject organization's project management community and intelligently evaluate that information to draw meaningful recommendations. Here, the assessment will be based on a proposed model in which this study will develop a model to assess project management maturity through the organization's knowledge management capabilities. This can be achieved by integrating knowledge management with two components of knowledge management infrastructure and knowledge management process with project management, in order to reach to the targeted maturity level in project management.

In conclusion, this chapter focused on the discussion of the current conducted researches that discuss the history of project management, project management maturity, project management maturity models, knowledge management and its capabilities. A clear relationship in this chapter towards project management and knowledge management capabilities has been discussed and how these two terms can be integrated to fill the existing gap in the current researches. The most used and famous project management maturity models were discussed. In addition, the model of this study had been adopted and developed, and will be used in other chapters for a clear understanding of assessing project management maturity through the organization's knowledge management capabilities. For the integration of knowledge management with project

management, Levin (2010) proposed nine guidelines for an organization to have successful implementation of these two terms.

Finally, the chapter ends with a knowledge management and project management research gap analysis, which discussed the current existing gap and how this gap can be filled in this study. The authors identified the gap and recommended and suggested that this gap can be filled with a proper and a suitable method of integrating the knowledge management into the project management, which it the main reason and need of this study.

# CHAPTER 3

# RESEARCH METHODOLOGY

## 3.1 Introduction

This chapter discusses the methodology of this study, starting by defining the research design, research method, population and sampling. It also includes the conceptual model, sample size, data collection, measurement of variables, and techniques for data analysis. It covers the descriptive statistics to find the relationship of knowledge management capabilities as factors in assessing project management maturity in higher education institutions in less developed countries, particularly Yemen. The assessment is done through seven capabilities: project-related technology, project-based organizational structure, project-oriented organizational culture, project knowledge acquisition, project knowledge conversion, project knowledge application and project knowledge protection. The chapter ends with the discussion on the statistical techniques used to analyse the data of the study.

## 3.2 Research Flow

According to Sekaran and Bougie (2016), the research process entails several activities which are divided into an applicable number of phases. In this study, the major activities are divided into three phases, as shown in Figure 3.1.

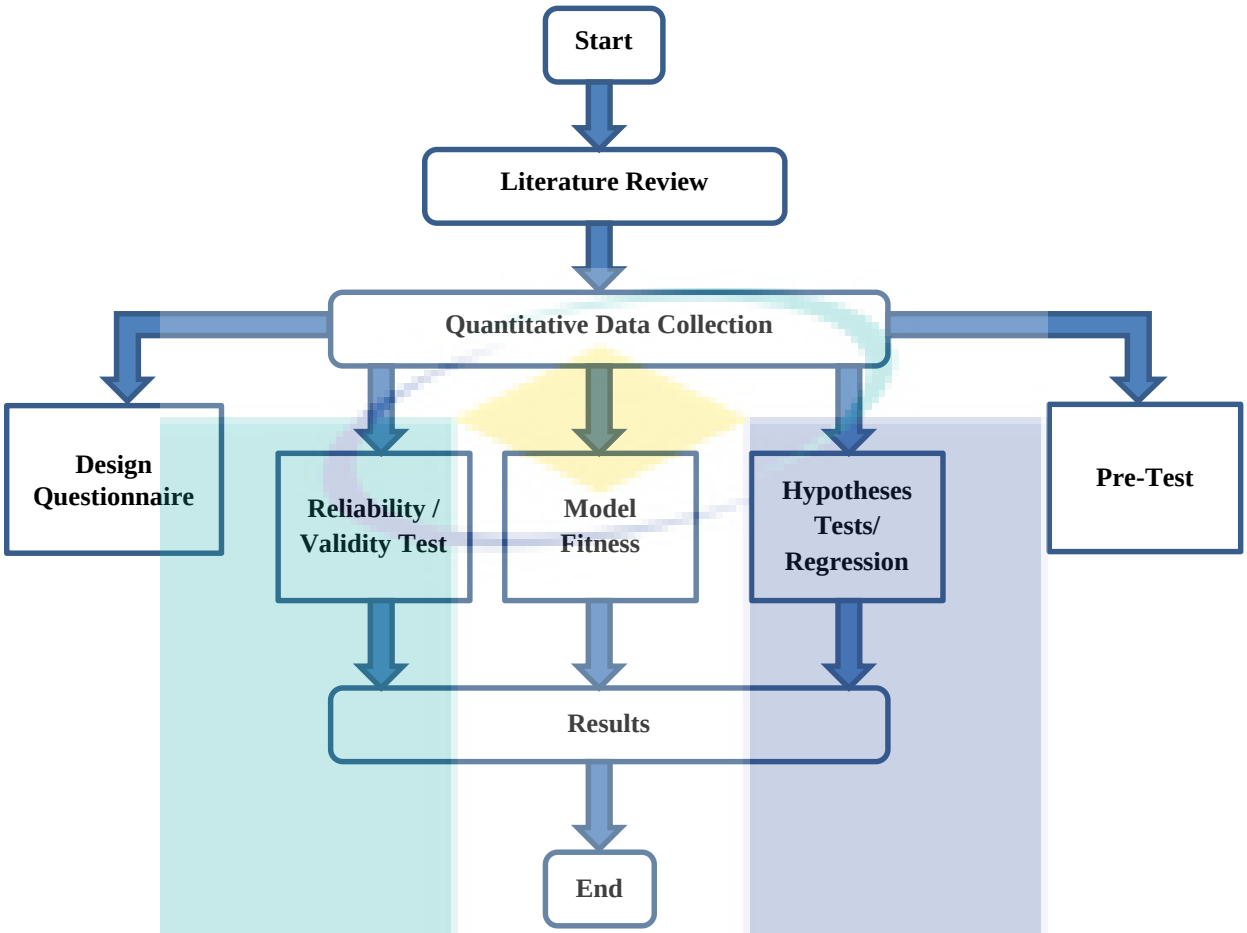


Figure 3.1 The research flow chart

The research flow illustrates the research processes, which consist of three phases. The first phase began with a comprehensive analysis of the literature review, in which every section was associated with the research area. The second phase included the conceptual model based on the model by (Gold et al., 2001) and variables which have been derived from the literature review. In addition, this phase contained quantitative research activities that determine the factors that influence project management maturity in higher education institutions in Yemen. The quantitative research includes activities such as designing and validating the survey instrument by academic experts. Afterwards, the questionnaire is sent to a translator to translate from English to Arabic. Then, the data was collected by survey and conducting a pilot test. The last phase after the data collection is the analysis, which is carried out in Chapter 4 and contains the complete analysed data from respondents. It examines the hypotheses, discusses and interprets the findings, and presents the research model so that the analysed data and revision model can be sent to academic experts for validation. Finally, the research is concluded through the findings and recommendations for this study highlighted in Chapter 5.

## 3.3 Research paradigm

The management and information system research typically consists of research that is positivist, interpretivist or critical (Candy, 1989). The choice of research paradigm is influenced by the context of the researcher (e.g. the country or university in which the researcher is based) as well as factors related to the characteristics of the research problem, the researcher and the research environment (Trauth, 2001). As a result of this thesis's research problem and the context of the researcher and his environment, the choice was made to conduct research using the positivist research paradigm. Understanding the research paradigm that is used assists in enabling an understanding of the researcher's underlying assumptions. The positivist paradigm of exploring social reality is based on philosophical ideas, observation and reason that are the best means of understanding human behaviour: true knowledge is based on experience of senses and can be obtained by observation and experiment (Antwi & Kasim, 2015). For this reason, the positivist paradigm – applied to this research – is now described.

**Positivism Paradigm**

Objectivism is reality-orientated and posits that everything exists independent of consciousness (Gellatly, 2011). These assumptions underpin the positivist perspective which is often regarded as a 'scientific method' involving knowledge being gathered in ways that are not subjective but are direct experiences (Crotty, 1998) and which are replicable involving logically deduced hypotheses and confirmed evidence. Reality is said to exist on cause-and-effect principles and that this reality can be measured. Positivists test casual explanations through the testing of theories and hypotheses using variables quantified through methods that yield numbers and statistics such as questionnaires or surveys (Gellatly, 2011). According to Antwi and Kasim (2015), the positivist research paradigm underpins the quantitative methodology. However, the data collected in this manner is efficient in testing pre-determined hypotheses and the importance of the researcher to remain objectively separated from the subject under scrutiny is stressed. It has been argued such an approach fails to capture the complexity of human behaviour and social interaction (Jensen, 1989).

## 3.4 Research Design

A quantitative method is adopted in the current study, where quantitative methods of data analysis can be of great value to the researcher who is attempting to draw meaningful results from a large body of quantitative data. The main beneficial aspect is that the quantitative analytical approach provides the means to separate a large number of confounding factors that often obscure the main qualitative findings (Abeyasekera, 2013; Salkind, 2010). In fact, statistical methods play an outstanding role in most researches that are dependent on quantitative analysis of data through converting the ordinal data to numeric data by using the rating scale (the five-point Likert scale) as will be mentioned later in another section of this chapter. As such, it helps to conclude better results and compare the results with similar previous research to show the contrast and the extent of progress of the data analysis. In addition, the statistical analysis helps the researchers to identify the degree of accuracy of the information and data of the study. It allows the reporting of summary results in numerical terms to be given with a specified degree of confidence (Salkind, 2010; Treiman, 2009). Positivism in the research relies on quantitative measures for collecting and analysing data, and aims to make predictions (Yilmaz, 2013).

A research design is about "organizing research activity, including the collection of data in ways that are most likely to achieve research aims and reaching to the expected result" (Easterby-Smith, Thorpe, & Lowe, 1991). The research design also refers to the plan and procedures used as a research guide which provides a framework for data collection and analysis (Bryman & Bell, 2007). Sekaran and Bougie (2016) argued that the research design is a plan to find the solution to the problem. As mentioned and discussed in Chapter One, this study aims to assess PM maturity in higher education institutions through knowledge management capabilities (i.e. project-related technology, project-based organizational structure, project-oriented organizational culture, project knowledge acquisition, project knowledge conversion, project knowledge application and project knowledge protection). Moreover, it will examine the independent variables on the dependent variable (i.e. project management maturity) in higher education institutions in the context of less developed countries, particularly Yemen. A quantitative research was designed to achieve the aim of this study. The quantitative research contains numerical analysis for the collected data during the study (Gelo, Braakmann, & Benetka,

2008). The quantitative research considers identifying behaviours which are quantified; quantitative researchers are more likely to use a questionnaire rather than interview to gather data (Atieno, 2009; Gelo et al., 2008).

This study uses the cross- sectional design, whereby data is gathered once to answer the study's research questions. Although a longitudinal design is often preferred over the cross-sectional one because it increases the quality of the data collected and the depth of analysis, it is expensive and time-consuming (Sekaran & Bougie, 2016). Subsequently, the cross-sectional design is adopted for this research. Furthermore, based on the scale instrument, it is conducted to obtain personal and social facts, beliefs and attitudes (Kerlinger & Pedhazur, 1973). The unit of analysis for this study is at the organizational level in dealing with projects, whereby the respondents are the departments' managers, staff and project managers, and academic staff in selected higher educational institutions in the Republic of Yemen, who are involved in project management or project teamwork.

## 3.5 The Proposed Conceptual Model

This research seeks to investigate the study's objectives and answer its questions by influencing the project management maturity level through the knowledge management capabilities in higher education institutions in less developed countries, particularly Yemen. The adopted model from (Gold et al., 2001) is the underlying theoretical lens for this study. This model serves as a theoretical lens to enable a better overview of the context of any institution with regards to their knowledge management capabilities and in relation to the maturity level in the institution. The model is used to identify how these capabilities affect PM maturity. In addition, it has been used by other researchers to analyse and explain how these capabilities lead the organization to gain a high level of performance and outcome excellence. Since its introduction, almost all researchers in knowledge management have used this model as the backbone of their research in terms of identifying knowledge capabilities, which are related to the achievement of the organization. The adopted model takes into consideration appropriate factors because it can support a wider scope of understanding in knowledge management with organizational project management maturity. Thus, this study has adopted this model with slight changes as a conceptual research model to identify how these capabilities are the main factors to achieve organizational performance or gain high maturity level in

project management. Overall, the researchers classified the factors that relate to and may influence project management maturity in terms of using:

a) Knowledge management infrastructure (project-related technology, project-based organizational structure and project-oriented organizational culture).
b) Knowledge management processes (project knowledge acquisition, project knowledge conversion, project knowledge application and project knowledge protection).

Therefore, the conceptual model in the study focuses on these seven factors as shown in Figure 3.2.

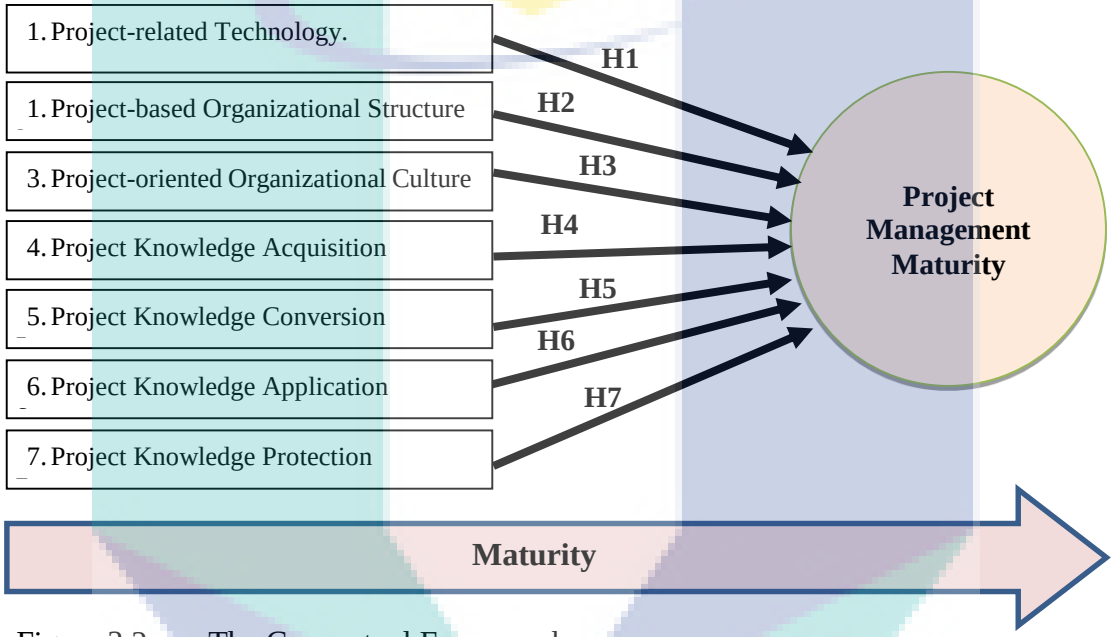


Figure 3.2 The Conceptual Framework

The conceptual model helps to address the main objective of this study by looking at the relationships between factors and the propensity to gain the maturity level in project management. This study will enrich the existing literature by filling the research gap on how these capabilities can influence in the level of project management maturity in less developed countries like Yemen. The model is fully validated through a more extensive data collection process across higher education institutions in Yemen.

## 3.6 Research Hypotheses

Hypothesis testing tends to highlight the nature of underlying relationships or recognize differences among various study factors in the situation, thus increasing the likelihood of understanding the research (Ranjit, 2011). Thus, examining the hypotheses will offer a better understanding of the relationship between the variables (Sekaran,

2003). Since this study is aimed to assess the project management maturity level through knowledge management capabilities in higher education institutions in the Republic of Yemen, based on the previous studies, a number of factors are proposed that affect organizational performance. These factors can be categorized as project knowledge infrastructure factors (project-related technology, project-based organizational structure and project-oriented organizational culture) and project knowledge processes factors (project knowledge acquisition, project knowledge conversion, project knowledge application and project knowledge protection). Table 3.1 summarizes the hypotheses that were developed in Chapter 2.

Table 3.1 Research hypotheses

| No | Hypothesis |
|---|---|
| H1 | Project-related technology has a significant positive effect on project management maturity. |
| H2 | Project-based organizational structure has a significant positive effect on project management maturity. |
| H3 | Project-oriented organizational culture has a significant positive effect on project management maturity. |
| H4 | Project knowledge acquisition has a significant positive effect on project management maturity. |
| H5 | Project knowledge conversion has a significant positive effect on project management maturity. |
| H6 | Project knowledge application has a significant positive effect on project management maturity. |
| H7 | Project knowledge protection has a significant positive effect on project management maturity. |

## 3.7 Population and Sampling

Sampling is defined as the process used to select cases from an entire population. In this case, Churchill, Brown and Suter (2010) proposed a six-step procedure that can be utilized as a guideline for the sampling process in this study.

**(1)** Define the population – The population refers to the whole group of people or organizations of interest to the researcher (Sekaran & Bougie, 2016). In the present study, the population is defined as public higher institutions in Yemen. Table 3.2 shows the name of every institution which is under the study's population.

Table 3.2 University name/ institution name

| Type | University Name/ Institution Name | State Name |
|---|---|---|
| Public | Aden University | Aden |
| | Amran University of Technology | Amran |
| | Dhamar University | Dhamar |
| | Hadhramout University | Hadhramout |
| | Hajja University | Hajja |
| | Hodeidah University | Hodeidah |
| | Ibb University | Ibb |
| | Sana'a University | Sana'a |
| | Taiz University | Taiz |
| | Al-Bayda University | Al-Bayda |

**(2)** Identify the sampling frame – The sample frame is a list from which a sample can be taken and which ultimately leads to the sample of units about which information is to be obtained. In this study, the sample frame is the higher public institutions.

**(3)** Select a sampling method – The step of choosing a sampling procedure is inextricably intertwined with the identification of the sampling frame because the choice of sampling method is based on what the researcher can develop for a sampling frame (Churchill et al., 2010).

**(4)** Determine the sample size – The sample size refers to the number of units that need to be surveyed to obtain precise and reliable findings. Zikmund (2003) stated that when the sample units in the population are limited, the researcher may decide to study the whole population rather than taking a sample for the study. However, the determined sample size was 502 and from that number, there were only 352 valid responses.

**(5)** Select the sample elements – One of the main variables in this study is structure. Therefore, general or project managers in the selected institutions were considered as an appropriate element of the present study in addition to any other professional in this area of the research.

**(6)** Collect the data from the designated respondents – A questionnaire survey based on the Likert scale was conducted for the pilot and main study between one to two months. Since universities in Yemen are located throughout different regions, the questionnaires were distributed personally to some institutions and in other minor parts, assistance was need from colleagues. This method was designed to cover a geographically spread sample at minimal cost. The researcher used various methods to increase the response rate, such as having research assistants and visiting universities located in the north and south parts of Yemen.

The questionnaire survey was conducted between January and March 2017. The designated respondents included professionals (heads of universities, management deans, project management team, and any other professional with related specialization) in the public higher educational institutions in Yemen as the target group. The total number of public higher educational institutions is 10 in Yemen with over 3,200 staff members. Marlow (2012) stated that sampling methods are categorized into probability and non-probability. The probability sampling method ensures an equal chance of being selected for each member of the population, while non-probability allows the researcher to choose appropriate respondents according to the nature of the problem being studied. Thus, this study used the probability sampling method in the selection of the sample at the time of data collection for an unbiased approach. The sampling techniques are classified into random and non-random sampling (Ranjit, 2011). A cluster sample was chosen as the type of the sampling. Cluster sampling is a type of probability sampling techniques in which respondents are sampled in groups because the whole population is subdivided into clusters of sources of data (Lavrakas, 2008). In other words, they were selected because of their working profile accessibility and proximity to the researcher (Dillman, Smyth, & Christian, 2000). The sample size was chosen to provide adequate information on reliability and a certain degree of validity in the gathered data.

The quantitative study aimed to determine drivers which impact the maturity level in the project management among the surveyed institutions. The questions at the initial level of the survey were used to screen the respondents. The screening was designed to identify participants as individuals who will be responsible to make decisions for the project management at educational institutions. This study used two techniques to identify the sample size number. The first technique was using a popular excel formula to calculate the approximate unit number needed for the survey. The calculation was outputted based on an assumed confidence level and standard deviation values. The result of that calculation was around 350 units to participate in the survey as shown in Table 3.3.

Table 3.3 Sample size calculation formula

| | |
|---|---|
| Confidence Level | 95% |
| Standard Deviation | 19 |
| Error | 2 |
| | |
| Alpha divided by 2 | 0.0.25 |
| Z-Score | 1.9566 |
| **Sample Size** | **347** |

$$n = \left(\frac{Z\sigma}{E}\right)^2$$

Although Comfrey and Lee (1992) considered a sample study of 300 as good, Krejcie and Morgan, (1970) recommended a sample size of 357 for a population exceeding 5,000. By following this guideline and by using a statistical approach to find the exact sample size, a general formula was used to calculate the size based on the confidence level, standard deviation, margin of error and Z-score. The value of the standard deviation and margin of error were assumed and estimated closely from a previous study that had been conducted on higher education institutions in project management and computer clouding for almost the same size of population. Another way of calculating the sample size is by using an online calculation tool offered by the Creative Research Systems (https://www.surveysystem.com/sscalc.htm), which gave a close number compared to the formula's answer. However, the author added some numbers to the sample size in order to avoid any inaccuracy in the finding; the sample size number is around 400.

After discussing the population and sampling issues, the next section presents the measurements of the constructs under investigation and the questionnaire and scale design used as the data collection approach.

## 3.8 Questionnaire Design, Development and Translating

A self-administered questionnaire was used for data collection with some assistance from colleagues in different universities. Three fundamental stages were taken for constructing the questionnaire: i) Identifying the first thoughts and ideas that construct the questions; ii) Formulating and formatting the final questionnaire paper; and iii) Revising the wording of each question in the three sections of the questionnaire.

The identification of items used for the study and preparation of the questionnaire was an important step towards the success of the research. A significant amount of work

had already been done on items for the project knowledge infrastructure capabilities, project knowledge process capabilities, and project management maturity. There is a well-documented and peer-reviewed set of those items available in the literature review in the previous chapter. According to the review of literature related to the assessment of project management maturity, a well-designed questionnaire was adapted from P3M3 assessment questionnaires. The questionnaire consisted of close-ended (multiple choice) questions. Close-ended questions are more difficult to design than open-ended questions, but they come up with much more efficient data collection, processing and analysis (Bourque & Fielder, 2003). Bourque and Fielder (2003) said that surveyors should avoid using open-ended questions in the mail and other self-administered questionnaires. Thus, the questionnaire is divided into three sections as follows.

- Section one relates to the respondents' demographic data and the way of work performance.
- Section two assesses the knowledge management capability levels of the higher education institutions by the professionals in the project management areas.
- Section three assesses project management maturity as the dependent variable of higher education institutions using adopted items from P3M3.

The questionnaire was provided with a cover letter explaining the aim and purpose of the research, the security and confidentiality of the information to encourage a high response, and the way to respond to the questionnaire. The variety of the questions aimed to meet the research objectives, cover the main questions of the study, and collect all the necessary data that can support the results and discussion in Chapter Four as well as the recommendations for the research. After answering the first part that relates to the respondents' demographic data and the way of work performance, respondents were asked to rate each item on a rating scale (five-point Likert scale). This required a ranking of 1–5, where 1 represented the lowest scale and 5 represented the highest scale. A 5-point Likert-type scale was used to increase the response rate and quality along with reducing respondents' frustration level (Babakus & Mangold, 1992). Previous research has found that a 5-point scale is readily comprehensible to respondents and enables them to express their views (Marton-Williams, 1986).

From the above justification, the rating scale (the 5-point Likert scale) was chosen to format the questions of the questionnaire with common sets of response categories

called quantifiers (they reflect the intensity of the particular judgment involved) (Naoum, 2007). The quantifiers were used to facilitate understanding as shown in Table 3.4

Table 3.4 The 5-point Likert scale quantifiers

| **Scoring System** | **Strongly Disagree** | **Disagree** | **Neutral** | **Agree** | **Strongly Agree** |
|---|---|---|---|---|---|
| Scale | 1 | 2 | 3 | 4 | 5 |

The KMC-PMM constructed its assessment structure related to the PM processes and the ten PM knowledge areas of PMBOK like most of the previous PM maturity models (Kent Crawford, 2006). Most PM maturity models (Kent Crawford, 2006; Paulk, Curtis, Chrissis, & Weber, 1993) including KMC-PMM develops its own assessment questionnaire in the organization that uses the model to assess its maturity level though the organization's knowledge management capabilities.

The KMC-PMM assessment survey is based on the five levels of the KMC-PMM. This assessment survey was developed to provide an efficient tool for measuring the level of project management maturity in the higher education institutions in Yemen. The final data of this assessment were used to evaluate the current project management level of the higher education institutions according to the developed KMC-PMM model. The primary aim and outcome of this assessment is to help leaders in higher education institutions to improve project management practices of their ongoing projects and future projects.

Each process will be assigned a score based on the Likert scale (1 to 5 points). The scores are summed and averaged to determine each PM knowledge area's level of assessment. These PM knowledge area scores are accumulated to obtain the average to determine the overall KMC-PMM level of project management maturity in the institutions. All the measurement items were used to operationalize the factors in the conceptual model that was adapted from the developed KMC-PMM model. All the measurement items were adopted from previous researchers (Chiu & Chen, 2016; Gold et al., 2001) and were slightly modified to cover all the aspects of project management. More details are given in Appendix C.

Table 3.5 Measuring factors/ independent variables

| Variables | No of items | Items | Source |
|---|---|---|---|
| Project-related Technology | 10 | Technology such as hardware, software and network infrastructure in the institution are being used efficiently to support all the processes of project management. | (Gold et al., 2001), (A. N. H. Zaied, 2012) |
| Project-based Organizational Structure | 10 | Project-based organizational structure allows all knowledge to be used and shared easily without any obstacles. It is designed with a complex structure that is difficult to use in processes of this area. | (Gold et al., 2001), (A. N. H. Zaied, 2012) |
| Project-oriented Organizational Culture | 10 | Organizational culture permits the project team members to exchange and share knowledge between themselves over the institution during these processes or there are some trammels that stop the sharing the knowledge. | (Gold et al., 2001), (A. N. H. Zaied, 2012) |
| Project Knowledge Acquisition | 10 | Acquisition of knowledge by extracting, structuring and organizing from human experts in your institution. | (Gold et al., (2001), Lee and Choi, (2003), Chiu and Chen, (2016) |
| Project Knowledge Conversion | 10 | Tacit and explicit knowledge are the main types of knowledge in the organization. The higher education institution converts these knowledge to obtain the benefit of it and store it in a knowledge repository to gain maturity in this project management area. | (Gold et al., 2001) |
| Project Knowledge Application | 10 | Knowledge is available and used to assist in making decisions and perform project tasks through direction and routines. | (Gold et al., (2001) and Chiu and Chen, (2016) |
| Project knowledge protection | 10 | Knowledge protection aims to stop people outside the institution from acquiring knowledge and grant rights that empower project team members to promote their knowledge and control its uses. | (Gold et al., 2001), (A. N. H. Zaied, 2012) |

**Measurement of the Dependent Variable**

After identifying the independent variables and their measurement tool, the next point is to identify the measurement tool for the dependent variable. While the final questionnaire is being used to assess the level of PM maturity which will be the major contribution of the project goal, this can be used only after verifying the research hypothesis and validating the proposed model. Verification and validation can only be achieved through complete measurements of both independent and dependent variables.

They are measured by the proposed questionnaire and the dependent variable is measured using the adopted PjM3 maturity model.

Measuring the dependent variable could be done by adopting the most used PMM model. One of the most used PMM models were selected as a measurement for this variable, which is the P3M3 and especially the project management part in this model. The PjM3 maturity model was adopted not only because it is one of the acknowledged and used models, but also because it is simple, quantifiable and understandable to be used by organizations to assess their project management maturity (Neverauskas & Railaite, 2013). This model supports the assessment questionnaire with multiple options. Respondents may choose one of the five given options. The five options represent five maturity levels from one to five to measure the dependent variable.

Owing to the importance of clearly understanding the questionnaires by respondents, native Arabic speakers (translators) who are fluent in both languages translated the questionnaire from English into Arabic and again from Arabic to English (forward and backward translation). According to Brislin (1976), a very common possibility to evaluate translated measurement instruments is by back translation. However, in this procedure, the target questionnaire was translated back into the source language by a different translator. Sekaran (2003) suggested that it is important to ensure that the translation of the instruments is developed accordingly. The forward and backward translation approach was used to conduct linguistic and cultural validations. Linguistic validation aimed to investigate the equivalence of the language concepts on both the translated copies of the questionnaire. Cultural validation was carried out to map the concept of each translator on the target culture in order to identify potential misinterpretation due to the different ways of thinking and the appropriateness of wording in the translated work. There needs to be a similarity between the forward and backward translations. Otherwise, differences between the two texts are rendered as potential translation problems (Zavala-Rojas, 2014). The final copy of the questionnaire was compared to the original questionnaire to ensure consistency of the translation process before embarking onto the other validation process of the questionnaire.

The first draft of the questionnaire was revised through three main stages after its translation, which were face validity, pre-testing of the questionnaire and the pilot study.

With each stage, the questionnaire was revised and refined until it was ready for distribution. The details of each stage is discussed in the following sections.

## 3.9 Face validity

Face validity was important to see whether the questionnaire appears to be valid or not from the field experts. It is a common sense assessment by the experts in both knowledge management and project management fields as well as the experts in statistics (Salkind, 2010). The questionnaire was presented to seven experts (from the study's country as well as outside Yemen) by hand delivery and email at different periods to assess the validity of the questionnaire. Many useful and important modifications were made for the questionnaire. The modifications are explained in Table 3.6.

Table 3.6 Results of the questionnaire face validity

| Name | Country | Specialization | Comments/Suggestions |
|---|---|---|---|
| Expert A | Yemen (Sana'a) | MSc of Statistics | • Added some remarks in part #1 of the questionnaire which was about the respondents' demographic data, work performance and years or experience. |
| Expert B | Yemen (Amran) Project Management | Prof. Project Management | • Some of the items in the different fields of the questionnaire were modified because respondents did not understand. |
| Expert C | Sudan (Khartoum) | PhD in Mathematics & Statistics | • Helped in designing the questions for measuring the research objective, which was to assess the PM maturity level in part 3.<br>• Advised to reconsider the description parts in part 3 as it led to confusion to the respondents on how to answer the questions. |
| Expert D | Kuala Lumpur (Malaysia) | PhD candidate in Knowledge Management. | • Audited the English version of the first draft of the questionnaire and modified some words.<br>• Proposed the words of the rating scale (the 5-point Likert scale) for each field. |
| Expert E | Pahang (Malaysia) | PhD in Technology Management. | • Audited the cover letter of the questionnaire and the general structure of the questionnaire. |

Table 3.6 continued.

| Name | Country | Specialization | Comments/Suggestions |
|---|---|---|---|
| Expert F | Sana'a (Yemen) | PhD in English Literature. | • Audited the Arabic version of the questionnaire. |
| Expert G | (Istanbul) Turkey | PhD student in Urban Planning | • Reviewed the English version of the questionnaire and checked the Arabic translation for the questionnaire. |

## 3.10 Pre-testing the Questionnaire

Pre-testing of the questionnaire was done to ensure that the questionnaire would deliver the right data and ensure the quality of the collected data. In other words, pre-testing was an important and necessary step to identify if the survey had any logical problems, if the questions were too hard to be understood, if the wording of the questions was ambiguous, or if it had any response bias, etc. (Lavrakas, 2008). The pre-test was conducted in two phases with ten professionals in KM and project management industries in Yemen and outside of Yemen (each phase was tested with five professionals). J Dupuy (1974) recommended having to two pre-tests and after each test, the evaluated information along with the actual data on the test performance was used to revise and reorder the test items from easiest to most difficult. Also, Synodinos (2003) urged the questionnaires to go through several stages of validations. The first phase of the pre-test resulted with some amendments to the wording in some of the questions, and further explanation was added to some items to facilitate the understanding of the question

The questionnaire was modified based on the results of the first phase of the pre-test. After that, the second phase was conducted with five other professionals and was sufficient to ensure the success of the questionnaire, where there were no more queries from any professional and everything was clear. Thus, the questions were assumed to be clear to be answered in a way that helps to achieve the target of the study and start the pilot study. Table 3.7 provides the details of the pre-test results.

Table 3.7 Questionnaires pre-test modification

| | Name | Specialization | Result/Outcome |
|---|---|---|---|
| First Presentation | A1 | Ph.D. in Technology Management | - Modified the main cover letter of the questionnaire to be more valuable to the respondents and to explain to them the reason their participation is needed in this study.<br>- Changed and updated some questions in the Demographic section.<br>- Modified all the items for the different variables in all the project management areas (in the English language) to facilitate understanding of the Likert scale measurement.<br>- Recommended to collect the questionnaires face to face as they were a professional survey. This was to facilitate or response to any doubt about the items in the questionnaires.<br>- Added a new section to measure project management maturity in the institutions. |
| | B1 | Ph.D. in Project Management | - Modified some items in the field of project stakeholder management and project integration management.<br>- Suggested a modification to the project management maturity questions (Section 3) so they became more understandable. |
| | C1 | MSc in Construction Management | - Modified the wording (in the Arabic language) of some items in the different fields of the questionnaire (see Appendix B). |
| | D1 | Ph.D. in Project Management | - Suggested and modified the formulation of the dependent variable questions in Part 3 to facilitate understanding to respond to these questions. |
| | E1 | MSc in Project Management | - Modified an item in the field of project communication management (in the English language) where it was in need of more explanation towards the involvement of the seven independent variables in this area of the project management. |
| Second Presentation | A2 | Ph.D. in English literature | - Everything was clear and understandable, in addition to suggesting minor translating corrections to be done to the Arabic questionnaire version. |
| | B2 | MSc in Business Management | Everything was clear and understandable. |
| | C2 | Ph.D. in Knowledge Management | Everything was clear and understandable. |
| | D2 | BSc in Computer Networking. | Everything was clear and understandable. |
| | E2 | BSc in Business Information Technology. | Everything was clear and understandable and no correction was demanded. |

## 3.11 Pilot study

After the success of the second phase of the pretest, a trial run on the questionnaire was done before circulating it to the whole sample to get valuable responses and to detect areas of possible shortcomings (Thomas, 2004). Naoum (2007) described the pilot study as getting the instrument (questionnaire) cleared from any defects and fragility so that subjects in the primary study will experience no difficulties in completing it. Hence, the researcher can carry out a preliminary analysis to see whether the wording and format of the questions will present any difficulties when the main data are analysed.

To conduct a pilot study, the researcher needs to test all the survey steps from start to finish with a reasonably large sample. The size of the pilot sample depends on how big the actual sample is. A sample of around 30-50 people is usually enough to identify any significant weaknesses (Thomas, 2004). In addition, Hill (1998) suggested 10 to 30 participants for a pilot study in survey research. Thus, 40 copies of the questionnaire were distributed to respondents from the target group in higher education intuitions. All the copies were collected, coded, and analysed using Statistical Package for the Social Sciences IBM (SPSS) version 23. Some tests were conducted as follows:

- The statistical validity of the questionnaire/criterion-related validity.
- Reliability of the questionnaire using the Cronbach's co-efficient alpha method.

### 3.11.1 Statistical validity of the questionnaire

In quantitative research, validity is the extent to which a study uses a particular tool to measure what it sets out to measure. To ensure the validity of the questionnaire, a correlation statistical test should be applied. The test is the structure validity test (Pearson test) that is used to test the validity of the questionnaire by testing the validity of each field and the validity of the whole questionnaire. It measures the correlation coefficient between one field and all the fields of the questionnaire that have the same level of a similar scale (Garson, 2013).

**Structure validity test –** Structure validity is the statistical test that is used to test the validity of the questionnaire by testing the validity of each field and the validity of the whole questionnaire. It measures the correlation coefficient between one field and all the other fields of the questionnaire that have the same level on the rating scale (5-point Likert

scale) (Garson, 2013). As shown in Table 3.8, the significance values (P-values) are less than 0.05, which indicates that the correlation coefficients of all the fields are significant at $\alpha = 0.05$. Thus, it can be said that the fields are valid to measure what they were set out to measure to achieve the main aim of the study. The Pearson correlation coefficient approach among all the variables was 0.50, which means that there is a strong positive relationship between each of the seven variables. This also means that the higher the score of a participant on one variable, the higher the score will be on the other variable among the seven variables. Project knowledge acquisition is positively related with project management maturity with a value of 0.169 which still considers a positive relation as it is zero in negative value. The more this process is managed, the more the project management maturity increases positively.

Table 3.8 Structure validity of the questionnaire

| Variables | | Tech | Struc | Cul | Aqu | Con_ | App | Pro | DV |
|---|---|---|---|---|---|---|---|---|---|
| Project-related Technology | Pearson Correlation | 1 | | | | | | | |
| | Sig. (2-tailed) | | | | | | | | |
| | N | 40 | | | | | | | |
| Project-based Organizational Structure | Pearson Correlation | .585** | 1 | | | | | | |
| | Sig. (2-tailed) | .002 | | | | | | | |
| | N | 38 | 40 | | | | | | |
| Project-oriented Organizational Culture | Pearson Correlation | .571* | .720** | 1 | | | | | |
| | Sig. (2-tailed) | .018 | .000 | | | | | | |
| | N | 40 | 40 | 40 | | | | | |
| Project Knowledge Acquisition | Pearson Correlation | .522** | .656** | .575** | 1 | | | | |
| | Sig. (2-tailed) | .001 | .000 | .000 | | | | | |
| | N | 40 | 40 | 40 | 40 | | | | |
| Project Knowledge Conversion | Pearson Correlation | .583** | .495* | .508** | .465** | 1 | | | |
| | Sig. (2-tailed) | .000 | .014 | .009 | .003 | | | | |
| | N | 40 | 40 | 40 | 40 | 40 | | | |
| Project Knowledge Application | Pearson Correlation | .513** | .689** | .562** | .705** | .304 | 1 | | |
| | Sig. (2-tailed) | .001 | .000 | .000 | .000 | .057 | | | |
| | N | 40 | 40 | 40 | 40 | 40 | 40 | | |
| Project Knowledge Protection | Pearson Correlation | .615** | .502** | .366* | .604** | .430** | .550** | 1 | |

Table 3.8 continued.

| Variables | Tech | Struc | Cul | Aqu | Con_ | App | Pro | DV | Variables |
|---|---|---|---|---|---|---|---|---|---|
| | Sig. (2-tailed) | .000 | .001 | .020 | .000 | .006 | .000 | | |
| | N | 40 | 38 | 40 | 40 | 40 | 40 | 40 | |
| Project Management Maturity | Pearson Correlation | .306 | .424** | .372* | .169 | .243 | .481** | .315* | 1 |
| | Sig. (2-tailed) | .055 | .008 | .018 | .297 | .131 | .002 | .048 | |
| | N | 40 | 38 | 40 | 40 | 40 | 40 | 40 | 40 |

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

### 3.11.2 Reliability test

Reliability is the degree of consistency or dependability with which an instrument (questionnaire for this study) measures what it is designed to measure. The test does this by repeating the questionnaire to the same sample of the target group different times and compare the scores that were obtained for the first time and for the second time by computing a reliability coefficient. For most purposes, Cronbach's alpha coefficient values of more than 0.7 are considered good (Ramayah, 2011; Sarstedt, F. Hair Jr, Hopkins, & G. Kuppelwieser, 2014), but values of more than 0.5 are acceptable (Ramayah, 2011). A period of two weeks to a month is recommended to distribute the questionnaires the second time (Garson, 2013). The normal range of Cronbach's coefficient alpha (Cα) value is between 0.0 and +1.0, and a higher value reflects a higher degree of internal consistency (Garson, 2013). The results were in the range from 0.68 and 0.80 and the general reliability for all items equals 0.75. This range is considered high, where it is above 0.7. The above results of the statistical validity of the questionnaire (the internal and structure of the questionnaire) as well as the results of reliability test Cronbach's coefficient alpha method showed the success of the tests and thus the success of the questionnaire (valid and reliable). Therefore, the questionnaire was adopted, and the 40 successful copies of the pilot study were included in the whole sample.

## 3.12 Data Collection

The collection of data was done after the self-reported questionnaires were obtained from the higher education institutions in Yemen. The data collection was carried out after obtaining approval from the institutions' top management. The collection of data had distribution and return dates of the questionnaires. The target population of the research was all universities, which deal mainly with projects and managing projects.

Community colleges were not part of the study population. At the time of the study, about 10 institutions were operating in the Republic of Yemen. In this study, the survey method was used to collect data to provide a description and explore the phenomenon. According to Garson (2013), the survey is a method of collecting efficient data from the respondents from a wide population by utilizing specific instruments that include open-ended or closed items. According to Sekaran and Bougie (2016), there are two modes of data collection: online and non-online. The non-online surveys are categorized in different ways such as ad hoc mail, door to door and self-administered questionnaires (Sekaran & Bougie, 2016). This study uses the self-administered questionnaire as the appropriate method for data collection due to its ability to stimulate respondents and achieve a higher rate of response.

The project managers are assumed to be the key respondents. According to Carter, Tull and Vanrooy (2012), project managers tend to have strong communication skills, are results oriented, focus on hitting goals, are flexible in their approach, provide strong team leadership and are more knowledgeable of the organization's daily activities. In case the project manager was not available, a higher-level person who could make the decision to project management was invited to respond to the survey. The survey instrument was distributed according to the sample target as aforementioned. The survey was distributed during working hours and was accompanied by a cover letter from the researcher requesting a prompt response and research contract promising complete anonymity.

The distribution of questionnaires and data collection procedure should not be time consuming and is easily performed in short span of time (Sekaran & Bougie, 2016). The questionnaire also considers a medium understanding for data communication including a set of questions in written format for respondents to answer. The questionnaires can be managed simultaneously with a large number of respondents with shorter time and less cost and skills. This study employed the questionnaire method for the assessment of maturity in project management in higher education institutions in Yemen.

### 3.13 Data Analysis Technique

In quantitative research, there are two ways to analyse data: descriptive statistics and inferential statistics. After collecting, the data is analysed using descriptive statistics, which enables the procedures used to describe a given collection of data with the purpose

to describe the sample at hand, which are the collection of cases that we will examine (Pretorius et al., 2012).

- **Data analysis**

There are many tests that can be used in statistics, which can become difficult to identify the correct test to use. When trying to work out the most appropriate test, there are three questions that needs to be considered: What level of measurement is used to analyse the data? In this study, the ordinal measurement was be chosen to measure the data. The second question is how many samples will the study have? Here, only one sample was randomly selected, in which the study tested the relevant statistic against a hypothesized value in higher education institutions. The last question is what is the purpose of the analysis? Again, the main purpose of this analysis was to come to a positive verification for the research hypotheses and be tested against the hypothesized value.

Data analysis was done using the professional statistical software SPSS to analyse the collected data from the questionnaires. The questionnaire was designed in two sections: the first part was to collect a general data of the respondents who will answer the questionnaires. The questions in the first part were mainly designed to collect the demographic information of the respondents on project management in higher education institutions in Yemen, including their experience and knowledge regarding the current project management activities in their institutions. The collected data from this part was analysed to determine the number of respondents who had worked in any project in their institutions, the age of the respondents, the respondent's university name, years of experience, level of education, current position and the latest number of projects managed yearly by the respondent's institution. Another portion of the demographic information section was to collect and analyse data on how many project team members were currently working for each project in the surveyed institution and analyse the main reason for project failure. Finally, data was collected to analyse the respondents' opinions and suggestions on integrating knowledge management with project management that will make respondent's institution achieve a higher level of maturity in project management. The data analysis was conducted for each question in the questionnaire to know and have a realistic finding on what the respondents knew and had experienced in project management as well as the percentage of willingness to have project management be integrated with knowledge management.

The second section of the questionnaires was to collect and gather the respondent's knowledge on the seven capabilities that were applied in the ten areas of project management. Each project had its own measurement items based on the knowledge management capabilities. The respondents evaluated these areas based on the Likert scale that began with strongly disagree, disagree, natural, agree and ended with strongly agree. Each scaling level referred to the developed model's level, where strongly disagree equalled to level one which was the **initial** level. The same went for the rest of levels. All the collected data in this section were analysed with SPSS to create a frequency table of these areas and present the findings in a chart to identify and show the responses and compare the findings with other project management areas. In addition, data was analysed to calculate the mean and show the means of scale items in one table. Data analysis was concluded by analysing the last part that has the items to measure the dependent variables (DV). The correlation was used to discover if there was a correlation between two variables and how strong the correlation was among these variables.

The level of the measurements also determine the choice of referential statistics completed and whether or not a nonparametric or parametric analysis was used. Nominal and ordinal levels of measurement can only be analysed using non-parametric analyses. A Likert-type scale data is considered as ordinal data, which is treated and analysed like a ratio and interval data. Non-parametric techniques are one of the classifications of statistical procedures. It is a distribution-free test because they do not assume that the data follows a specific distribution and are often the more suitable technique for smaller samples or when the data collected is measured at the ordinal (ranked) level or nominal level (Conover, 1980; Walsh, 1962). As it was chosen, the ordinal measurement level for analysis was based on the number of samples and the purpose of the analysis, and the non-parametric techniques would more likely work with ordinal data to verify and test the hypotheses. Murray (2013) contended that Likert data is of an ordinal or rank order in nature, hence, only non-parametric tests would yield valid results and in using the regression test.

### 3.14 Structural Equation Modelling

This study gained further insight from the data analysis and hypotheses testing aided by a number of statistical tools and methods. The research hypotheses were tested based on structural equation modelling (SEM) by employing software application

SmartPLS 3.0 (Ringle, Wende, & Will, 2015). Structural equation model is a very general statistical modelling technique, and this model is widely used in behavioural sciences. It is a model that can be viewed as a combination of factor analysis and regression or path analysis (Hox & Bechger, 1998).

According to Kline (2015), SEM is considered as the best second generation multivariate method that meets the purpose. SEM is also used to analyse the causal relationship among variables. These relationships explain the changes in variables that affect other variables. According to Baumgartner, Hans and Steenkamp (1996), SEM should be considered during the selection of research methodologies, particularly in the study of issues that are connected to social science. SEM consists of two major function. The first function is the measurement (i.e. what are the things to be measured, how should they be measured and how reliability and validity conditions are met) and the second function is to explain a causal relationship among variables which are complex and unobserved (Hair et al., 2010). Due the benefit of SEM, this method is deemed most appropriate to test the conceptual model and hypotheses in this study. Other reasons for choosing PLS-SEM over CB-SEM is that PLS-SEM is an exploratory methodology that relies on primary or secondary data (Sarstedt et al., 2014). Table 3.9 shows the key features for each technique.

Table 3.9 Key features of PLS-SEM and CB-SEM

| PLS-SEM | CB-SEM |
|---|---|
| • Theory prediction and development<br>• Normality assumptions need not be met (less restrictive assumptions)<br>• Able to operate with small sample size<br>• Data could be formative<br>• Exploratory study | • Theory testing and confirmation<br>• Requires large sample size<br>• Normality assumptions must be met (restrictive assumptions)<br>• Data are continuous (reflective)<br>• Confimatory study |

Source: Hair, Black, Babin, & Anderson, (2010); Sarstedt et al., (2014)

This study develops Gold's (2001) theory. For theory development or theory building, it is considered another advantage to use partial least squares path modeling (PLS-PM). PLS-SEM also provides R2 values and indicates the significance of relationships among constructs in order to demonstrate how well the model is performing. Chin and R. Newsted (1999) recommended that the PLS approach is suitable with respect to the researcher's prediction-oriented objective and does not require normal data distribution and accommodates small sample sizes. Conversely, CB-SEM need bigger

sample size (minimum >400). One of the main advantages of PLS-SEM over CB-SEM is that PLS-SEM can handle numerous independent variables at the same time, even when these display multicollinearity (Hair, Ringle, & Sarstedt, 2011). PLS-SEM is very powerful to test the theory compared to CB based SEM (Lowry & Gaskin, 2014).

The main interest in this model is often on theoretical constructs, which are represented by latent factors. The relationships between the theoretical constructs are represented by regression or path coefficients between the observed variables, which provides an alternative name covariance structure modelling. However, the discussion of the construct and the measurement model has assumed a reflective measurement theory because the formative measurement is conceptually ambiguous (Edwards, 2011). (Devinney, Coltman, Midgley, & Venaik, 2008; Jarvis, Mackenzie, & Podsakoff, 2003; S.B. MacKenzie, Podsakoff, & Jarvis, 2005) and others agree that the formative model does not have a "common cause" for items in the construct. The reflective measurement model is used for this study as the constructs are interrelated and have a strong correlation. Chiu and Chen (2016) mentioned that KM capabilities are interrelated processes and thus the reflective measurement was used.

According to recent researches (Henseler and Sarstedt, 2013; Hair et al., 2010), goodness-of-fit (GoF) index is not suitable for model validation (see also (Sarstedt et al., 2014). For instance, by using PLS path models with simulated data, the authors showed that goodness-of-fit index is not suitable for model validation because it cannot separate valid models from invalid ones (Hair, et al., 2010). In the light of recent development on the inappropriateness of the PLS path modelling in model validation, this study adopted a two-step process to assess and report the finding of PLS-SEM path, following the recommendation by Reinartz, Haenlein and Henseler (2009). The assessment of a measurement model and the assessment of a structural model are the two-step processes adopted in this study. The first process is the assessment of the measurement model (examining individual item reliability, ascertaining internal consistency reliability, ascertaining convergent validity and ascertaining discriminant validity) and second process is the assessment of the structural model (assessing the significance of path coefficients, evaluating the level of R-squared values, determining the effect size and ascertaining the predictive relevance). The two-step process of the PLS path model assessment was introduced by several researchers (Hair et al., 2014; Reinartz et al., 2009).

The evaluation of model is followed by two phases. Firstly, the evaluation of measurement model was used to calculate reliability, convergent and discriminate validity of the research variables. Secondly, the evaluation of structural equation modelling analysis was used to achieve the objective of this study and identify the relationship between the variables and the strength of this relationship. The results of the analysis were used to test the significance of the path coefficients between the model variables (independent variables and dependent variables). The validity of the instrument was assessed using a convergent test or discriminate a validity test, and more will be discussed in Chapter Four.

- **Validation Approach**

The validation approach of research outcomes is done by validating the survey result with developed model levels. The validation is conducted by a comparison between the collected result with characteristics of each level in the developed model. The main purpose of the validation in this research was to ensure the integrity of the research outcomes or findings toward the developed model in order to establish confidence and interest in the findings and the model.

## 3.15 Data Screening and Preliminary Analysis

The data screening preliminary analysis method ensured that no ambiguous data characteristic negatively affects the results. It can help the researchers to have a better understanding on the data collected for further analysis, as well as to identify any possible violations of the key assumptions regarding the application of multivariate techniques of data analysis (Sekaran & Bougie, 2016). Prior to initial data screening, all the 378 usable questionnaires were coded and entered into SPSS 23. A preliminary data analysis was conducted such as missing value analysis, assessment of outliers, normality test, and multicollinearity test (Hair et al., 2010).

### 3.15.1 Missing Value

In the original SPSS 23 dataset, out of the 31,680 data points, 183 were randomly missed during the data entry or they were not filled in during the collection, which accounted for 0.057% of the total. Specifically, technology, structure and culture had the biggest number of missing data with 12, 13, and 16, respectively. Likewise, other items

such as project knowledge acquisition, project knowledge conversion, project knowledge application and project knowledge protection had 9, 32, 39 and 41, respectively, and the rest for project management items had around 21 missing values. While there is no widely accepted and common percentage of missing values in a dataset for making a valid statistical inference and correct interpretation, scholars generally agreed that the missing rate of 5% or less is non-significant (Tabachnick & Fidell, 2013). However, scholars and researchers have recommended that the mean substitution is the easiest way to replace the missing values if the total percentage of missing data is 5% or less (Tabachnick & Fidell, 2013) .Therefore, in this study, random missing values in the dataset were replaced using mean substitution (Tabachnick & Fidell, 2013). Table 3.10 shows the percentage and total of random missing values in this study.

Table 3.10 Total and percentage of missing values

| Latent Variables | Number of Missing Values |
|---|---|
| Project-related Technology | 12 |
| Project-based Organizational Structure | 13 |
| Project-oriented Organizational Culture | 16 |
| Project Knowledge Acquisition | 9 |
| Project Knowledge Conversion | 31 |
| Project Knowledge Application | 32 |
| Project Knowledge Protection | 39 |
| Project Management Maturity | 21 |
| **Total** | 183 out of 31,680 data points |
| **Percentage** | 0.057%. |

Note: Percentage of missing values is obtained by dividing the total number of randomly missing values for the entire data set by total number of data points multiplied by 100.

### 3.15.2 Outlier Detection

According to Barnett and Lewis (1995), the outliers were defined as observations or subsets of observations which appeared to be inconsistent with the remainder of the data. Verardi and Croux (2008) indicated that in regression analysis, the presence of outliers in the data set could strongly distort estimates of regression coefficients and lead to unreliable and inconsistent results. Outliers are often detected through an evaluation of the Mahalanobis distance; it is a type of evaluation that is a standardized form of Euclidean distance (D2). The scales are based on standard deviations, and it standardizes the data through adjustments of variable correlations (Tabachnick & Fidell, 2013). Mahalanobis analysis can be conducted through SPSS in regression. Furthermore, the data were examined for univariate outliers using standardized values with a cut-off of

±3.29 (p < .001). Tabachnick and Fidell (2013) defined Mahalanobis distance (D2) as "the distance of a case from the centroid of the remaining cases where the centroid is the point created at the intersection of the means of all the variables". Multivariate outliers were detected using the Mahalanobis distance (D2). Outlier's detection had its basis on whether D2 values were more than the chi square values (x2) of the number of items used. In the current research, 79 items were entered in SPSS 23, and any item having a D2 score higher than the chi-square value of 79 items (x2= 108.26) was known to be an outlier (Hair et al., 2010). Based on the 79 observed variables of the study, the recommended threshold of chi-square was 108.26 (p = 0.001). Mahalanobis values that exceeded this threshold were deleted. Following this criterion, the 26 multivariate outliers were detected and removed from the dataset, as they could affect the accuracy of the data analysis technique. Therefore, after removing the 26 multivariate outliers, the final dataset in this study was 352 questionnaires.

### 3.15.3 Test of Normality

Prior to conducting research, Reinartz, Haenlein and Henseler (2009) and Wetzels, Odekerken-Schroder and Van Oppen (2009) traditionally assumed that PLS-SEM provides accurate model estimations in situations that are extremely non normal. However, this assumption may turn out to be false. Lately, Hair et al. (2010) recommended that scholars should perform a normality test on the data. Highly skewed or kurtosis data can inflate the bootstrapped standard error estimates (Chernick, 2012) which in turn underestimate the statistical significance of the path coefficients (Ringle, Sarstedt, & Straub, 2012).

Field (2009) stated that a large sample decreases the standard errors, which in turn inflates the value of skewness and kurtosis statistics. The researcher next conducted normality and extreme value testing. The result of the sample normality is shown in Appendix D. The skew of the sample ranged from −0.895 to .562, and kurtosis ranged from −.733 to 2.318, meaning that the skewness was almost near 1 and the kurtosis exceeded the proposal value (Bulmer, 1979) in which the skew and kurtosis' acceptable range was -1 and 1. Therefore, the PLS-SEM was used in this study for the statistical analyses of the collected sample. Exploratory research was carried to predict research objectives and develop the adopted theory. Hair et al. (2014) stated that PLS-SEM is an exploratory methodology that relies on primary or secondary data. Chin and R. Newsted

(1999) added that the PLS approach was suitable with respect to the researcher's prediction-oriented objective, does not require normal data distribution and accommodates small sample sizes. In contrast, CB-SEM needs a bigger sample size (minimum >400). This type of structure modelling provides R2 values and indicates the significance of relationships among constructs in order to demonstrate how well the model is performing.

### 3.15.4 Multicollinearity Test

Multicollinearity is the degree to which a variable can be described by other variables. It is imperative that the correlation values of the research are less than the value recommended by many researchers (Hair et al., 2010; Tabachnick & Fidell, 2013) which is 0.80. If the correlation value is more, then it is said to have multicollinearity. The presence of multicollinearity among the exogenous latent constructs can substantially distort the estimation of regression coefficients and their statistical significance tests (Chatterjee & Yilmaz, 1992; Hair et al., 2010; Tabachnick & Fidell, 2013). In particular, multicollinearity increases the standard errors of the coefficients, which in turn renders the coefficients statistically non-significant (Tabachnick & Fidell, 2013).

To identify multicollinearity among the variables, the researcher applied the Variance Inflated Factor (VIF) method following the checking of the correlation matrix for exogenous latent constructs. The Variance Inflated Factor (VIF), condition index and tolerance value were examined to identify the multicollinearity problem. The common recommendation by (Sarstedt et al., 2014) was that multicollinearity is a concern if the VIF value is higher than 5 and tolerance value is less than .20. Table 3.11 shows the VIF values, tolerance values, and condition indices for the exogenous latent constructs.

Table 3.11 Tolerance and variance inflation factors (VIF)

| Latent constructs | Collinearity Statistics | |
|---|---|---|
| | Tolerance | Outer VIF Values |
| PIM_Cul1 | .594 | 1.684 |
| PSM_Cul2 | .622 | 1.609 |
| PTM_Cul3 | .658 | 1.520 |
| PQM_Cul5 | .776 | 1.289 |
| PHRM_Cul6 | .643 | 1.556 |
| PCoM_Cul7 | .782 | 1.279 |
| PRM_Cul8 | .718 | 1.393 |

Table 3.11 continued.

| Latent constructs | Collinearity Statistics | |
|---|---|---|
| | Tolerance | Tolerance |
| PSkM_Cul10 | .652 | 1.535 |
| PIM_Acq1 | .353 | 2.836 |
| PTM_Acq3 | .361 | 2.766 |
| PQM_Acq5 | .475 | 2.105 |
| PCoM_St7 | .476 | 2.100 |
| PRM_St8 | .480 | 2.081 |
| PProM_St9 | .385 | 2.596 |
| PCoM_Pro7 | .646 | 1.549 |
| PRM_Pro8 | .613 | 1.632 |
| PProM_Pro9 | .642 | 1.557 |
| PSkM_Pro10 | .758 | 1.320 |
| PCM_App4 | .809 | 1.236 |
| PHRM_App6 | .466 | 2.148 |
| PRM_App8 | .464 | 2.157 |
| PRM_Conv8 | .779 | 1.284 |
| PProM_Conv9 | .646 | 1.547 |
| PSkM_Conv10 | .789 | 1.267 |
| PQM_Tech5 | .438 | 2.284 |
| PCoM_Tech7 | .457 | 2.189 |

## 3.16 Common Method Variance Test (CMV)

In behavioural researches, Common Method Variance (CMV) is viewed as a potential problem. According to Podsakoff et al. (2003), CMV is defined as a variance that is attributable to the measurement method rather than to the construct of interest. Scholars have generally agreed that CMV is a major concern for scholars using self-report surveys (Podsakoff et al., 2003).

The common method bias may be a potential problem when both the dependent and independent variables are generated from the same respondents at the same time (Buck, Liu, & Ott, 2010). This study adopted several procedural remedies to minimize the effects of CMV (MacKenzie & Podsakoff, 2012; Podsakoff et al., 2003; Weijters & Baumgartner, 2012). To reduce evaluation apprehension, the participants were informed that there is no right or wrong answer to the items in the questionnaire; they were also given an assurance that their answers were confidential throughout the research process. Furthermore, semantic differential scales and 5-point Likert-type scales were used

(Podsakoff et al., 2003). The questionnaire also used both positively worded items to reduce common method variance. Therefore, the questionnaire items were re-coded to make all the constructs symmetric.

In the present study, CMV was tested using Harman's (1976) single-factor test that was performed following the approach outlined by prior researchers (Mattila & Enz, 2002; Podsakoff et al., 2003). A principal component factor analysis with varimax rotation demonstrated that all self-reported items revealed a seven-factor structure. The 35.1% variance explained by a single factor shows that the common method bias is not a major concern in this study (less than 50% cut-off point). The result was obtained by running an unrotated, a single-factor constraint of factor analysis in SPSS statistic. Therefore, CMV did not appear to be a significant problem in this study.

Table 3.12 Common method variance - Harman's one-factor test

| Factor | Extraction Sums of Squared Loadings | | |
|---|---|---|---|
| | **Total** | **% of Variance** | **Cumulative %** |
| Total variance explained | | | |
| 1 | 7.235 | 10.336 | 10.336 |
| 2 | 5.705 | 8.150 | 18.486 |
| 3 | 2.739 | 3.913 | 22.399 |
| 4 | 2.549 | 3.642 | 26.040 |
| 5 | 2.212 | 3.160 | 29.200 |
| 6 | 2.116 | 3.022 | 32.222 |
| 7 | 2.018 | 2.883 | 35.105 |
| ***N* = 352** | | | |

## 3.17 Power Analysis and Sample Size

It is important in any research survey to determine a suitable sample size and to collect enough additional data to obtain statistical significance while ignoring the scientific meaning (Lenth, 2001). Post hoc analysis is a statistical power 1-β computed as a function of significance level α, sample size, and population effect size, (Faul, Erdfelder, Buchner, & Lang, 2009). Statistical power is the probability that the study will find a statistically significant difference between interventions when an actual difference does exist (Sullivan & Feinn, 2012). The power analysis "is the probability that it will correctly lead to the rejection of a false null hypothesis" (Greene, 2012). G*power is used to validate the calculated sample size in Table 3.3, which gave a similar value with a small difference.

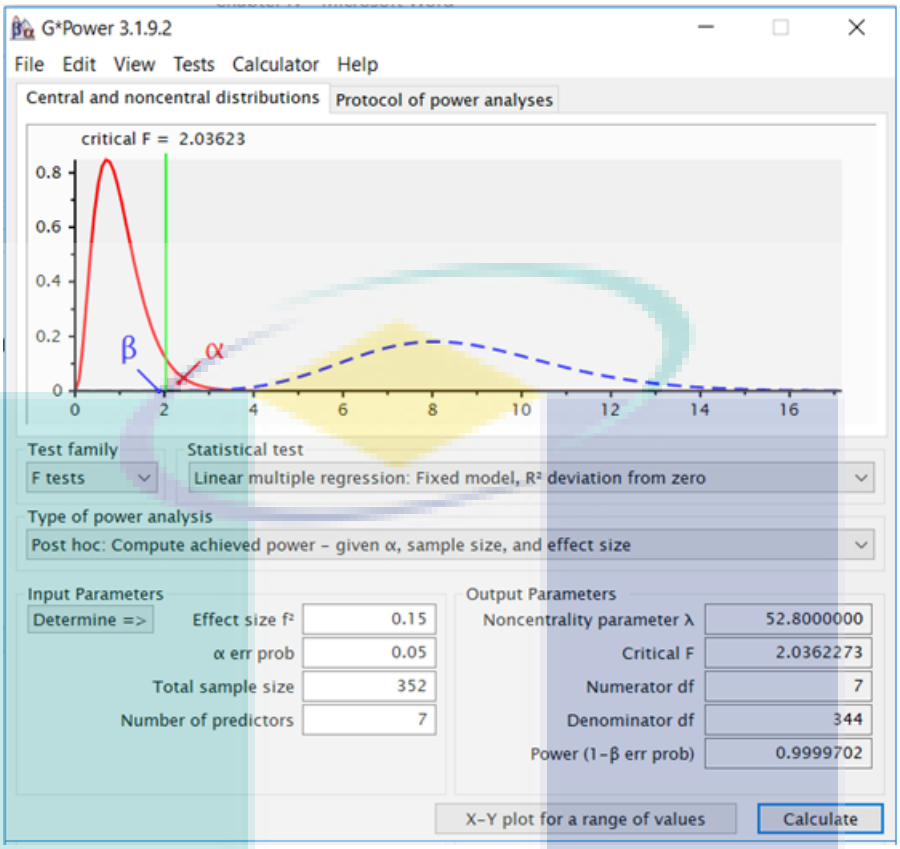


Figure 3.3 G-power to determine a suitable sample size

A post hoc power analysis using the software package G-Power 3.1.9.2 following (Faul et al., 2009) was applied on the findings. Figure 3.3 indicates the input and output parameters, the post hoc power analysis procedure that requires the population "Effect size f2 0.15", the alpha level used for this analysis that "α err prob ($p < .05$)", the total sample size "352", and the total number of predictors"3" in the regression model as the input parameters. The output parameters were "Non-centrality parameter λ= 52.80" ("Critical F= 2.03623)" the degrees of freedom ("Numerator df= 7," "Denominator df = 344"), and the power of the omnibus F test "Power (1-β err prob = 0.9999702)". Therefore, there was more than adequate power (i.e., power = .999) for this study's effect size levels.

## 3.18 Summary

This chapter has critically discussed the research method that was employed in collecting the data for this study. This research primarily used quantitative approaches. The survey was distributed and collected from the participants in ten different institutions in Yemen and were subsequently used in validating and testing the necessary hypotheses on the relationships mentioned previously. The following chapter elaborates on the research findings. This chapter discusses the methodology used in the study and included the research process, approach, design and sampling method and instrument to collect and analyse data. In addition, it identified the validation process for the study outcomes which would be validated and compared with the proposed model that was discussed in Chapter 2. Finally, the collected data was analysed using the PLS–SEM and the hypotheses were tested using SPSS to test the relationships among the independent variables and dependent variable.

# CHAPTER 4

# RESULTS AND DISCUSSION

## 4.1 Introduction

This chapter presents the results of data analysis by applying the Structural Equation Modelling (SEM) using Partial Least Squares (PLS) path modelling. The first section reports the results of the response rate. Then, data screening and preliminary analysis are discussed to polarize the good data needed for the analysis part. The finding of the descriptive statistics for all constructs are reported accordingly to the structural model. It follows the measurement model assessment to determine the individual item reliability, convergent validity, internal consistency reliability, and discriminant validity. All the findings of the structural model are reported and explained such as significance of the path coefficients, effect size, level of the R-squared values, and predictive relevance of the model. Finally, it ends by examining the relationship and effects of knowledge infrastructure capabilities and knowledge process capabilities on project management maturity. The chapter concludes with a comprehensive discussion on the findings, where it enriches the institutions in Yemen with elaborate and positive arguments that benefits the higher education institutions if they give full attention.

## 4.2 Questionnaire Distribution and Collection

The complex questionnaire consists of three parts. Part 1 comprises 11 questions aiming to explore respondents' profile and is given in Section One of the questionnaire. With five questions, Section Two focuses on revealing the demand for PMs and the respondents' experience in PM and obtained their opinion for the integration of KM with PM in their institutions. Section Three consists of nine multiple-choice questions taken from the PjM3 model and assesses PMM in the ten public universities.

This section provides the questions, the organizational process area they are intended to assess, and descriptions of each question. Each of the nine questions has five options to choose from (a) to (e), which correspond to the PMM level of 1 to 5, respectively. The complete PjM3 questionnaire was applied in this research with minor modification on it and had shortened the explanation of each option by avoiding the length and confusion that the respondents may encounter while answering this survey using nine multiple-choice questions, instructions. Self-assessment tips were also available for download from the link given (Office of Government Commerce, 2010a).

In the second section of the questionnaire, respondents judged each KM capability for every PM area. If the overall judgment was "strongly disagree" based on the Likert scale (Table 3.4), then an institution is best characterized as having immature processes and only partial awareness of their capability in that particular PM area. However, the total average of KM capabilities in the ten PM areas was identified the level of PM maturity in the higher education institutions in Yemen based on each capability. The same went for the third section where if the overall judgment was positive then an institution was best characterized as having mature processes and has a full awareness of PM. This implies that an institution always delivers individual initiatives that produce excellent results.

The survey was conducted during the first quarter of 2017. The researcher contacted PM professionals in different higher education institutions in Yemen. Six institutions were visited by the researcher and the questionnaire was handed to the respondents with an explanation and instructions on how the questionnaire was important to their institutions and that they should fill in the survey with full attention and positive participation. In addition, for the targeted universities, some of the colleagues and PM professionals assisted the researcher in distributing and collecting the questionnaires. One of the main reasons identified for the low response rate from the institutions that were not visited was that the PM professionals did not take the tasks seriously and did not find enough time to distribute and explain to the respondents the importance of the survey to their institution. To complete the three sections of the questionnaire, a respondent would spend, on average, about 15-20 minutes.

## 4.3 Response Rate

A suggested number of questionnaire distribution was set and discussed in Chapter 3. The entire group of questionnaires was distributed to the respondents in ten different universities located in different governorates in the northern and southern parts of Yemen. Despite the big geographical distance between the universities as well as the unstable political situation in Yemen, the researcher obtained a reasonable response rate because the survey was face to face and handed manually, and the researcher approached the respondents nicely to answer the survey and they accepted the offer from the researcher voluntary. Questionnaires were distributed in the universities with a different number value (see Table 4.1) based on the level of project engagement in each university. The highest number of questionnaires was distributed in Sana'a university as it was the biggest among the universities. The rest were distributed almost equivalent for each university with the same portion. Table 4.1 shows the number of distributed questionnaires for each university. To reduce possible sample biases, respondents were invited in multiple cities in the different states of the northern and southern parts of Yemen. In each city, different locations were selected and the distribution was conducted at different times of the day, in the morning and noon, for those who worked during the second shift. The filling duration of the survey was divided into two separate times, i.e. between 8am-12pm and 1pm-4pm. Table 4.1 summarizes the sample frame of the study.

Table 4.1 Sample frame

| No | States | Sample size | | University Name | Distributed | Collected | Valid | Not Co/v* |
|---|---|---|---|---|---|---|---|---|
| 1 | Northern | 387 | 1 | Sana'a University | 64 | 58 | 53 | 11 |
| | | | 2 | Dhamar University | 45 | 37 | 33 | 12 |
| | | | 3 | Taiz University | 42 | 30 | 27 | 15 |
| | | | 4 | Ibb University | 46 | 41 | 38 | 8 |
| | | | 5 | Amran University of Technology | 47 | 39 | 35 | 12 |
| | | | 6 | Al-Bayda University | 49 | 42 | 37 | 12 |
| | | | 7 | Hajja University | 50 | 38 | 36 | 14 |
| | | | 8 | Hodeidah University | 44 | 35 | 32 | 12 |
| 2 | Southern | 115 | 9 | Hadhramout University | 54 | 40 | 39 | 15 |
| | | | 10 | Aden University | 61 | 53 | 48 | 13 |
| **Total** | | 413 | | | 502 | 413 | 378 | 124 |

The survey in this study sought high response rates from the respondents because this study used the cluster-sampling technique. The survey was distributed to every individual who worked for the project management department in the universities and anyone who volunteered to respond to the survey for the researcher to fill the survey. Therefore, the outcomes of this survey were 413 returned questionnaires out of 502 questionnaires that were distributed to the target respondents in all 10 universities. This gave a response rate of 82% based on (Jobber, 1989) definition of response rate. Out of the collected questionnaires, 35 were invalid because a significant part of the questionnaires was not completed and left blank; the remaining 378 valid questionnaires were used for further analysis. This accounted for a 75% valid response rate. Therefore, this percentage is considered as a high response rate, while Sekaran (2003) suggested that a response rate of 30% is sufficient for surveys and may lead to insufficient results. Based on what they said, this is considered an adequate rate to analyse the data.

Table 4.2 Response rate of the survey

| Response | Frequency/Rate |
|---|---|
| No. of distributed questionnaires | 502 |
| Questionnaires not Returned | 89 |
| Returned questionnaires | 413 |
| Valid questionnaires | 378 |
| Excluded questionnaires | 35 |
| Response rate | 82% |
| Valid response rate | 75% |

## 4.4 General information of the Respondents

Information about the respondents captured in survey included gender, age, highest educational qualification, experience in PM and other information as well as their opinion in integrating knowledge management with project management. This section discusses the information about the respondents' background in PM and projects in their institutions as well as the rationale for grouping respondents for analysis. From the total sample population, only 54 female employees participated in this survey, and this indicates there was not enough female engagement with PM in these institutions. In measuring categorical judgments, where the options represent different objects as opposed to points along a single continuum, researchers sometimes try to combine open and closed formats by including an "other" response alternative in addition to specifying a set of substantive choices (Krosnick & Presser, 2009). That response was an alternative

to the respondent who did not want to share their profile, working title or related choice due lack of knowledge in getting the right choice.

Table 4.3 Characteristics of survey respondents

| *Variables* | *Category* | *N* | *%* |
|---|---|---|---|
| ***Gender*** | | | |
| | Male | 298 | 84.66 |
| | Female | 54 | 15.34 |
| ***Age*** | | | |
| | 16-25 | 109 | 30.95 |
| | 26-35 | 148 | 42.04 |
| | 36-50 | 80 | 22.72 |
| | 51-65 | 15 | 4.26 |
| ***Institutions*** | | | |
| | Aden University | 45 | 12.78 |
| | Amran University of Technology | 32 | 9.09 |
| | Dhamar University | 33 | 9.37 |
| | Hadhramout University | 33 | 9.37 |
| | Hajja University | 35 | 9.94 |
| | Hodeidah University | 28 | 7.95 |
| | Ibb University | 36 | 10.22 |
| | Sana'a University | 50 | 14.20 |
| | Taiz University | 22 | 6.25 |
| | Al-Bayda University | 38 | 10.79 |
| ***Educational level*** | | | |
| | Associate Degree | 59 | 16.76 |
| | Bachelor | 186 | 52.84 |
| | Master | 58 | 16.48 |
| | Doctoral | 30 | 8.52 |
| | Other | 19 | 5.40 |
| ***PM Experience*** | | | |
| | Less than 2 years | 83 | 23.58 |
| | 3 – 5 years | 132 | 37.50 |
| | 6 – 10 years | 85 | 24.15 |
| | 11 – 20 years | 43 | 12.22 |
| | More than 20 years | 9 | 2.55 |
| ***Position*** | | | |
| | Dean of faculty | 14 | 3.98 |
| | Project Manger | 29 | 8.24 |
| | Project team member | 160 | 45.45 |
| | General Supervisor | 29 | 8.24 |
| | Other | 120 | 34.09 |
| ***Managed projects*** | | | |
| | less than 5 projects | 156 | 44.31 |
| | 5 – 10 projects | 175 | 49.71 |
| | 15 – 20 projects | 21 | 5.96 |
| ***Project team No*** | | | |
| | Less than 5 | 158 | 44.88 |
| | 5 – 10 members | 157 | 44.60 |
| | More than 10 members | 37 | 10.51 |
| ***Project failure*** | | | |
| | Lack of project resources | 117 | 33.24 |

Table 4.3 continued.

| *Variables* | *Category* | *N* | *%* |
|---|---|---|---|
| | Wide project scope | 94 | 26.70 |
| | Poor experience in PM | 51 | 14.49 |
| | Insufficient time management | 47 | 13.35 |
| | Others | 43 | 12.22 |
| ***PM and KM integration*** | | | |
| | Yes | 268 | 76.14 |
| | No | 84 | 23.86 |

The second question in this questionnaire asked the respondents about their ages and from that, it can identify the current age of employees who are dealing with and managing the projects. The result shows that the majority were between 25 and 35 years old for around 148 respondents; 109 of respondents were between 18 and 25 years and could refresh the PM based on their age. Lastly, 95 respondents' ages were above 35 and this shows they have enough of knowledge and experience in PM and they have many years in managing projects. Table 4.3 shows the age distribution of respondents who have participated in filling the survey.

Sana'a University had the big percentage of participants with 14.20% of the entire sample population, as it is one of the biggest institutions in Yemen. This is then followed by Aden University with a close rate of12.78%. Dhamar, Hadaramout and Amran universities had almost same percentages at 33% along with Ibb, Albayda and Hajja. Tazi University had the lowest rate of 22% as the situation was not stable during the distribution of the questionnaires and employees were not on duty due the conflict/war in the city of Tazi. That was the reason for not getting the desired number of respondents in this university. Table 4.1 shows the distribution of the questionnaires from the ten universities in Yemen.

The Table 4.3 shows the educational level of the respondents from the different institutions. Almost more than half of the respondents at 52.84% were bachelor's degree graduates and around 16.48% had a master degree, while less had a PhD degree with 8.52% from the entire sample population. The rest of the respondents had other qualifications and associate degrees with 21.99%. Lastly, we can conclude from this question that more than the half of the respondents had recognized academic qualifications, which would help them to understand project management processes. The researcher could thus expect a reasonable and accurate response to the questionnaire from the educated persons.

The experience level question aimed to find out the years of experience of respondents in project management in the assessed institutions. Table 4.3 shows that more than a third of the respondents have 3-5 years of experience in PM at 37.5%, followed by the second group who have between 6-10 years of experience at 24.15%. Another group (12.22%) had more than 10 years but less than 20 in PM at 12.22%. However, there were a few respondents who were over-experienced in PM and had more than 20 years at 2.55%. The last group was considered as refreshers to PM and they had less than two years of experience in PM with a 23.58% percentage from the entire sample. As a result, from Table 4.3, more than 75% of respondents have solid PM experience which can improve the questioners' validity and accuracy as they answered each item based on what they have discovered and experienced in PM and KM.

The aim of the next question was to find out the respondents' positions/roles and how they are related to PM professions. There is a large percentage of project team members who participated in this survey with an estimate of 45.45%. The second largest group had other roles in PM with a percentage of 34.09%, and these roles differ based on the neutrality of the job that the respondents had in the institution. A good number of project managers and sub-project team leaders (supervisors) were involved in this survey with a rate of 8.24%, 8.24% and 3.98% for the deans of the faculties. Table 4.3 shows an explicit percentage that respondents have related to project management roles. Not all the respondents were responsible for PM activities in their institutions; from the entire population, 71.6% were responsible to carry out PM activities, while 28.4% were not mainly involved or may be only partially responsible for such activities.

Question 8 was to find out the number of projects their institutions managed and completed yearly. Table 4.3 shows that half of the respondents with a frequency of 156 stated that less than five projects were managed and sometimes none was managed due to financial constraints. The second group stated that 5 to 10 projects were being managed and they do not reach 10 projects as the average was seven projects annually. Projects managed were educational and learning projects, which do not require immense budget or funding unlike university buildings and constructions projects which demand a huge financial fund. The last group stated that their universities run and manage annually more than ten projects with a frequency of 21 respondents. In general, the total annual number of projects varied from one university to another which primarily depended on the

institution's budget. Table 4.3 shows the percentage of the project team members for each running project. Some projects had 5 and less, which had a percentage of 44.8%. The next consisted of 5 to 10 members for each project and the last group managed projects with more than 10 members for each project at 10.5%. Thus, the number of team members depended on how big or small the project is. For instance, some institutions managed small projects with a limited budget and time frame, which required a smaller number of team members, unlike the big projects which required a big number of personnel for that project. Thus, the number of members differed from one project to another.

The aim of this question was to find out the reasons that cause project failure in the respondents' institutions. Lack of resource was the major cause of project failure at 33.24%. Yemen is one of the less developed countries with limited resources, and that affects the institutions' demand of resources from the government. Sometimes, the scope of the project becomes wider than planned, which leads projects to failure. This is caused by the lack of experience in running projects at 24.7%. Another reason is poor experience in project management leadership at 14.49% as they might have enough experience required to manage and execute the project management phases.

The Failure occurred because the scheduled time to accomplish the project's activities was not set sufficiently based on the estimated time for each task/activity in the project, in which the failure rate was 13.5% of the respondents' feedback. The last group with 12.2% percent had other concerns such as lack of training and less wages paid to the team members, in which some of them left the institutions in the middle of the project's progress without completing the assigned tasks. Others mentioned that because of lack of knowledge or sharing of lessons from the previous projects, there was not an automated archive or ordinary storage of such knowledge.

The last question in Part One aimed to get the respondents' opinion and experience in integrating knowledge management into project management for the sake of improving the maturity of project management. 76.14% of the respondents gave positive responses and the rest did not. From Table 4.3, the percentage of responses shows that the PM personnel in these institutions were in need of having KM integrated into PM.

As a summary to this section, out of the total sample population, only 15.34% of female employees participated in this survey, which indicates that there not enough

females engaged with PM. The age distribution of respondents who participated in filling the survey was between 18-65 years old with different participations in every university. However, more than the half of the respondents had recognized academic qualifications, which would help them to understand the project management processes. Also, whenever a person is educated, we can expect a reasonable and accurate response to the questionnaires. For experience level, more than 75% of respondents had solid PM experience that can improve the questionnaire's validity and accuracy as they answered each item based on what they had discovered and experienced in PM and KM.

Out of the entire population, 71.6% were responsible for carrying out PM activities. Therefore, the total annual running of project number varied from one university to another and that primarily depended on the institution's budget. Some institutions manage small projects with a limited budget and time frame, which requires a smaller number of team members, unlike big projects which require a bigger number of personnel for that project. Thus, the number of members differed from one project to another. A lack of resources is the major cause for project failure at 33.24%, Yemen is one of the less developed countries with limited resources and that affects the institutions' demand of resources from the government. 76.14% of the respondents gave positive responses and the rest did not, in which PM personnel in these institutions needed to have KM integrated into the PM.

## 4.5 Assessment of Project Management Maturity

An empirical approach using the adopted questionnaires was used to measure project management maturity of the institution using their knowledge management capabilities. The questionnaire was mainly designed to assess the level of project management maturity using the developed project model in Chapter 2 (see Figure 2.8 and Appendix E). The five-level maturity model was used for each project management knowledge area to assess the maturity of the institutions in handling projects. In addition, this section discusses the descriptive statistics for the independent variables and the entire project management maturity as the dependent variable. The combination of each KM capability in every project management area shows the actual effect of these capabilities and indicates the level of project management maturity based on the accumulative average of this capability in the ten areas. Previous studies have relied upon simple comparisons of sample means (Grant & Pennypacker, 2006). Research relies upon

inferential statistics to draw valid conclusions regarding differences between capabilities according to their mean values.

Table 4.4 Descriptive statistics for constructs

| Variables | N of Items | Mean | Standard Deviation | Maturity Level |
|---|---|---|---|---|
| Project-related Technology | 10 | 3.3 | .437 | Organizational Standardization |
| Project-based Organizational Structure | 10 | 3.6 | .411 | Organizational Standardization |
| Project-oriented Organizational Culture | 10 | 2.2 | .681 | Planned |
| Project Knowledge Acquisition | 10 | 3.6 | .430 | Organizational Standardization |
| Project Knowledge Conversion | 10 | 3.3 | .419 | Organizational Standardization |
| Project Knowledge Application | 10 | 3.4 | .422 | Organizational Standardization |
| Project Knowledge Protection | 10 | 2.8 | .531 | Planned |

Table 4.4 illustrates that the overall mean for all the constructs ranged between 2.2 and 3.6. In particular, the standard deviation and mean for the technology were .437 and .681, respectively, and the rest of the variables with similar values are shown in Table 4.4. This indicates the level of the project management maturity based on the mean of the mentioned variables. All the variables are in level three, except culture and project knowledge acquisition which are in level two. This shows that the respondents tend to assess the level of the project management maturity through knowledge capabilities. The mean value indicates the level based on the assessment model categorization (See Table 3.4).

From the result, the overall project management maturity of key knowledge management capabilities was found below maturity level 4 (approximately 3.1) as shown in the spider diagram below. For the majority of the KM capabilities, the PM had reached maturity level 3 through these capabilities.

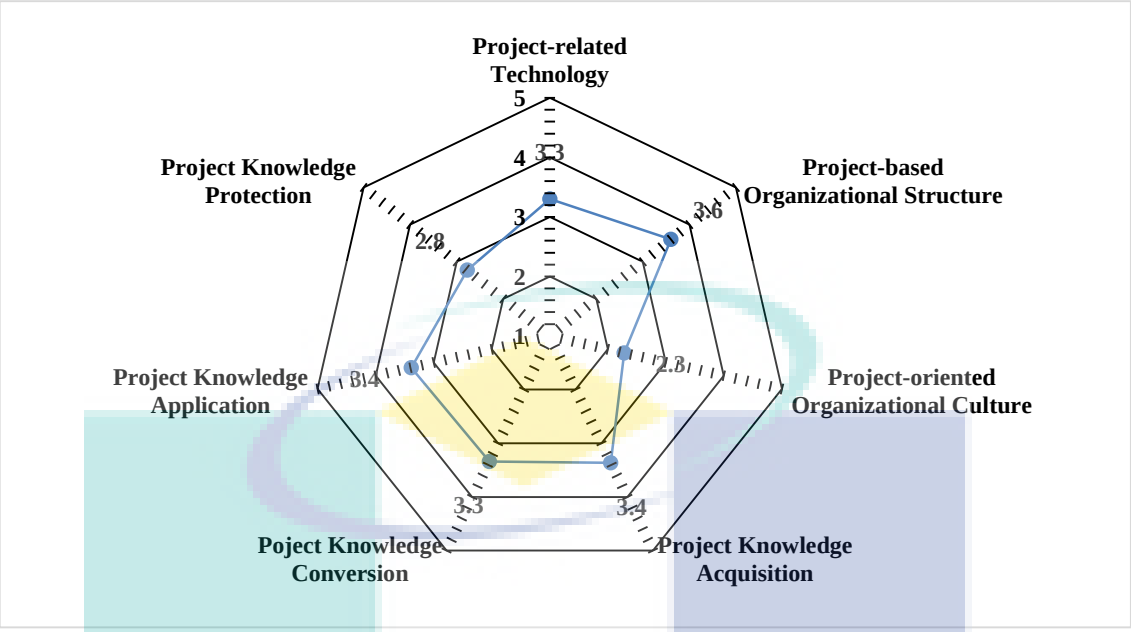


Figure 4.1 Actual result of PM maturity level via KM capabilities

This indicates that institutions have a good foundation of knowledge infrastructure and processes that exist and support project management (organizational standardization level). However, in contrast, there are some planned processes and informal approaches in some capabilities, like project-oriented organizational culture and project knowledge protection. The capabilities matrix in Appendix E describes the key characteristics of each maturity level in the above figure. The maturity level 2 has a consistent and basic approach to project execution, and repeatable processes are applied to basic project management steps while generic tools and techniques are used for key PM processes.

Table 4.5 Result of the assessment of each knowledge area

| PM Area | Tech | Str | Cult | K_ Acq | K_Conv | K_App | K_ Pro |
|---|---|---|---|---|---|---|---|
| PIM | 3.1 | 3.5 | 2.4 | 3.3 | 3.4 | 3.1 | 3.9 |
| PSM | 3.53 | 3.55 | 2.3 | 3.35 | 3.47 | 3.53 | 3.74 |
| PTM | 3.57 | 3.62 | 2.26 | 3.36 | 3.57 | 3.14 | 3.88 |
| PCM | 3.54 | 3.59 | 2.36 | 3.41 | 3.56 | 3.57 | 2.39 |
| PQM | 3.65 | 3.66 | 2.24 | 3.34 | 3.2 | 3.53 | 2.3 |
| PHRM | 3.35 | 3.77 | 2.3 | 3.32 | 3.11 | 3.65 | 2.26 |
| PCoM | 3.62 | 3.7 | 2.25 | 2.23 | 2.07 | 3.34 | 2.39 |
| PRM | 2.88 | 3.68 | 2.18 | 3.5 | 3.69 | 3.62 | 2.29 |
| PProM | 3.6 | 3.71 | 2.27 | 3.45 | 3.73 | 3.17 | 2.26 |
| PSkM | 2.14 | 3.23 | 2.28 | 3.41 | 3.61 | 3.26 | 2.36 |

Integration and scope management had a relatively higher score of maturity level (greater than 3) in the KM capabilities except that culture is in level two. This indicated that knowledge infrastructure is standardized and available structured knowledge

processes support these processes such as scope planning, scope definition, verification. In addition, Project knowledge acquisition, conversion, application and protection were applied for each project. The processes were repeatable and the standardized project management model was applied by all projects. Technology and project-based organizational structure were performed to organize the project's activities. Culture is at the planned phase of the organizational project management, though the institutions lacked standard cultural resource fundamentals in the stages of the project.

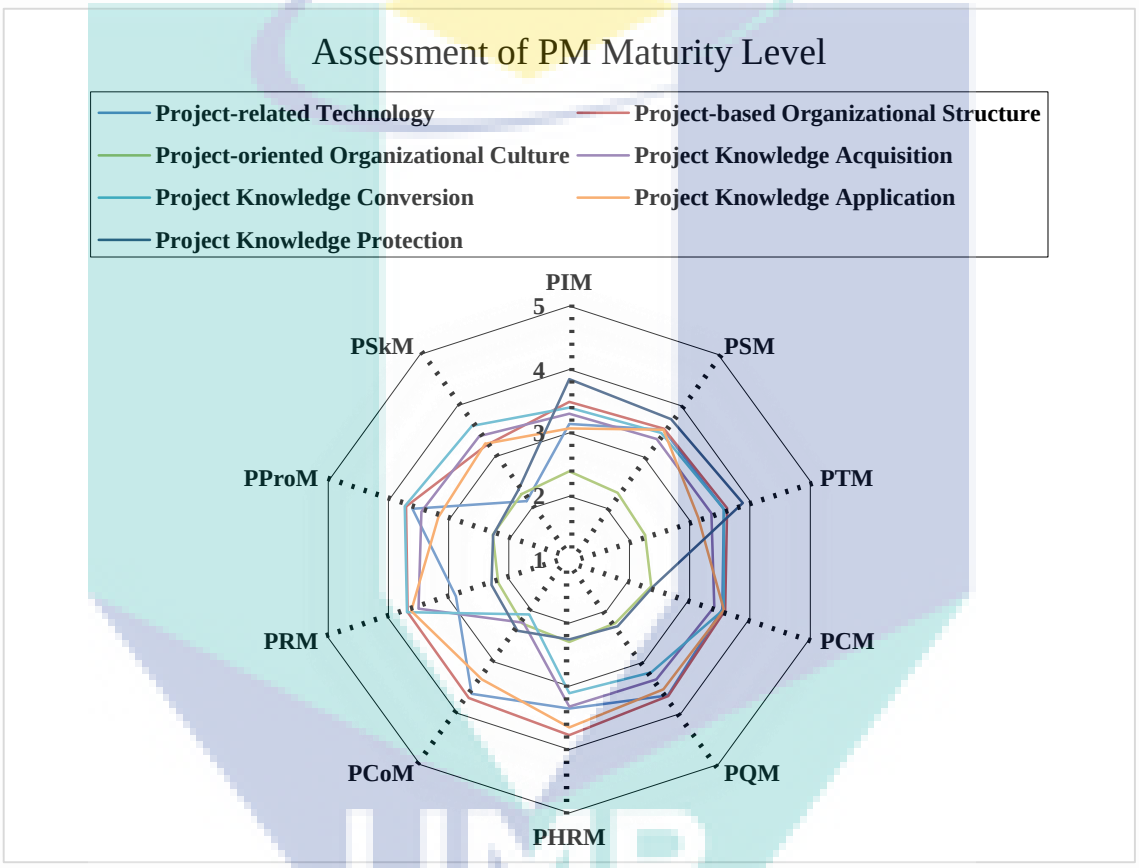


Figure 4.2 The assessment result of each knowledge area and corresponding maturity level

With regards to rest of the project management areas, their maturity level is around level 3, in which organizational standardized practices are in place and the knowledge is being created and applied smoothly. This as a result increases the PM maturity level and the knowledge management infrastructure was adopted and used professionally in supporting the PM processes. While culture and knowledge protection capabilities are still in level two of the maturity, the institutions did not utilize these capabilities as they are still in the planning level. The institutions know what these capabilities are, but they should add more effort to develop this level in order to get a

higher maturity level. Table 4.5 shows the assessment result of each project management area through every knowledge management capability and which capability needs to be reconsidered to increase the particular PM maturity level. Figure 4.2 illustrates graphically the level of each project management area based on the assessed knowledge management capability.

## 4.6 Assessment of Measurement Model/ Outer Model

An assessment of a measurement model or what is alternatively called the outer model involves determining individual item reliability, internal consistency reliability, content validity, convergent validity and discriminant validity (Hair, J. F. et al., 2010; Reinartz et al., 2009; Sarstedt et al., 2014) as shown in Figure 4.3.

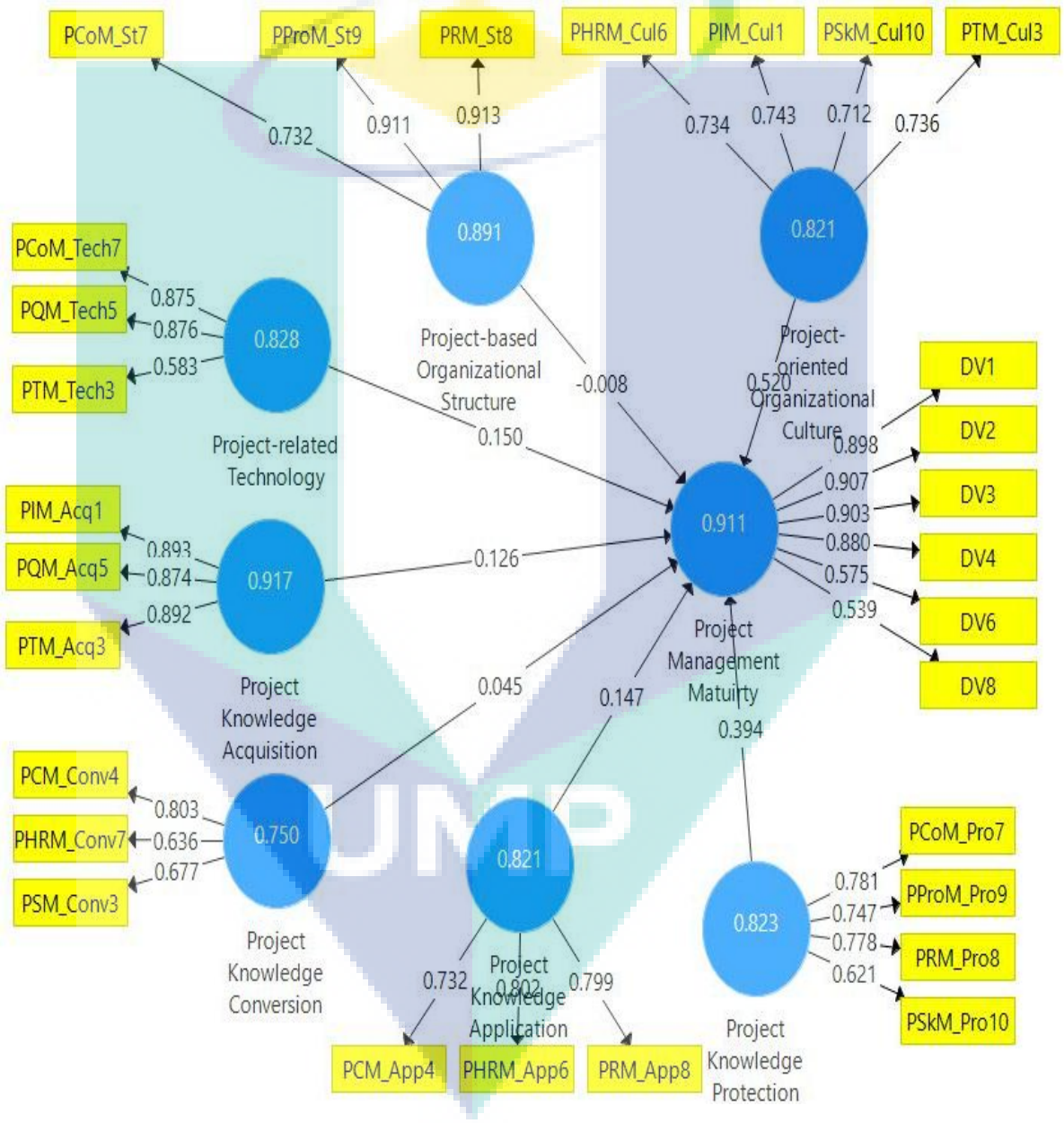


Figure 4.3 Measurement Model/ Outer Model

### 4.6.1 Individual Item Reliability

The measurement model is assessed by examining the outer loadings of each construct item (Duarte & Raposo, 2010; Hair et al., 2010; Sarstedt et al., 2014). According to Hair et al. (2014), the rule of thumb to retain items with loadings between .40 and .70 was that out of 79 items, 40 were deleted because their loading was below the threshold of 0.40. Therefore, in the full model, 29 items were retained as they had loadings between 0.533 and .947 (see Table 4.6) and the deleted items were less than the suggestion by Hair et al. (2010) for items loading (see Appendix C).

### 4.6.2 Internal Consistency Reliability

Internal consistency reliability refers to the extent to which all components are measured on a particular (sub) similar concept (Lee & Lee, 2007). Composite reliability coefficient and Cronbach's alpha coefficient are the most frequently used to estimate the internal consistency reliability of items in social researches (Peterson & Kim, 2013). The composite reliability coefficient was chosen to ascertain the internal consistency reliability of measures adopted in the present study.

The justification for using composite reliability coefficient is because the composite reliability coefficient provides a much less estimation of the bias of the reliability than Cronbach's alpha coefficient because the later assumes all items contribute equally to its construct without considering the actual contribution of individual loadings (Götz, Liehr-Gobbers, & Krafft, 2010). On the other hand, Cronbach's alpha may over- or underestimate the reliability scale in any study. However, the Cronbach's alpha as a whole for all items is .756, which is considered a good reliability as it is above Hair et al.'s (2010) recommended value.

The composite reliability takes into account that indicators have different loadings and can be explained in the same way as Cronbach's α (that is, no matter which particular reliability coefficient is used, an internal consistency reliability value above .70 is regarded as satisfactory for an adequate model, whereas a value below .60 indicates a lack of reliability). However, in this study, the explanation of internal consistant reliability using composite reliability coefficient was based on the rule of thumb provided by (Bagozzi & Yi, 1988). Furthermore, as recently suggested by Hair et al. (2010), composite

reliability coefficient should be at least .70 or more. Table 4.6 illustrates the composite reliability and the coefficients of the latent constructs.

Table 4.6 Items loadings, average variance extracted and composite reliability

| Constructs | Items | Loadings | Average Variance Extracted (AVE) | Composite Reliability (CR) |
|---|---|---|---|---|
| **Project-related Technology** | PQM_Tech5 | 0.876 | 0.624 | 0.828 |
| | PCoM_Tech7 | 0.875 | | |
| | PTM_Tech3 | 0.583 | | |
| **Project-based Organizational Structure** | PRM_St8 | 0.913 | 0.733 | 0.891 |
| | PProM_St9 | 0.911 | | |
| | PCoM_St7 | 0.732 | | |
| **Project-oriented Organizational Culture** | PTM_Cul3 | 0.736 | 0.535 | 0.821 |
| | PIM_Cul1 | 0.743 | | |
| | PHRM_Cul6 | 0.734 | | |
| | PSkM_Cul10 | 0.712 | | |
| **Project Knowledge Acquisition** | PIM_Acq1 | 0.893 | 0.786 | 0.917 |
| | PTM_Acq3 | 0.874 | | |
| | PQM_Acq5 | 0.892 | | |
| **Project Knowledge Conversion** | PCM_Conv4 | 0.803 | 0.502 | 0.750 |
| | PHRM_Conv7 | 0.636 | | |
| | PSM_Conv3 | 0.677 | | |
| **Project Knowledge Application** | PHRM_App6 | 0.802 | 0.605 | 0.821 |
| | PRM_App8 | 0.799 | | |
| | PCM_App4 | 0.732 | | |
| **Knowledge Protection** | PCoM_Pro7 | 0.781 | 0.540 | 0.823 |
| | PProM_Pro9 | 0.747 | | |
| | PRM_Pro8 | 0.778 | | |
| | PSkM_Pro10 | 0.621 | | |
| **Project Management Maturity** | DV_1 | 0.898 | 0.640 | 0.911 |
| | DV_2 | 0.907 | | |
| | DV_3 | 0.903 | | |
| | DV_4 | 0.880 | | |
| | DV_6 | 0.575 | | |
| | DV_8 | 0.539 | | |

### 4.6.3 Convergent Validity

The measurement model has to be examined for convergent validity (Devinney et al., 2008). Convergent validity refers to the extent to which items truly represent the intended latent construct and correlate with other measures of the same latent construct (Hair et al., 2010). Convergent validity for the reflective measurement model indicators

were evaluated using Average Variance Extracted (AVE) as suggested by Hair et al. (2010). Assessing convergent validity was done by examining the AVE of each latent construct. To achieve adequate convergent validity, following the recommendation by Chin (1998), the AVE of each latent construct should be .50 or more. In this study, the AVE values showed high loadings for all the constructs, which is more than > .50 (see Table 4.6).

### 4.6.4 Discriminant Validity

Discriminant validity refers to the extent to which a particular latent construct is different from other latent constructs (Duarte & Raposo, 2010). The measure for discriminant validity is the Heterotrait-monotrait (HTMT) ratio of correlation. Henseler, Ringle and Sarstedt (2015) proposed superior performance of this method by means of the Monte Carlo simulation study and found that HTMT was able to achieve higher specificity and sensitivity rates (97% to 99%) compared to the cross-loadings criterion (0.00%) and Fornell and Larcker (1981) (20.82%). HTMT values close to 1 indicated a lack of discriminant validity. Using the HTMT as a criterion involves comparing it to a predefined threshold (Ab Hamid, Sami, & Mohmad Sidek, 2017). If the value of the HTMT is higher than this threshold, one can conclude that there is a lack of discriminant validity. Some authors suggested a threshold of 0.85 (Kline, 2011). In addition, Gold, Malhotra, And and Segars (2001) argued and proposed a value of 0.90. Table 4.7 shows the output from the HTMT analysis. The output can be easily calculated using the formula as in (Henseler et al., 2015).

Table 4.7 HTMT results

| | Latent Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| **1** | Project-oriented Organizational Culture | - | | | | | | | |
| **2** | Project Knowledge Acquisition | 0.10 | - | | | | | | |
| **3** | Project Knowledge Application | 0.10 | 0.20 | - | | | | | |
| **4** | Project Knowledge Conversion | 0.12 | 0.27 | 0.35 | - | | | | |
| **5** | Project Knowledge Protection | 0.68 | 0.07 | 0.16 | 0.13 | - | | | |
| **6** | Project Management Maturity | **0.96** | 0.25 | 0.36 | 0.27 | 0.82 | - | | |
| **7** | Project-based Organizational Structure | 0.05 | 0.16 | 0.29 | 0.65 | 0.07 | 0.13 | - | |
| **8** | Project-related Technology | 0.15 | 0.26 | 0.45 | 0.53 | 0.14 | 0.38 | 0.32 | - |

From the HTMT results, the values (in bold) in Table 4.7 indicated discriminant validity problems according to the HTMT 0.85 criterions. This implied that the HTMT criterion detected collinearity problems among the latent constructs (multicollinearity). The constructs of project-oriented organizational culture and project management maturity had problems. There is a probability that most of the items measure the same thing. In other words, it contains overlapping items from the respondents' perception in the affected constructs. According to Ab Hamid et al. (2017), HTMT criterion has a high sensitivity and specificity in detecting discriminant validity problems and more empirical evidence is needed to use this approach.

Chin (1998) mentioned that discriminant validity can be ascertained by comparing the indicator loadings with cross-loadings. For this study, following this suggestion, all the indicator loadings should be higher than the cross-loadings. Table 4.8 compares the indicator loadings with other reflective indicators. All indicator loadings were greater than the cross-loadings, suggesting adequate discriminant validity for further analysis.

Table 4.8 Cross loading

| Variables | Tech | Stru | Cul | K_Acq | K_ Con | K_App | K_Pro | PMM |
|---|---|---|---|---|---|---|---|---|
| PQM_Tech5 | **0.8756** | 0.2367 | 0.0671 | 0.1603 | 0.2696 | 0.2998 | 0.0739 | 0.2792 |
| PCoM_Tech7 | **0.8748** | 0.2221 | 0.0415 | 0.1699 | 0.2528 | 0.1862 | 0.0737 | 0.2645 |
| PTM_Tech3 | **0.5825** | 0.1731 | 0.1147 | 0.1342 | 0.2008 | 0.2504 | 0.0817 | 0.1938 |
| PRM_St8 | 0.2330 | **0.9133** | 0.0287 | 0.1936 | 0.4146 | 0.2384 | 0.0555 | 0.1416 |
| PProM_St9 | 0.2758 | **0.9106** | 0.0336 | 0.1248 | 0.4156 | 0.2147 | 0.0333 | 0.1327 |
| PCoM_St7 | 0.1112 | **0.7319** | 0.0001 | 0.0138 | 0.2684 | 0.1328 | -0.0352 | 0.0268 |
| PIM_Cul1 | 0.1178 | 0.0615 | **0.7425** | 0.0924 | 0.0871 | 0.0415 | 0.3909 | 0.5763 |
| PTM_Cul3 | 0.0706 | 0.0019 | **0.7359** | 0.0572 | 0.0113 | 0.0774 | 0.2819 | 0.5759 |
| PHRM_Cul6 | 0.0559 | -0.0047 | **0.7341** | 0.0396 | 0.0564 | 0.0449 | 0.3811 | 0.5007 |
| PSkM_Cul10 | 0.0074 | 0.0308 | **0.7122** | 0.0020 | 0.0104 | 0.0458 | 0.3743 | 0.5234 |
| PIM_Acq1 | 0.1338 | 0.1322 | 0.0031 | **0.8928** | 0.0970 | 0.0956 | -0.0163 | 0.1773 |
| PTM_Acq3 | 0.2354 | 0.2182 | 0.0217 | **0.8923** | 0.2078 | 0.1730 | 0.0272 | 0.2087 |
| PQM_Acq5 | 0.1489 | 0.0887 | 0.1393 | **0.8738** | 0.1511 | 0.1510 | 0.0589 | 0.2249 |
| PCM_Conv4 | 0.2069 | 0.3949 | 0.0487 | 0.1233 | **0.8028** | 0.1816 | 0.0657 | 0.1538 |
| PSM_Conv3 | 0.2323 | 0.3771 | -0.0094 | 0.1834 | **0.6771** | 0.1240 | 0.0076 | 0.0906 |
| PHRM_Conv7 | 0.2220 | 0.2048 | 0.0620 | 0.0890 | **0.6357** | 0.1504 | 0.0311 | 0.1489 |
| PHRM_App6 | 0.2253 | 0.1940 | 0.0325 | 0.1438 | 0.1407 | **0.8015** | 0.0994 | 0.2192 |
| PRM_App8 | 0.2111 | 0.1423 | 0.0459 | 0.0689 | 0.1339 | **0.7989** | 0.0503 | 0.1955 |
| PCM_App4 | 0.2674 | 0.2166 | 0.0810 | 0.1479 | 0.2189 | **0.7317** | 0.1134 | 0.2786 |
| PCoM_Pro7 | 0.1195 | 0.0061 | 0.3641 | -0.0100 | 0.0991 | 0.1212 | **0.7809** | 0.5800 |
| PRM_Pro8 | 0.0915 | 0.0250 | 0.4020 | 0.0261 | -0.0332 | 0.0673 | **0.7785** | 0.5412 |
| PProM_Pro9 | 0.0457 | 0.0589 | 0.3484 | 0.0185 | 0.0598 | 0.0863 | **0.7472** | 0.4908 |
| PSkM_Pro10 | -0.0040 | 0.0427 | 0.3128 | 0.0707 | 0.0330 | 0.0660 | **0.6215** | 0.3698 |
| DV2 | 0.3099 | 0.1254 | 0.6471 | 0.2450 | 0.1893 | 0.3187 | 0.6457 | **0.9075** |

Table 4.8 continued.

| Variables | Tech | Stru | Cul | K_Acq | K_ Con | K_App | K_Pro | PMM |
|---|---|---|---|---|---|---|---|---|
| DV3 | 0.3369 | 0.1575 | 0.6178 | 0.2672 | 0.2136 | 0.2995 | 0.6499 | **0.9033** |
| DV1 | 0.3220 | 0.1634 | 0.6018 | 0.2367 | 0.1890 | 0.3302 | 0.6462 | **0.8978** |
| DV4 | 0.3145 | 0.1581 | 0.5828 | 0.2041 | 0.1886 | 0.2776 | 0.6464 | **0.8802** |
| DV6 | 0.0674 | 0.0029 | 0.7338 | 0.0562 | 0.0143 | 0.0788 | 0.2818 | **0.5748** |
| DV8 | 0.0230 | 0.0029 | 0.4071 | -0.0136 | 0.0722 | 0.0423 | 0.2662 | **0.5392** |

Note: DV1 = Org1, DV2= Mag_Control2, DV3= Benefits_Mag3, DV4= Financial_Mag4, Cul= Project-oriented Organizational Culture, K_Acqu= Project Knowledge Acquisition, K_Appl= Project Knowledge Application, K_ Conv= Project Knowledge Conversion, K_Pro= Project Knowledge Protection, PMM= Project Management Maturity, Stru= Project-based Organizational Structure, Tech= Project-related Technology.

## 4.7 Assessment of Structural Model

This part presents the results of the structural model and tests of hypotheses for this study. Specifically, this section is concerned with the testing of the hypotheses related to the main effects of the dependent variable. This study applies the PLS standard bootstrapping procedure with a number of 2000 bootstrap samples and 352 cases to assess the significance of the path coefficients (Hair et al., 2010; Henseler & Sarstedt, 2013; Sarstedt et al., 2014). Bootstrapping is a nonparametric procedure that can be applied to test whether coefficients such as outer loadings, outer weights and path coefficients are significant by estimating standard errors for the estimates. Figure 4.5 shows the estimates for the full structural model.

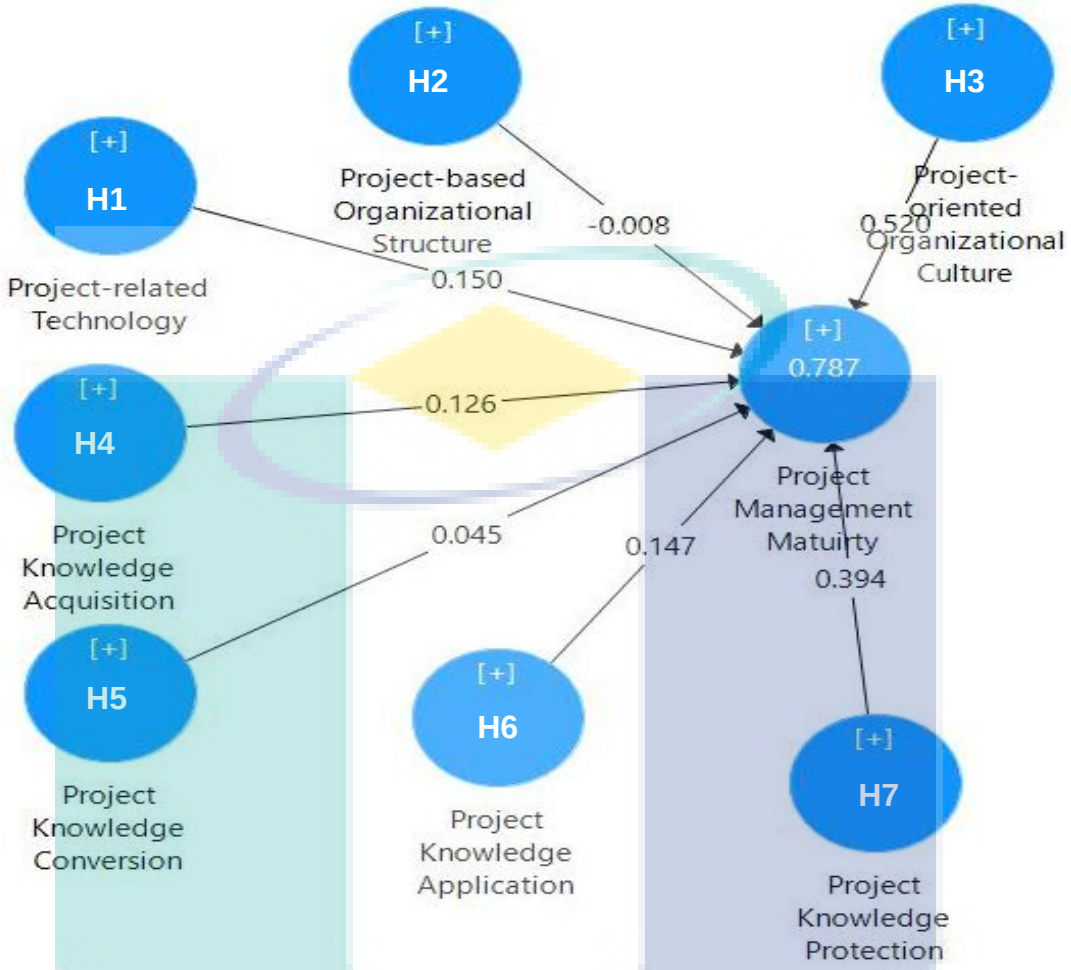


Figure 4.4 Structural Model (Full Model)

### 4.7.1 Path analysis (Hypothesis Testing)

At the outset, Hypothesis 1 predicted that technology as a knowledge management infrastructure has a significant effect on project management maturity. The finding (Table 4.9, Figure 4.3) revealed a significant positive bond between technology and PMM ($\beta$ = 0.150, t = 5.269, p< 0.05), supporting Hypothesis 1. With regards to Hypothesis 2 on the influence of structure on the level of project management maturity, the results indicated that there is no a significant positive relationship between the structure as knowledge management infrastructure and PMM ($\beta$ = -0.008, t = 0.274, p> 0.05). Hence, this hypothesis was not supported.

Table 4.9 Significance testing of the total effects

| H | Relation | Beta | SE | T-Value | P-value | Findings |
|---|---|---|---|---|---|---|
| **H1** | Project-related Technology → PMM | 0.150 | 0.028 | 5.269 | 0.000 | Supported |
| **H2** | Project-based Organizational Structure → PMM | -0.008 | 0.022 | 0.274 | 0.784 | Not Supported |
| **H3** | Project-oriented Organizational Culture → PMM | 0.520 | 0.024 | 15.02 | 0.000 | Supported |
| **H4** | Project Knowledge Acquisition → PMM | 0.126 | 0.029 | 4.215 | 0.000 | Supported |
| **H5** | Project Knowledge Conversion→ PMM | 0.045 | 0.026 | 1.696 | 0.091 | Not Supported |
| **H6** | Project Knowledge Application→ PMM | 0.147 | 0.028 | 5.171 | 0.000 | Supported |
| **H7** | Project Knowledge Protection→ PMM | 0.394 | 0.033 | 11.669 | 0.000 | Supported |

H= Hypothesis, PMM=Project Management Maturity

Furthermore, Hypothesis 3 predicted that culture has a positively significant relationship with project management maturity. As illustrated in Table 4.9, the significant result was $\beta = 0.520$, $t = 15.02$, $p < 0.05$. Therefore, this hypothesis definitely supports the alternate hypotheses. In examining the influence of project knowledge acquisition and project management maturity, the result revealed that project knowledge acquisition process had a significant positive relationship with PMM ($\beta = 0.126$, $t = 4.215$, $p < 0.05$).

Besides that, in examining the influence of the project knowledge conversion process on PMM, the finding from Table 4.9 indicates that there is no significant positive relationship between project knowledge conversion as a process and PMM ($\beta = 0.045$, $t = 1.696$, $p > 0.05$). With respect to Hypothesis 6 on the effect of project knowledge application on PMM, the results revealed that there is a positive significance between project knowledge application as a process of applying the knowledge and PMM level ($\beta = 0.147$, $t = 4.171$, $p < 0.05$). Hypothesis 7 which predicted a positive relationship between project knowledge protection and the project management maturity was supported because the estimations from the PLS model were significant ($\beta = 0.394$, $t = 11.669$, $p < 0.05$).

### 4.7.2 Significance Testing of the Total Effects

The significance of the total effects, including the direct (project-related technology, project-based organizational structure, project-oriented organizational

culture, project knowledge acquisition, project knowledge conversion, project knowledge application and project knowledge protection on project management maturity) effects, was obtained by bootstrapping in SmartPLS and is summarised in Table 4.9.

#### 4.7.2.1 Assessment of R Square

In PLS analysis, the predictive power of a particular model is assessed by the R squared ($R^2$) values of the endogenous constructs or latent variables, as well as by ascertaining the standard path coefficient for each relationship from the exogenous variables to endogenous variables. In addition, to assess the structural model in PLS-SEM, there is an R-squared value, which is also known as the coefficient of determination (Hair et al., 2010; Henseler & Sarstedt, 2013; Sarstedt et al., 2014). The R-squared value represents the proportion of variation in the dependent variable that can be explained by the variables. The $R^2$ values are interpreted in the same way as those obtained from multiple regression analysis. The $R^2$ value indicates the amount of variance in the construct that is explained by the variables (Hair et al., 2010; Sarstedt et al., 2014).

Meanwhile, the acceptable level of $R^2$ value depends on the research context, (Sarstedt et al., 2014). As suggested by Falk and Miller (1992), an R-squared value of 0.10 is a minimum acceptable level. In the same line with that proposed by Chin, (1998) the R-squared values of 0.67, 0.33, and 0.19 in PLS-SEM can be considered as substantial, moderate, and weak, respectively. In this study, Table 3.10 declares the R-squared values of the dependent variable only.

Table 4.10 Variance explained in the dependent variable

| Latent Variables | Variance Explained ($R^2$) |
|---|---|
| Project Management Maturity | 0.787 |

#### 4.7.2.2 Assessing Effect Size (f2)

Effect size indicates the relative effect of a particular exogenous latent variable on the endogenous latent variable(s) by means of changes in the R-squared (W. W. Chin, 1998). It is calculated as the increase in R-squared of the latent variable, to which the path is connected relative to the latent variable's proportion of unexplained variance (Cohen, 1988). According to Cohen (1988), an effect size of 0.02 is small, 0.15 is medium, and greater than 0.35 is large. From the outcome provided by SmartPLS 3, the effect size for

this study between the exogenous latent variable on endogenous latent variable of the structural model is illustrated in Table 4.11.

Table 4.11 Effect size of predictive variables

| Predecessor latent variables | Dependent Variable | Effect size ($f^2$) | Effect size rating |
|---|---|---|---|
| Project-related Technology | Project Management Maturity | 0.156 | Medium |
| Project-based Organizational Structure | Project Management Maturity | 0.000 | None |
| Project-oriented Organizational Culture | Project Management Maturity | 0.965 | Large |
| Project Knowledge Acquisition | Project Management Maturity | 0.069 | Small |
| Project Knowledge Conversion | Project Management Maturity | 0.007 | None |
| Project knowledge application | Project Management Maturity | 0.088 | small |
| Project knowledge protection | Project Management Maturity | 0.551 | Large |

As illustrated in Table 4.11, the effect sizes for the project-based organizational structure, project knowledge conversion, project knowledge acquisition, project knowledge application, project-related technology, knowledge protection and project-oriented organizational culture on project management maturity were 0.000, 0.007, 0.069, 0.088, 0.156, 0.551 and 0.965, respectively. Therefore, following Cohen's (1988) guideline, the effect sizes of these exogenous latent variables on project management maturity can be considered as large, none, large, large, none, large and large respectively.

#### 4.7.2.3 Blindfolding and Predictive Relevance (Q2)

The present study also applied the Stone-Geisser test of predictive relevance of the research model using blindfolding procedures (Geisser, 1974; Stone, 1974). The Stone-Geisser test of predictive relevance is usually used as a supplementary assessment of goodness-of-fit in partial least squares structural equation modelling (Duarte & Raposo, 2010). Even though this study used blindfolding to ascertain the predictive relevance of the research model, it is worth noting that according to Sattler et al. (2010), "blindfolding procedure is only applied to endogenous latent variables that have a reflective measurement model operationalization" (p. 320). Reflective measurement model specifies that a latent or unobservable concept causes variation in a set of

observable indicators (Mcmillan & Conner, 2003). Hence, because all endogenous latent variables in present study were reflective in nature, a blindfolding procedure was applied mainly to these endogenous latent variables. In particular, a cross-validated redundancy measure ($Q^2$) was applied to assess the predictive relevance of the research model (Geisser, 1974; Götz et al., 2010; Ringle et al., 2012; Sarstedt et al., 2014; Stone, 1974). The $Q^2$ is a criterion to a measure how well a model predicts the data of omitted cases (Chin, 1998; Sarstedt et al., 2014). According to Reinartz, Haenlein and Henseler (2009), a research model with $Q^2$ statistic (s) greater than zero is considered to have predictive relevance. Additionally, a research model with higher positive $Q^2$ values suggests more predictive relevance. Table 4.12 presents the results of the cross-validated redundancy $Q^2$ test.

Table 4.12 Construct cross-validated redundancy

| Total | SSO | SSE | 1-SSE/SSO |
|---|---|---|---|
| Project Management Maturity | 2,464 | 1,327 | 0.461 |

As shown in Table 4.12 Construct cross-validated redundancy, the cross-validation redundancy measure $Q^2$ for endogenous latent variable was above zero, suggesting predictive relevance of the model (Chin, 1998; Reinartz et al., 2009).

#### 4.7.2.4 Computing q Square ($q^2$)

The effect size $q^2$ tests the impact a particular independent latent variable has on the dependent latent variable predictive relevant $q^2$. The blindfolding procedure was used in examining the effect size through the cross-validated redundancy approach. Furthermore, the researchers recommended that the $q^2$ values of 0.35, 0.15 and 0.02 indicate that an independent latent factor has large, medium or small predictive relevance respectively on the dependent variable (Reinartz et al., 2009; C.M. Ringle et al., 2015; Sarstedt et al., 2014). Comparing the effect size outcome $q^2$ illustrated in Table 4.13 with threshold values recommended by researchers, there is an effect size $q^2$ in the correlation among the independent variables with project management maturity as the dependent variable. The relationship is found at a large level with project knowledge. Furthermore, as shown in Table 4.13 below, in relation to the predictive relevance, the effect size $q^2$ of all other correlations among the variable is small and medium, which indicate a good result of the overall effect size.

Table 4.13 Values of effect size ($q^2$)

| Predecessor latent variables | Dependent Variable | ($q^2$) Included | ($q^2$) Excluded | Effect size ($q^2$) | Remarks |
|---|---|---|---|---|---|
| Project-related Technology | Project Management Maturity | 0.461 | 0.445 | 0.029 | Small |
| Project-based Organizational Structure | Project Management Maturity | 0.461 | 0.452 | 0.016 | Small |
| Project-oriented Organizational Culture | Project Management Maturity | 0.461 | 0.316 | 0.269 | Medium |
| Project Knowledge Acquisition | Project Management Maturity | 0.461 | 0.446 | 0.027 | Small |
| Project Knowledge Conversion | Project Management Maturity | 0.461 | 0.451 | 0.018 | Small |
| Project knowledge application | Project Management Maturity | 0.461 | 0.226 | 0.361 | Large |
| Project knowledge protection | Project Management Maturity | 0.461 | 0.378 | 0.154 | Medium |

### 4.7.3 Model Fit - SRMR and RMStheta

As exhibited in Table 4.10, the research model explains 78% of the total variance in project management maturity as a dependent variable. This suggests that all the independent variables collectively explain 78% of the variance of PMM.

For measuring the model fit, we used Standardized Root Mean Square Residual (SRMR). The SRMR is an absolute measure of fit and is defined as the standardized difference between the observed correlation and the predicted correlation. Because the SRMR is an absolute measure of fit, a value of zero indicates perfect fit. The SRMR has no penalty for model complexity. The SRMR value is 0.0767, however, Hu and Bentler (1999) stated that a value less than .08 is generally considered a good fit.

Henseler, Hubona and Ray (2016) talked about another promising approximate model fit criterion which is the root mean square error correlation (RMStheta) (see, Lohmöller, 1989). A recent simulation study (Henseler et al., 2014) provides evidence that the RMStheta can indeed distinguish well-specified from ill-specified models. However, thresholds for the RMStheta are yet to be determined, and PLS software still

needs to implement this approximate model fit criterion. However, the running result value of the RMStheta of this model was 0.1532.

#### 4.7.3.1 Bench-marking the proposed conceptual model

Overall, and as shown in Table 4.5, the level is at level three, which indicates that higher education institutions in Yemen have not yet used knowledge management capabilities effectively in order to support PM maturity. The shows that they just moved up from level 2 in their PMM in higher education institutions. In addition, it shows that the institutions ensure that each project is running with its own processes and procedures to a minimum specified standard of knowledge processes capabilities set in the institutions. However, it also implies that there is limited consistency or coordination of knowledge process capabilities between the different projects within the institutions (see Figure 4.5 for the maturity level for each knowledge management capabilities for the ten areas of project management).

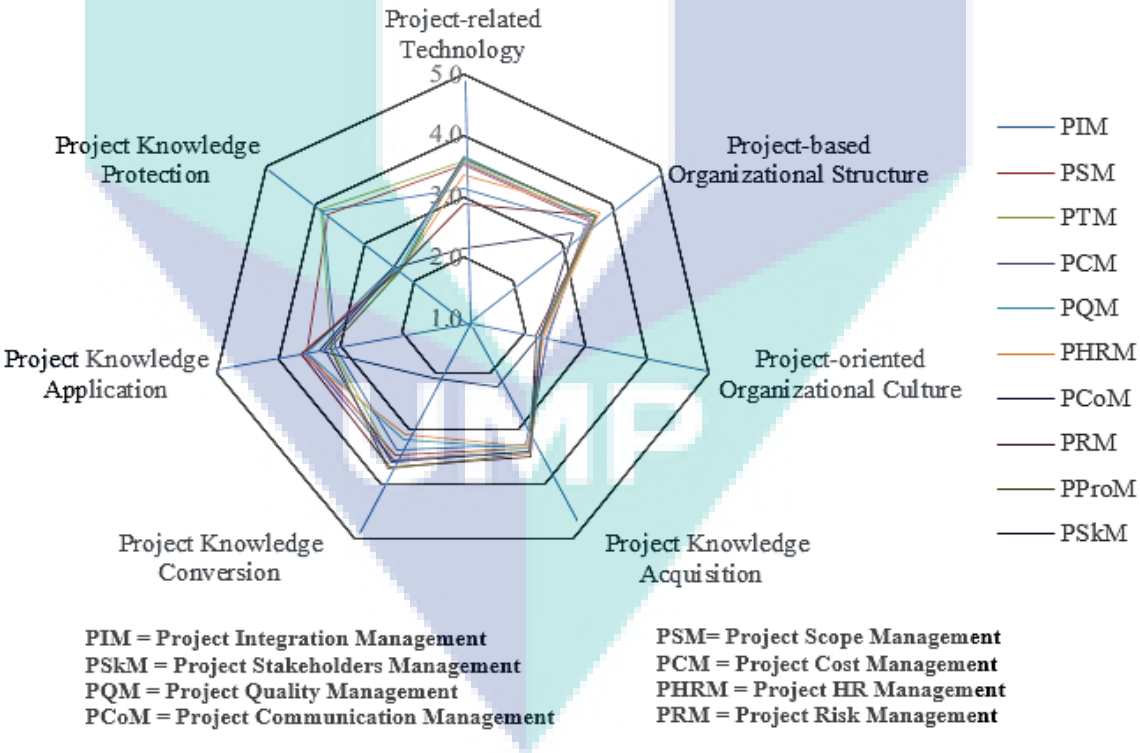


Figure 4.5 The maturity level of each project management area through the knowledge management capabilities.

This study used PjM3's model questionnaires to assess the institutions' project management maturity and compare the findings with the result obtained from the developed model. PjM3 has different questions, and their answers are scaled from 1 to 5 that assesses maturity based on the respondents' feedback on each question. In general, the model only covered project management from narrow angles; it does not focus on each area of project management. The calculated average of the nine questions' evaluations points of project management maturity level was at the value of 2.056, which indicates that the maturity of project management is moving forward from level two (Planned) to level three (Organizational Standardization). However, from the finding results of the two assessments, maturity level was approximately between level 2 and level 3. This can prove that the developed model could be used as valid as other PMM models.

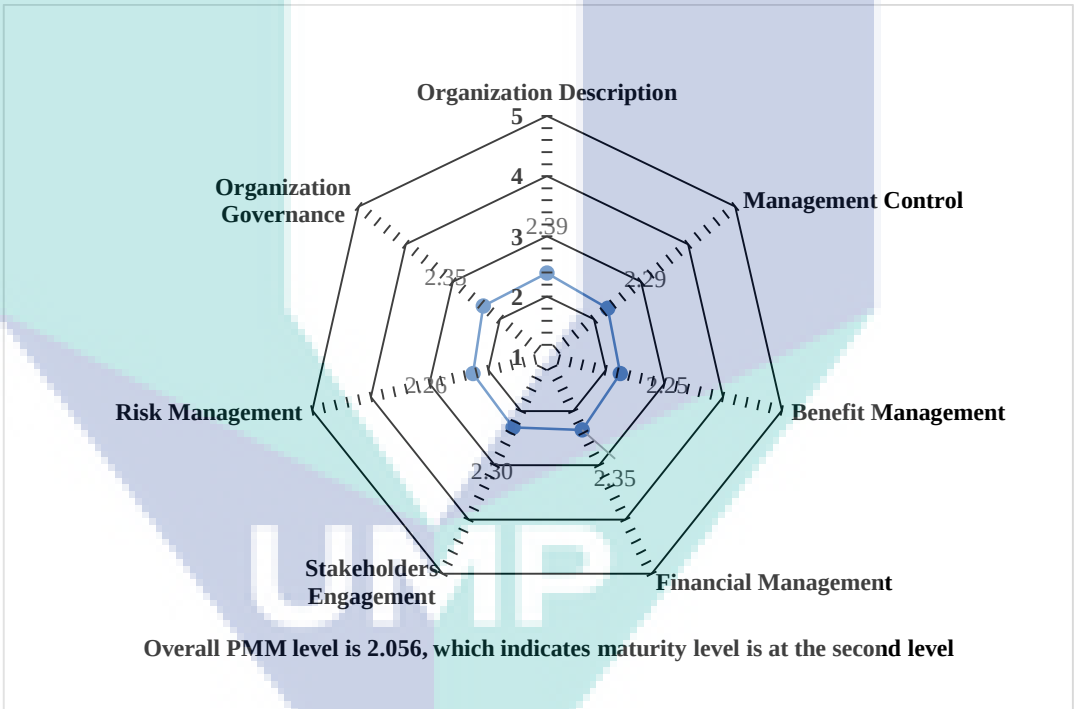


Figure 4.6 Project management maturity via PjM3 model questionnaires

Finally, the study finds that there is a functional measurement similarity between the developed model and the PjM3 model in terms of levelling system and results. However, it differs from other models with its measurement characteristics of each knowledge management capabilities in each evaluated level in project management.

## 4.8 Discussion

The nature of knowledge management capabilities covered in the study was more closely related to project management maturity as a united term. Therefore, integrating the KM capabilities into PM enables the organization to perform critical tasks along value chain activities and enhance the PM maturity level. The mean goal of this study was to extend, find and fill in the gap between these two domains in order to get integrate them and get the benefit the organization. It was conducted in the higher institutions in Yemen by identifying KM capabilities that can assess the level of the PM maturity in these institutions. It was found that out of the seven capabilities which were identified by (Gold et al., 2001), five supported PM maturity and two did not.

### 4.8.1 Project-related Technology in Project Management Maturity

Communication and information technology (IT) have developed rapidly within the last decade. As a result, project managers must be prepared to manage the current and future challenges within the project management field, as well as within the IT industry (Rahim & Dawson, 2013). However, Low, Chen and Wu (2011) noted that expected benefits can provide motivation for innovation technology expansion because pf employees' appreciation of the relative advantages of the new system to raise work efficiency, especially in the organization's project management. The relative advantage of project-related technology implementation could improve the speed of business activities, efficiency of coordination among organizations, decision-making and access and share knowledge easily.

Spalek (2014) revealed in his study that the most mature branch in knowledge management is information technology. Technology as a knowledge management infrastructure was observed to have a significantly positive influence on the project management maturity in the higher institutions in Yemen. This finding implies that organizations realize the use of technology to create, apply and protect organizational knowledge with IS applications, but that they may have a lower level of knowledge manipulating know-how. One possible reason is that technology is new and is upgraded in project management, which has complex charging mechanisms of understanding on how to implement the new technologies. Thus, the organization may consider upgrading their technology accordingly.

According to Rahim and Dawson (2013), technology facilitates the sharing of information in a timely and widespread manner Therefore, effectively using technology to support corporate operations is an important part of managerial operations in most organizations. With regards to this context, the study's finding shows that technology has a significantly positive effect on project management. Whenever the organizations take care of their technology infrastructure, they get a higher project management maturity level compared to the time prior to using this infrastructure. In addition, organizations with sophisticated technological resources (hardware, software, and expertise) may influence initial KM and PM integration.

### 4.8.2 Project-based Organizational Structure in Project Management Maturity

Organizational structure plays an important role in the day-to-day functioning of the organization. The structure supports projects as the dominant form of business. Each project is treated as a separate and relatively independent unit within the organization. (Nahod & Radujkovic, 2019).

Project-based organizational structure was not found to be a significant infrastructure to higher education institutions for supporting project management maturity. The learning organization is seen to be a way of supporting transformation with a recognizable structure, which enables acquisition and transfer of knowledge. If it is to be successful, such acquisition and transfer must be possible. This finding is inconsistent with previous discussions (Blackman, 1999; Kloosterman, 2013). Nevertheless, this inconsistency does not mean that the organizations think that having a project-based organizational structure does not have proper integration with PM. As shown in Figure 4.6, the hypothesis does not support what was planned to answer the research question.

One possible explanation for this being insignificant is the immaturity of project management and the unclear structure mechanism in forming the project-based organizational structure to facilitate PM activities and knowledge usage. If organizations' previous experiences with structure are compatible and match existing KM infrastructure, then the changes introduced by adopting a flexible structure will be consistent with existing practices and project management. This correlation implies that the technology and structure of KM implementation can be part of a barrier to KM and PM integration if they did not manage well in the organizations. The project-based organizational structure

is an important infrastructure. It should be assessed and be evaluated periodically to measure whether the organization structure supports the project management maturity. In case it does not, the organization must take a serious step to revive or reconstruct its existing structure. An organization structure enables a company to group people in a controlled manner for the purpose of performing work (Rory Burke & Steve, 2015).

### 4.8.3 Project-oriented Organizational Culture in Project Management Maturity

Culture plays a vital role in the success or failure of project management. Thus, in the practice of project management, culture should be treated as a significant aspect in controlling conflicts, improving quality outcomes, and encouraging innovation (Nguyen & Watanabe, 2017).

In past research, Cho (2006) indicated that the characteristics of an organization should play an important role in the decision-making process. In this study, organizational culture was significant as a knowledge management infrastructure. Furthermore, based on the positive effect in the linear regression, it is clear that the integration of knowledge management into project management requires an organizational culture that supports and has adequate capability in this integration. Larger institutions have a higher probability of integrating these domains because they have more resources and may be better able to take on risks. They also have a good and supportive culture which encourages such integration in order to get the highest level of project management maturity. Ranf (2010) stated that culture has a significant influence on project management strategy.

This finding is consistent with other scholars mentioned in organizational culture. The organization has to manage and strive to improve its culture. The more they invest in the culture and make it smooth, the better they get the knowledge to be created and shared among their employees. The authors also argue that a project culture should be designed to align to the goals and objectives of the organization with those of the individual participants (Nguyen & Watanabe, 2017). Therefore, culture as an infrastructure is considered as one of the important infrastructures in the organization. It may have several and multinational employees, which have different behaviours and customs. Project managers have to work efficiently to integrate this infrastructure with project management processes. Many employees have excessive knowledge and ideas and they

hesitate to share it because of the culture barrier and organizational culture restriction. In this point, the organization has to set up a new regulation that makes its employees understand the importance of knowledge sharing despite cultural difficulties. Again, if the organization is looking to get the highest level of project management maturity, they have to reconsider their existing culture and reassess and evaluate it if it supports the project portfolio.

### 4.8.4 Project Knowledge Acquisition in Project Management Maturity

The process of project knowledge acquisition is explored in more detail as it is one of the foundational knowledge processes, noting that barriers to successful project knowledge acquisition include a lack of management skill (Royal, O'Donnell, & Rowley, 2013). This finding is consistent with other scholars who mentioned project knowledge acquisition. Innovation, learning, and knowledge acquisition are required on an ongoing basis in this sector (Royal et al., 2013). The organization has to manage and encourage the creation of project knowledge. The hypothesis result in Table 4.9 shows that acquiring knowledge as a knowledge management process has a significant effect on project management maturity in higher education institutions in Yemen.

Effectively managing knowledge in projects is a key factor in the company that gains a decisive advantage (Spalek, 2014). Knowledge must be acquired and obtained on time in order to support project management activities, otherwise, it would be meaningless if it was delivered or created after it was looked for. As such, a project team can acquire the knowledge necessary to perform an activity or solve a problem, which is crucial to the success of future projects (Todorović, Petrović, Mihić, Obradović, & Bushuyev, 2015). Hence, it is necessary to understand the project knowledge acquisition process in project management in the higher institutions. Organizations that want this integration can start with gradual knowledge creation, and slowly increase the number of ways to create this knowledge by developing technology, structure and culture infrastructure.

Organizations should have a strategy that encourages its employees to go for knowledge creation and gathering techniques. The more they create knowledge, the more the project management will use the founded knowledge and support the project processes and decision making. In addition, employees can refer to the organization's lessons

learned to enrich their knowledge creativities and thinking skills. In addition, organizations should provide training sessions and workshops to its employees and collect what they may think can improve the project management progress and achieve the organization's strategic goal. The knowledge management process cannot stand without the main process, which considers a source for the process like project knowledge conversion, application and protection. They work in sequence and support each process.

### 4.8.5 Project Knowledge Conversion in Project Management Maturity

Unexpectedly, project knowledge conversion process did not significantly influence nor positively affect project management maturity. This finding is consistent with previous studies (Bojnord & Afrazeh, 2006). In the project management process, tacit and explicit knowledge should be managed and converted from raw ideas to useful knowledge. Explicit knowledge can be codified and is therefore easy to transfer. Tacit knowledge cannot be transferred easily because it is not expressed in an explicit form. However, the knowledge conversion begins with the individual, then increases and develops as it proceeds through various interactional communities (Al-Adaileh, Dahou, & Hacini, 2012).

Project management as a combined process and multiple skills cannot use the knowledge without converting it into a useful form of information and data. However, once the knowledge is created and collected, the organization should convert it into an understandable and readable source. The organization's employees can obtain and have access to this converted knowledge in order to be familiar with what knowledge is needed for a particular project task or activities. The knowledge conversion process assures the creation of new knowledge and most importantly, the transfer of this knowledge through social interaction between tacit and explicit knowledge via patterns of interactions (Al-Adaileh et al., 2012).

Converting the knowledge in a proper and quick manner will assist the organization to score the highest level of the project management maturity. Finally, in order to compete in an increasingly complex environment, the organization must create, share and manage knowledge that will give them a competitive advantage and these mentioned processes cannot be done without a systematic project knowledge conversion. It emphasizes the value of interaction between knowledge creation processes to generate

a knowledge conversion in which project team members must socialize with users to understand their needs by converting tacit knowledge into explicit knowledge (Astorga-Vargas, Flores-Rios, Licea-Sandoval, & Gonzalez-Navarro, 2017).

### 4.8.6 Project Knowledge Application in Project Management Maturity

The project knowledge application is the core of the project management definition, and the definition starts by insisting knowledge sharing among the organization's members for a successful project management environment. This finding is consistent with previous studies (Sivasubramanian, 2016). Knowledge fulfilment requires the ability to identify appropriate and applicable knowledge resources that can fulfil the knowledge needs of a project and ensure that such knowledge is disseminated and used in the project. Core knowledge management processes such as the application of knowledge are performed within the context of the influence of corporate processes, practices and culture and project management. This could imply that knowledge transfer concern is slightly more important than the concern with knowledge protection when the focus is on building up and considering the project management domain. Spalek (2014) recommends having an incentive system which would enable people to gain benefit if they transfer their invaluable knowledge to the data repository.

The organization has to manage and help apply the project knowledge. The hypothesis result in Table 4.9 shows that project knowledge application as a KM process has a significant effect on project management maturity in higher education institutions in Yemen. The development and application of knowledge must be relevant and in context to the business direction, the stakeholders' needs and the project management's progress. Optimum project knowledge application, sharing and flow is only delivered as part of the business processes of the organization (Vaezi, 2005). Organizations should follow and track if the knowledge is being applied in a sufficient way within their boundaries. For some processes of project management, knowledge must be applied within a fixed time in order to achieve the targeted and planned goal. Argote and Hora (2017) mentioned that individual members are especially effective at transferring knowledge because they can transfer tacit as well as explicit knowledge.

Furthermore, scoring the highest level of project management maturity requires the knowledge to be continuously applied in different aspects of project management.

Expected benefits of project knowledge application can provide motivation for other employees to use and expand it and to raise work efficiency.

KM in project-based organizations draw attention to the fact that the process of knowledge capture, transfer and learning in project settings rely very heavily upon social patterns, practices and processes. Usually, the knowledge that is created through the effort to resolve problems during a project is retained by the project members who will be able to use and apply this knowledge in future projects (Mannan, Saad Jameel, & Haleem, 2013).

### 4.8.7 Project Knowledge Protection in Project Management Maturity

Knowledge protection is one of the important processes driven by PMOs that help organisations to keep and enjoy the competitive advantage that comes about as a result of their successful knowledge transfer processes (Tshuma et al., 2018).

Knowledge protection is positively significant to project management maturity. Knowledge protection increases the level of PM maturity and thus enhances the organization's ability to protect its critical knowledge. Because a higher level of knowledge protection can increase the difficulty of knowledge transfer and ensure the application security, an organization requires a higher level of project management maturity to facilitate the process of knowledge and resource exchange with the employees inside the organization or with external partners. Moreover, the existence of a knowledge protection mechanism can prevent its employees from appropriating knowledge and thus give an organization the confidence and ability to build up project management relations more actively in order to use the required knowledge for the required activity. This finding is consistent with previous studies (Lee, Chang, Liu, & Yang, 2007).

Therefore, organizations must protect their knowledge base and take steps to exploit effectively both the internal and external knowledge which is of relevance to their operations and make it explicitly accessible to their employees (Mannan et al., 2013). Lee et al. (2007) stated that, in this economy, knowledge protection will play as critical a role as innovation. In fact, it has a powerful control against knowledge sharing and accessing it with how organizations look to gain competitive advantage and get the highest level of project management; they should protect their access from lost or unauthorized access. The more the knowledge is secured and protected, the higher the

excellence of project management in that organization. Therefore, it would be pointless for organisations to innovate and create new and unique knowledge, yet fail to protect this knowledge, as competitors will pounce and organisations may find themselves being victims of the failure to protect their knowledge (Tshuma et al., 2018).

Finally, the results are consistent with those suggested to integrate KM into PM. Levin (2010) observed that the knowledge management and project management integration create capabilities that enhance an organization's ability to diffuse project success. Thus, organizations with a stronger KM-PM integration concept are in a better position to facilitate easier diffusion of project activities and achieve managerial tasks. Table 4.14 summarizes the key differences between KM in PM and KM in general.

Table 4.14 Differences in characteristics of KM in PM and KM in general

| Characteristic | KM in PM | KM in General |
|---|---|---|
| Context | KM as well as mainstream project activities happen in the business context of the project and its customer or sponsor. | KM happens in the generic context of the entire organization. |
| Locality | Most members belong to a few well-connected locations. | Members are distributed throughout the organization. |
| Time | Typically short timelines with tight deadlines. | KM benefits may be realized in the long term. |
| Motivation for Knowledge Sharing | Members are driven by the business and knowledge needs of the project. | Members are driven by business needs at times and by long-term career goals at other times. |
| People Network | Informal and close relationships are common among members. | Formal and indirect relationships facilitated by systems are essential in large organizations. |
| Type of Knowledge Involved | Tacit and relatively incompletely embodied knowledge can be shared effectively through direct collaboration. | Mostly explicit knowledge is shared indirectly through systems; tacit and informal knowledge exchange cannot be directly managed. |
| Measurement | Easier to measure KM parameters and to correlate them with cost, quality and productivity measures of the project | Measuring KM parameters is difficult; non-KM metrics may not be available to demonstrate KM benefits. |

Source: Latha, K Suresh, & Mahesh, (2010)

However, by promoting KM and PM integration in a wider scope of value organizational activities, the main implication of this finding is that increasing user awareness of the benefits of this integration positively affects the efficient use and diffusion of knowledge and handling of project processes. According to Latha, K Suresh

and Mahesh (2010), KM in projects is necessarily situated in the context of the project whereas KM in general need not be strongly situated in a business context

## 4.9 Summary

To promote KM-PM integration, it is necessary to clarify the capabilities that explain this integration and make a perspicacious analysis to understand if different capabilities have the same drivers to this integration. In this chapter, the justification for using Partial Least Squares Structural Equation Modelling (PLS-SEM) to test the theoretical model was presented. Subsequently, the assessment of significance of the path coefficients and the clear findings of this research were offered. The path coefficients revealed a significant positive relationship between knowledge management capabilities and project management maturity, except for project-based organizational structure and project knowledge conversion capabilities which did not support the hypotheses. While KM capabilities have been regarded as an important domain that can provide strategic and operational advantages to project management, significant rates of implementation in the higher institutions are yet to be seen. The next chapter (Chapter 5) discussed further the conclusion of the thesis.

# CHAPTER 5

# CONCLUSION

## 5.1 Introduction

This chapter summarizes the research and aims to provide recommendations and conclusions on how project management maturity is assessed using knowledge capabilities in higher education institutions in Yemen. In addition, this chapter includes research benefits to project management as well knowledge management as the main domains and suggests areas of future research after a review of the limitations of this research. By revisiting the research objectives and key findings, an overview is discussed to assess the extent to which the research objectives are met in the entire research.

An investigation into the prospects and benefits of integrating project management into knowledge management in higher education was conducted. An extensive review of the literature was carried out to achieve the aim of the study and cover the study's objectives. The purpose of the research was to develop a clear understanding about how project management maturity can be assessed using knowledge management capabilities and how these two terms are integrated to achieve better PM maturity level in higher education institutions in Yemen. The results of 352 collected questionnaires were analysed quantitatively to obtain comprehensive findings and accurate results.

## 5.2 Conclusions

In achieving the aim of the research, at the beginning of the research, four primary objectives were outlined and made through the findings of the analysed and collected questionnaire data. These objectives were related to the research questions that were developed to increase the knowledge and familiarity with the subject of the two domains of the research. The outcomes were concluded as follows:

### 5.2.1 Outcome of research objective one

- The objective was to identify and define knowledge management capabilities in project management (KMC-PM). This objective is related to the following research question:
- What are the knowledge management capabilities in project management?

The interest in organizational capabilities has created focus on the development and implementation of KM processes and infrastructure required to support daily work practices (Singh Sandhawalia & Dalcher, 2011). The study findings have identified knowledge capabilities that can be used in project management as a key involvement to measure its maturity in a particular organization. However, their names and definitions were slightly refined to answer the first research question. For instance, the first capability was named as technology capability based on the knowledge capabilities categorization by Gold et al. (2001). Later on, this capability was renamed and defined to adopt the PM terminology to project-related technology capability, and the same goes with the rest of the capabilities. The new definition tried to integrate the importance of knowledge management into project management and integrate them as one definition. In addition to that, each capability was defined with a new and clear description to the PM domain. (See Heading 1.7 Operational Definition).

### 5.2.2 Outcome of research objective two

- The objective was to develop a novel assessment model of project management maturity through knowledge management capabilities. This objective is related to the following research question:
- What measurement model could be developed to assess project management maturity through knowledge management capabilities?

A number of project management practitioners have developed benchmarks to assess project management capability based on the principles of maturity models, and this seems likely to remain an important area for future development (D. Hillson, 2003). Thus, the main motivation of this research was to develop a new model that assesses the maturity level of organizations' project management through knowledge management. As many models exist today, different kinds of benefits from using them have been identified, but also its obstacles and disadvantages (Backlund et al., 2014). The model

was developed based on the Capability Maturity Model (CMM) levelling system and the rating scale and measurement was based on the seven knowledge management capabilities developed by Gold et al. (2001). The findings showed that several models were developed to measure PM using developed principles and guidelines in order to assess the maturity level. According to Hillson (2003), a number of existing models use a complex structures that makes assessment difficult to implement and interpret. This was considered during the model development in this study. The developed model is named the knowledge management capabilities/project management maturity (KMC-PMM) in Figure 2.8, and it has five levels of measurement: initial, planned, organizational standardization, managed, and continuous improvement. Each level has its own characteristics, which provides a brief context on the level of the maturity based on the designated knowledge management capability. For instance, the organization can get the highest degree of project management maturity if it has well managed and maintained its seven knowledge management capabilities using the developed assessment model. As a result of this objective, each of the capabilities has a significant role in raising the project management maturity level. The project-oriented organizational culture and the project knowledge protection capabilities are at level two. Table 5.1 shows the level of maturity in project management according to the institutions' knowledge management capabilities.

Table 5.1 Project knowledge management capabilities levels

| Project Knowledge Management Capabilities | Mean | Maturity Level |
|---|---|---|
| Project-related Technology | 3.3 | Organizational Standardization |
| Project-based Organizational Structure | 3.6 | Organizational Standardization |
| Project-oriented Organizational Culture | 2.2 | Planned |
| Project Knowledge Acquisition | 3.6 | Organizational Standardization |
| Project Knowledge Conversion | 3.3 | Organizational Standardization |
| Project Knowledge Application | 3.4 | Organizational Standardization |
| Project Knowledge Protection | 2.8 | Planned |

*Maturity Level

0-1 Initial Level 1-2 Planned Level 2-3 Organizational Standardization

3-4 Managed 4-5 Continuous Improvement

The institutions have to give full support to their culture and ensure it is widely communalized with every project member in the firms. However, they should add extra effort to their knowledge protection methods in order to keep the knowledge stored, secured, confidential and protected from unauthorized personnel. Overall, it is advisable to work efficiently and smartly if they are looking to increase their PM maturity by following the latest techniques and tools to utilize their knowledge.

### 5.2.3 Outcome of research objective three

- The objective was to examine the level of project management maturity through knowledge management capabilities in higher education institutions in Yemen. This objective is related to the following research question:
- What project management maturity level could be examined using the knowledge management capabilities in higher education institutions in Yemen?

The increase in maturity in project management relates to a company's activities and processes which are undertaken to enhance the continuous progress in the planning and execution of projects (Spalek, 2014). A survey was conducted to assess and measure the level of project management maturity in the higher education institutions. The result was positive as five of the knowledge management capabilities supported the hypotheses except the structure as the KM infrastructure and project knowledge conversion as a KM process. The overall average of the KM capabilities was rated to be at the third level of PM maturity, which is "Organizational Standard". The PM maturity in the institutions had just moved up from level two (the planning level) to the organizational standard. Knowledge is being converted and used with supported procedures to ensure proper conversion within the institution's premises.

The result of the assessment of project management maturity (PMM) shows how good the company is at managing projects (Spalek, 2014). The result indicates that the higher education institutions are at the medium level of project management maturity. All capabilities are in level three except culture and knowledge protection capabilities which are at level two (planned level). This means that these two capabilities are less mature compared to the capabilities in level three of the PMM. The institutions in Yemen are not immature nor mature, but in between. At this level, organizations should continue their ongoing practices in order to be pushed up to the next maturity level and onto the last level, which is continuous improvement. For future assessment, the higher educations institutions can use the questionnaire as a tool of assessment using date collection and be comparing the finding with the described levels for each capability in Appendix E. However, the results should generate the mean value for each capability in each PM area. After finding the mean, it can be compared against the designated level using the scaling system (see Figure 2.8).

### 5.2.4 Outcome of research objective four

- To find the relationship between knowledge management capabilities with project management maturity in higher education institutions in Yemen. This objective is related to the following research question:
- What are the relationships between knowledge management capabilities with project management maturity in the higher education institutions in Yemen?

This question was answered in CHAPTER 4 and Table 4.9 as this objective was considered as a major objective in this study through a series of statistical analyses in SPSS and SmartPLS, based on a survey of 352 to examine the effects of the KM capabilities on the level of the maturity of project management and their relationships. This study conducted structural equation modelling (SEM) to test Hypotheses 1–7 to find the relationships. Furthermore, to examine the effects of knowledge management capabilities on the project management maturity, this study conducted bootstrapping revisions on the regression analysis to test hypotheses 1 to 7. Mattila (2001) stated that even when the sample number is small or the sample shows a different distribution status, bootstrapping still has inferential abilities to come out with acceptable and reasonable results. The results of the hypotheses in this study are summarized in CHAPTER 4.

Surprisingly, this research shows no significant relationship between the structure as knowledge infrastructure capability and project knowledge conversion as knowledge process capability with project management maturity. As already mentioned previously, these results are different from the conclusions of past researchers (Gold et al., 2001), and (H. Lee & Choi, 2003) in related literature and previous research results and findings. Thus, knowledge management capabilities have a significant effect on project management maturity, however, this is not the case for all the capabilities which have a strong significance to the dependent variable.

To summarize, first, regardless of the relationships between project-related technology, project-oriented organizational culture and project management maturity or the knowledge management processes capabilities and project management maturity, no significant effect was found for the project-based organizational structure infrastructure and project knowledge conversion process. The relationships between the rest of the knowledge management capabilities and project management had significant effects. The

findings confirm that capabilities with a positive effect is not sufficient to drive to a high level of PM maturity, so organizations also need to encourage and improve their project-based organizational structure and their project knowledge conversion process. Getting all of capabilities in place will definitely increase the level of the project management maturity.

## 5.3 Theoretical Contribution

This study adds results and findings to the earliest studies that analyse the use of KMC in measuring organizational performance effectiveness, however, this study also measures project management maturity instead. This study developed a model to explain the integration of KMCs on project management maturity and considered the major role played by these capabilities in getting the highest level of project management maturity, especially project management. This study made certain significant contributions to the previous literature in a number of ways. Thus, the findings in this study complement and extend the foregoing studies and researches.

Past knowledge management capabilities-related studies chose cases from manufacturing and finance institutions (Gold et al., 2001), manufacturing institutions (Chuang, 2004), and manufacturing and service organizations (De Long & Fahey, 2000). As this study had mentioned in Chapter 2, most of the relevant previous conducted studies generally used private and individual institutions as their research subjects and interest to cover the private section of the institutions. However, this study chose public higher education institutions as its research object with the hope and aim to expand the scope of relevant studies on knowledge management capabilities and project management. It focused to fill an important research gap by integrating knowledge management into project management in order for the organizations to overcome their projects' failure upon using this integration. The results and finding of this study will serve as a solid reference to scholars in this area in the upcoming future.

As another contribution, this study presents a hypothesized model that shows not only the integration and correlation of KMC and project management maturity, but also presents the important role of each capability to the organization once it is adopted. It adds new knowledge to management science on several fronts related to PM by providing an in-depth look at assessing project management maturity using these capabilities. KMC

and PM were related in public education institutions and demonstrated a clear path to project management effectiveness for future research.

Taken together, the present study has provided additional evidence to the existing body of knowledge concerning the integration of common domains (project management and knowledge management) and discovered the relationships between each project knowledge capability and project management maturity in higher education institutions. The results from this study lend support to the key theoretical propositions. In particular, the current study has successfully answered all the research questions and objectives despite its limitations. While there have been many studies examining these two domains, however, the present study addressed the theoretical gap by integrating these two domains and came out with an integrated model to assess project management maturity through project knowledge capabilities.

This study also lends theoretical and empirical support for the primary role of each project knowledge capability on the project management maturity. The study has also managed to evaluate how these capabilities theoretically affect the endogenous variable, which is project management maturity. The theoretical framework of this study has also added to the domain of knowledge integration theory by examining the effect of organisational project knowledge capabilities on the project management maturity. In addition to the theoretical contributions, the results from this study provide some important practical implications to higher education institutions and managers. Furthermore, on limitations of the current study, several future research directions were drawn. In conclusion, the present study has added valuable theoretical, practical, and methodological ramifications to the growing body of knowledge in the field of knowledge management and project management.

## 5.4 Practical Contribution

Practically, this study is the first formal study that evaluated and integrated KMCs with PM in higher education institutions in Yemen. The results of the proposed study will assist managers in these institutions by pointing out areas of strength and highlighting the perception of project management based on their seven knowledge management capabilities. By focusing on these findings and using the developed model, managers can develop and enhance their organization's effectiveness and performance, thereby

establishing and maintaining the long-term KIC and KPC strategy of an organizational direction, such as Yemen. They have to reconsider integrating the KMCs with their project management if they are looking to get the highest level of PM maturity. As this study mentioned previously, Alavi and Leidner (2001) believed that KM aims at understanding strategic know-how, building organizational competencies, and creating intellectual capital when knowledge is considered from a capability perspective.

Second, this study has identified another element that is also important for any public institution, namely knowledge process capabilities. The researcher believes that it is very important to manage and keep track of this dimension accordingly, especially if the government wants to gain a competitive advantage in project management through these processes in a public institution. Acquiring, converting, transferring and protecting knowledge requires the willingness of a group or an individual to work with others in order to get their knowledge mutual benefit. Without sharing, it is almost impossible for knowledge to be transferred to others within the institution. This shows that knowledge transfer will not occur in an institution unless its employees and work groups display a high level of cooperative behaviour (Goh, 2002). In project management, the performance of an employee is greatly dependent on their motivation, inspiring them to come to work regularly, work diligently, be flexible, and be willing to carry out their duties (Kok et al., 2015). Project management maturity does indeed focus on enabling a change in organizational culture, structure, and values, which emphasize and support the knowledge processes. If all the dimensions (KICs, KPCs) are managed effectively and efficiently, knowledge can be easily created and transferred in the institution, which will lead to a higher project management maturity level.

Third, knowledge providers (either employees or workers) are represented by subject-matter specialization in each area of an institution. The institutions' intranet network and social media networks enable knowledge organizations to co-produce knowledge outputs by leveraging their internal capacity and sharing their ideas and thoughts with these massive networks. Concerning the human interaction management in the organization, Harrison-Broninski (2005) asserted five effective knowledge work characterizations: (1) Build effective teams; (2) Communicate in a structured way; (3) Create, share and maintain knowledge; (4) Align your time with strategic goals; and (5) Negotiate next steps as you work. If the knowledge can be kept and protected, knowledge

worker contributions will serve to expand the knowledge assets of an institution that he/she is working in by updating the organizational knowledge base. Furthermore, employees need to have at their disposal tools that improve their capacity to create and share knowledge with colleagues wherever and whenever. These technologies enhance knowledge management and usually involve more people in the knowledge creation process as they allow multiple people to collaborate when creating knowledge (Majchrzak, Wagner, & Yates, 2013).

Fourth, the results in this research can be the benchmark for evaluating projects and knowledge-based public institutions rather than higher education institutions. As De Angelis (2013) stated, the public sector is influenced by a growing need for "competition, performance standards, monitoring, measurement, flexibility, emphasis on results, and social control". This study should help managers understand the inter-relationship between the KMCs and project as the mechanism for enhancing PM maturity accordingly to the developed model with the five levels. Understanding the current situation and actual needs of employees from the knowledge creation perspective can help institutions improve overall competitiveness and operational performance, increase project management maturity and upgrade managerial standards in their institutions.

The last contribution is with regards to population selection, in which a rich and wide selection of literature was examined with KMC to organizational performance and organization competitive advantage like senior executives (Gold et al., 2001) and professionals (Khalifa & Liu, 2003); (Chiu & Chen, 2016). The major sampled population of this study was the PM employees of the ten public higher education institutions in Yemen. The staff members were knowledgeable workers who disseminated information throughout communities and found or provided ways to address problems. To be successful at KM and PM, particularly in providing services to the public and conducting educational projects, all staff members should be responsible for managing all types of knowledge that are available in the organization to ensure excellent deliverables. They should have hands-on experience in maintaining a proper knowledge infrastructure by using the four knowledge process capabilities. However, this statement can be considered as a managerial and theoretical contribution as well.

A possible reason for these results is that the higher education institutions have started developing their KM in the past. However, the related knowledge infrastructure

may be quite complex to be managed along with the knowledge processes capabilities. Therefore, the employees' perspectives of KIC have not been very strong and they are still facing some obstacles that stop them from fully using the knowledge in the project management environment. Another reason is that institutions are now using social media tools on the internet as well as their intranet network to drive more powerful collaborations for acquiring, converting and sharing knowledge to support PM processes and activities. As expected, the results of this study are consistent with the views of previous studies and literature.

## 5.5 Recommendations

To this end, it is clear that Yemen as a nation and government has a long way to go to achieve a sustainable project development environment with a high maturity level. Moreover, a lot has to be done in order to enhance their PM benchmarking and standards. In order to achieve the goals of the organizational performance agenda, the country has to look upon project management development and knowledge management capabilities as a way through. Most of the distinction agenda is centralized on project management development; therefore, eliminating challenges that would bar integrating KM with PM requires the effort of both the government and organizations in Yemen.

The current study developed a model to assess project management maturity through knowledge management capabilities for higher education institutions in Yemen. The model has been developed and tested against Yemeni institutions. In addition, the model was used to explain how various challenges facing the KMCs affect projects and the PM maturity level. Finally, the model explained how KMCs would help Yemeni institutions achieve their goals and looked at the role played by project management and maturity in the country. For this purpose, quantitative data from Yemeni institutions were collected and used to answer the research questions. Although the result of this study may contribute to verify the phenomenon in Yemen, several suggestions could be made for managers, academicians and business practitioners.

First, the study exposed a number of opportunities for further examination pertaining to organizational elements that influence the success of project management and its maturity as a whole. One of the elements that needs further research is the knowledge infrastructure capability (KIC). Separate research in this area, particularly in

a public or private organization, could have different results based on each infrastructure. Another important area that needs to be explored is knowledge process capabilities. We believe that the success of implementing knowledge process capabilities in a public organization will be in line with this area.

Second, in the meantime, although this research cannot take into account all the correlations of KMC and project management maturity in other public utility fields and even private organizations in Yemen, the overall structure and process can be employed in an analysis and discussion in other areas of study.

Third, this study used a cluster sampling method consisting of 352 responses. Future research can overcome this limitation by using a larger sample size and evaluate a survey on every institution rather studying it in-group, which may provide a more individual and comprehensive result. Subsequent studies can attempt to apply a qualitative research method and conduct in-depth and long-term studies of specific service providers or use the interview method and conduct face-to-face interviews with the expectation that these methods may obtain data that are more relevant. Addressing qualitative research methods was beyond the scope of this research, and we invite future research to shed additional light on these important issues.

Furthermore, this study uses the fifth edition of PMBOK as it was the latest version while conducting the search and distributing the questionnaires. Future researches may refer to the sixth version of the PMBOK to integrate KM into PM with a new version of PM's knowledge guide. Finally, based on this study's limitations, future research may consider other mediating variables in the relationship between KMC and project management maturity. For example, future studies can consider including environmental and external variables (e.g., political situation, policies, government regulations etc.). Also, it can enable factors of knowledge producers and workers (e.g., human resource and human capital policies etc.) into the survey instrument to rigorously test the effects of environmental and external variables or human resources on the KMCs and PM maturity to increase the richness of the research model's content.

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**APPENDIX A**
**ENGLISH ASSESSMENT QUESTIONNAIRE**


**ASSESSING PROJECT MANAGEMENT MATURITY THROUGH KNOWLEDGE MANAGEMENT CAPABILITIES IN INSTITUTIONS OF HIGHER EDUCATION IN YEMEN**

Dear Respected Respondent,

We are conducting a survey on assessing the project management maturity level though the knowledge management capabilities in higher education institutions in Yemen. If you are one of the project stakeholders and you are always involved in the projects' processes at your institution, we would like to invite you to participate in this survey. Basically the purpose of the survey it to assess the project maturity level through knowledge management capabilities for higher education institutions in Yemen. We are interested in your thoughts, assessment and experience in the nine areas of project management.

These questionnaires below provide a mean of self-assessing the maturity level reached in project management areas, which is your institution is managing through the knowledge management capabilities. It gives you a chance to assess for yourself in each project management area of your choice, what level each knowledge management capability has been reached in achieving the desired maturity for each project management area.

Please tick (√) the most appropriate answer or **write** your rating accordingly. You are advised to answer the questions based on your knowledge and experience on project management. We would appreciate it very much if you could answer the questions carefully as the information you provide will influence the accuracy and the success of this research. It will take around 20 minutes to complete the questionnaire. All answers will be treated as strictly confidential and will be used for the purpose of the academic study only.

Thank you for your cooperation and the time taken in answering this questionnaire. If you have any questions regarding this research, you may address them to us at adnan2ali@gmail.com

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Faculty of Industrial Management
UNIVERSITI MALAYSIA PAHANG

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## SECTION I: DEMOGRAPHIC INFORMATION

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### A. Respondent's Background

1. What is your gender?
   [ ] Male [ ] Female

2. Please specify your age range:
   [ ] 18-25 [ ] 26-35
   [ ] 36-50 [ ] 51-65 [ ] more than 66

3. What is your University?
   [ ] Sana'a University [ ] Aden University
   [ ] Hadhramout University [ ] Hodeidah University
   [ ] Taiz University [ ] Ibb University
   [ ] Dhamar University [ ] Amran University of Technology
   [ ] Hajja University [ ] Al-Bayda University

4. What is your highest level of education?
   [ ] Associate Degree [ ] Bachelor's Degree
   [ ] Master's Degree [ ] Doctoral Degree
   [ ] Other (please specify): _____

5. How many years of work the experience do you have in project management?
   [ ] Less than 2 years [ ] 3 to 5 years.
   [ ] 6-10 years. [ ] 11-20 years.
   [ ] More than 21 years

6. What is your position or title in your institution?
   [ ] President [ ] Dean of Faculty
   [ ] Project Manager [ ] Project Team Member
   [ ] General Supervisor [ ] Other (please specify):_____

7. Are you responsible or involved for any tasks and processes in the project management at your institution?
   [ ] Yes. [ ] No.

### B. Institution's Background in Project Management

8. What is the number of projects yearly managed by your institution?
   [ ] less than 5 Projects [ ] 5– 10 Projects
   [ ] 15–20 Projects [ ] 20 or more Projects

9. How many project team members are currently working for each project in your institution?

   [ ] 5 or less projects. [ ] 5–10 projects.

   [ ] More than 10 projects.

10. What is the main reason for the project failure in your institution?

    [ ] Lack of Resources. [ ] Project's Scope was very wide.
    [ ] Poor Experience in PM. [ ] Time was not enough.
    [ ] Others……

11. In your opinion and experience, Will integrating knowledge management with Project management make your institution achieve a higher level of maturity in Project management?

    [ ] **Yes.** [ ] **No.**

    Why? Reasons Please!

    ……

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## SECTION II: KNOWLEDGE MANAGEMENT CAPABILITIES AND PROJECT MANAGEMENT

**Note: The term maturity is used to mean as a state where the organization is in a perfect condition to achieve its objectives and reaching its planned and desired perfection.**

These questionnaires consist of five project management maturity levels for each capabilities and been categorized based on the proposed model, (Level 1) is the lowest maturity, where (Level 5) is the highest and each level is measured with Likert Scale.

1. **Level 1:**

   No established KM capabilities, standards and maturity at this level is not exist.
2. **Level 2:**

   Some KM capabilities practices and standards are in place in the business case as project resources selection but not across the institution.
3. **Level 3:**

   KM capabilities practices and standards are instituted and mostly used in the institution.
4. **Level 4:**

KM capabilities are Managed and fully in used throughout the project life cycle until the project deliverable.

5. **Level 5:**

Continuous improvement regarding each KM capability through the efficient collection, use, and decimation of data obtained in level 4 is in place.

**Project Integration Management** (i.e. The project charter, develop project management plan, direct and manage project work, monitor and control project work, perform integrated change control and close project / phase). Please mark with (√) the appropriate level you would assess each of the following capabilities. The assessment is based on a scale ranging from level 1 to level 5.

**1.** Strongly disagree **2.** Disagree **3.** Natural **4.** Agree **5.** Strongly agree

| | **Knowledge Management Capabilities** | **1** | **2** | **3** | **4** | **5** |
|---|---|---|---|---|---|---|
| **Technology** | Technology such as hardware, software and network infrastructure in the institution are being used efficiently to support all the processes in this area and technology is currently being implemented. | | | | | |
| **Structure** | The institution structure allows all knowledge to be used and shared easily without any obstacles. Somehow, it's been designed with a complex structure that's difficult to use and the knowledge. | | | | | |
| **Culture** | The institution culture permits the project team members to exchange and share the knowledge between themselves over the institution during these processes or there are some trammels stopping sharing the knowledge. | | | | | |
| **Knowledge Acquisition** | As capability in your institution is used through this area. Acquisition of Knowledge is done by extracting, structuring, organizing it from human experts and create it from the existing knowledge. | | | | | |
| **Knowledge Conversion** | Tacit and Explicit Knowledge are the main types of knowledge in your institution and they are converted in order to obtain the benefit of it and store it in knowledge repository to gain the higher level of maturity. | | | | | |
| **Knowledge Application** | Here, knowledge is available and assisting in making decision and used in performing the project tasks through direction and routines in your institution. | | | | | |
| **Knowledge Protection** | Knowledge protection aims to stop people outside the institution from acquiring knowledge and also granting rights that empower project team members to promote their knowledge and control its uses in your institution. | | | | | |

**Project Scope Management** (i.e. Plan scope management, collect requirements, define scope, create WBS, validate scope and control scope). Please mark with (√) the appropriate level you would assess each of the following capabilities. The assessment is based on a scale ranging from level 1 to level 5.

**1.** Strongly disagree **2.** Disagree **3.** Natural **4.** Agree **5.** Strongly agree

| Knowledge Management Capabilities | | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| **Technology** | Technology such as hardware, software and network infrastructure in the institution are being used efficiently to support all the processes in this area and technology is currently being implemented. | | | | | |
| **Structure** | The institution structure allows all knowledge to be used and shared easily without any obstacles. Somehow, it's been designed with a complex structure that's difficult to use and the knowledge. | | | | | |
| **Culture** | The institution culture permits the project team members to exchange and share the knowledge between themselves over the institution during these processes or there are some trammels stopping sharing the knowledge. | | | | | |
| **Knowledge Acquisition** | As capability in your institution is used through this area. Acquisition of Knowledge is done by extracting, structuring, organizing it from human experts and create it from the existing knowledge. | | | | | |
| **Knowledge Conversion** | Tacit and Explicit Knowledge are the main types of knowledge in your institution and they are converted in order to obtain the benefit of it and store it in knowledge repository to gain the higher level of maturity. | | | | | |
| **Knowledge Application** | Here, knowledge is available and assisting in making decision and used in performing the project tasks through direction and routines in your institution. | | | | | |
| **Knowledge Protection** | Knowledge protection aims to stop people outside the institution from acquiring knowledge and also granting rights that empower project team members to promote their knowledge and control its uses in your institution. | | | | | |

**Project Time Management** (i.e. Plan schedule management, define activities, estimate activity resources, estimate activity durations, develop schedule and control schedule). Please mark with (√) the appropriate level you would assess each of the following capabilities. The assessment is based on a scale ranging from level 1 to level 5.

**1.** Strongly disagree **2.** Disagree **3.** Natural **4.** Agree **5.** Strongly agree

| Knowledge Management Capabilities | | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| **Technology** | Technology such as hardware, software and network infrastructure in the institution are being used efficiently to support all the processes in this area and technology is currently being implemented. | | | | | |
| **Structure** | The institution structure allows all knowledge to be used and shared easily without any obstacles. Somehow, it's been designed with a complex structure that's difficult to use and the knowledge. | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Culture** | The institution culture permits the project team members to exchange and share the knowledge between themselves over the institution during these processes or there are some trammels stopping sharing the knowledge. | | | | | |
| **Knowledge Acquisition** | As capability in your institution is used through this area. Acquisition of Knowledge is done by extracting, structuring, organizing it from human experts and create it from the existing knowledge. | | | | | |
| **Knowledge Conversion** | Tacit and Explicit Knowledge are the main types of knowledge in your institution and they are converted in order to obtain the benefit of it and store it in knowledge repository to gain the higher level of maturity. | | | | | |
| **Knowledge Application** | Here, knowledge is available and assisting in making decision and used in performing the project tasks through direction and routines in your institution. | | | | | |
| **Knowledge Protection** | Knowledge protection aims to stop people outside the institution from acquiring knowledge and also granting rights that empower project team members to promote their knowledge and control its uses in your institution. | | | | | |

**Project Cost Management** (i.e. Plan cost management, estimate costs, determine budget and control costs.). Please mark with (√) the appropriate level you would assess each of the following capabilities. The assessment is based on a scale ranging from level 1 to level 5.

**1.** Strongly disagree **2.** Disagree **3.** Natural **4.** Agree **5.** Strongly agree

| | **Knowledge Management Capabilities** | **1** | **2** | **3** | **4** | **5** |
|---|---|---|---|---|---|---|
| **Technology** | Technology such as hardware, software and network infrastructure in the institution are being used efficiently to support all the processes in this area and technology is currently being implemented. | | | | | |
| **Structure** | The institution structure allows all knowledge to be used and shared easily without any obstacles. Somehow, it's been designed with a complex structure that's difficult to use and the knowledge. | | | | | |
| **Culture** | The institution culture permits the project team members to exchange and share the knowledge between themselves over the institution during these processes or there are some trammels stopping sharing the knowledge. | | | | | |
| **Knowledge Acquisition** | As capability in your institution is used through this area. Acquisition of Knowledge is done by extracting, structuring, organizing it from human experts and create it from the existing knowledge. | | | | | |
| **Knowledge Conversion** | Tacit and Explicit Knowledge are the main types of knowledge in your institution and they are converted in order to obtain the benefit of it and store it in knowledge repository to gain the higher level of maturity. | | | | | |

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|---|---|---|---|---|---|---|
| **Knowledge Application** | Here, knowledge is available and assisting in making decision and used in performing the project tasks through direction and routines in your institution. | | | | | |
| **Knowledge Protection** | Knowledge protection aims to stop people outside the institution from acquiring knowledge and also granting rights that empower project team members to promote their knowledge and control its uses in your institution. | | | | | |

**Project Quality Management** (i.e. Plan Quality Management, Perform Quality Assurance (QA) and Perform Quality Control (QC)). Please mark with (√) the appropriate level you would assess each of the following capabilities. The assessment is based on a scale ranging from level 1 to level 5.

**1.** Strongly disagree **2.** Disagree **3.** Natural **4.** Agree **5.** Strongly agree

| | **Knowledge Management Capabilities** | **1** | **2** | **3** | **4** | **5** |
|---|---|---|---|---|---|---|
| **Technology** | Technology such as hardware, software and network infrastructure in the institution are being used efficiently to support all the processes in this area and technology is currently being implemented. | | | | | |
| **Structure** | The institution structure allows all knowledge to be used and shared easily without any obstacles. Somehow, it's been designed with a complex structure that's difficult to use and the knowledge. | | | | | |
| **Culture** | The institution culture permits the project team members to exchange and share the knowledge between themselves over the institution during these processes or there are some trammels stopping sharing the knowledge. | | | | | |
| **Knowledge Acquisition** | As capability in your institution is used through this area. Acquisition of Knowledge is done by extracting, structuring, organizing it from human experts and create it from the existing knowledge. | | | | | |
| **Knowledge Conversion** | Tacit and Explicit Knowledge are the main types of knowledge in your institution and they are converted in order to obtain the benefit of it and store it in knowledge repository to gain the higher level of maturity. | | | | | |
| **Knowledge Application** | Here, knowledge is available and assisting in making decision and used in performing the project tasks through direction and routines in your institution. | | | | | |
| **Knowledge Protection** | Knowledge protection aims to stop people outside the institution from acquiring knowledge and also granting rights that empower project team members to promote their knowledge and control its uses in your institution. | | | | | |

**Project Human Resources Management** (i.e. Plan Human Resource Management, Acquire Project Team, Develop Project Team and Manage Project Team). Please mark with (√) the appropriate level you would assess each of the following capabilities. The assessment is based on a scale ranging from level 1 to level 5.

**1.** Strongly disagree **2.** Disagree **3.** Natural **4.** Agree **5.** Strongly agree

| Knowledge Management Capabilities | | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| **Technology** | Technology such as hardware, software and network infrastructure in the institution are being used efficiently to support all the processes in this area and technology is currently being implemented. | | | | | |
| **Structure** | The institution structure allows all knowledge to be used and shared easily without any obstacles. Somehow, it's been designed with a complex structure that's difficult to use and the knowledge. | | | | | |
| **Culture** | The institution culture permits the project team members to exchange and share the knowledge between themselves over the institution during these processes or there are some trammels stopping sharing the knowledge. | | | | | |
| **Knowledge Acquisition** | As capability in your institution is used through this area. Acquisition of Knowledge is done by extracting, structuring, organizing it from human experts and create it from the existing knowledge. | | | | | |
| **Knowledge Conversion** | Tacit and Explicit Knowledge are the main types of knowledge in your institution and they are converted in order to obtain the benefit of it and store it in knowledge repository to gain the higher level of maturity. | | | | | |
| **Knowledge Application** | Here, knowledge is available and assisting in making decision and used in performing the project tasks through direction and routines in your institution. | | | | | |
| **Knowledge Protection** | Knowledge protection aims to stop people outside the institution from acquiring knowledge and also granting rights that empower project team members to promote their knowledge and control its uses in your institution. | | | | | |

**Project Communication Management** (i.e. Plan Communications Management, Manage Communications and Control Communications). Please mark with (√) the appropriate level you would assess each of the following capabilities. The assessment is based on a scale ranging from level 1 to level 5.

**1.** Strongly disagree **2.** Disagree **3.** Natural **4.** Agree **5.** Strongly agree

| Knowledge Management Capabilities | | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| **Technology** | Technology such as hardware, software and network infrastructure in the institution are being used efficiently to support all the processes in this area and technology is currently being implemented. | | | | | |
| **Structure** | The institution structure allows all knowledge to be used and shared easily without any obstacles. Somehow, it's been designed with a complex structure that's difficult to use and the knowledge. | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Culture** | The institution culture permits the project team members to exchange and share the knowledge between themselves over the institution during these processes or there are some trammels stopping sharing the knowledge. | | | | | |
| **Knowledge Acquisition** | As capability in your institution is used through this area. Acquisition of Knowledge is done by extracting, structuring, organizing it from human experts and create it from the existing knowledge. | | | | | |
| **Knowledge Conversion** | Tacit and Explicit Knowledge are the main types of knowledge in your institution and they are converted in order to obtain the benefit of it and store it in knowledge repository to gain the higher level of maturity. | | | | | |
| **Knowledge Application** | Here, knowledge is available and assisting in making decision and used in performing the project tasks through direction and routines in your institution. | | | | | |
| **Knowledge Protection** | Knowledge protection aims to stop people outside the institution from acquiring knowledge and also granting rights that empower project team members to promote their knowledge and control its uses in your institution. | | | | | |

**Project Risk Management** (i.e. Plan risk management, identify risks, perform qualitative risk analysis, and perform quantitative risk analysis, plan risk responses and control risks). Please mark with (√) the appropriate level you would assess each of the following capabilities. The assessment is based on a scale ranging from level 1 to level 5.

**1.** Strongly disagree **2.** Disagree **3.** Natural **4.** Agree **5.** Strongly agree

| | **Knowledge Management Capabilities** | **1** | **2** | **3** | **4** | **5** |
|---|---|---|---|---|---|---|
| **Technology** | Technology such as hardware, software and network infrastructure in the institution are being used efficiently to support all the processes in this area and technology is currently being implemented. | | | | | |
| **Structure** | The institution structure allows all knowledge to be used and shared easily without any obstacles. Somehow, it's been designed with a complex structure that's difficult to use and the knowledge. | | | | | |
| **Culture** | The institution culture permits the project team members to exchange and share the knowledge between themselves over the institution during these processes or there are some trammels stopping sharing the knowledge. | | | | | |
| **Knowledge Acquisition** | As capability in your institution is used through this area. Acquisition of Knowledge is done by extracting, structuring, organizing it from human experts and create it from the existing knowledge. | | | | | |
| **Knowledge Conversion** | Tacit and Explicit Knowledge are the main types of knowledge in your institution and they are converted in order to obtain the benefit of it and store it in knowledge repository to gain the higher level of maturity. | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Knowledge Application** | Here, knowledge is available and assisting in making decision and used in performing the project tasks through direction and routines in your institution. | | | | | |
| **Knowledge Protection** | Knowledge protection aims to stop people outside the institution from acquiring knowledge and also granting rights that empower project team members to promote their knowledge and control its uses in your institution. | | | | | |

**Project Procurement Management** (i.e. Plan procurement management, conduct procurements, control procurements and close procurements). Please mark with (√) the appropriate level you would assess each of the following capabilities. The assessment is based on a scale ranging from level 1 to level 5.

**1.** Strongly disagree **2.** Disagree **3.** Natural **4.** Agree **5.** Strongly agree

| | **Knowledge Management Capabilities** | **1** | **2** | **3** | **4** | **5** |
|---|---|---|---|---|---|---|
| **Technology** | Technology such as hardware, software and network infrastructure in the institution are being used efficiently to support all the processes in this area and technology is currently being implemented. | | | | | |
| **Structure** | The institution structure allows all knowledge to be used and shared easily without any obstacles. Somehow, it's been designed with a complex structure that's difficult to use and the knowledge. | | | | | |
| **Culture** | The institution culture permits the project team members to exchange and share the knowledge between themselves over the institution during these processes or there are some trammels stopping sharing the knowledge. | | | | | |
| **Knowledge Acquisition** | As capability in your institution is used through this area. Acquisition of Knowledge is done by extracting, structuring, organizing it from human experts and create it from the existing knowledge. | | | | | |
| **Knowledge Conversion** | Tacit and Explicit Knowledge are the main types of knowledge in your institution and they are converted in order to obtain the benefit of it and store it in knowledge repository to gain the higher level of maturity. | | | | | |
| **Knowledge Application** | Here, knowledge is available and assisting in making decision and used in performing the project tasks through direction and routines in your institution. | | | | | |
| **Knowledge Protection** | Knowledge protection aims to stop people outside the institution from acquiring knowledge and also granting rights that empower project team members to promote their knowledge and control its uses in your institution. | | | | | |

**Project Stakeholders Management** (i.e. Identify Stakeholders, Plan Stakeholder Management, Manage Stakeholder Engagement and Control Stakeholder Engagement.) Please mark with (√) the appropriate level you would assess each of the following capabilities. The assessment is based on a scale ranging from level 1 to level 5.

**1.** Strongly disagree **2.** Disagree **3.** Natural **4.** Agree **5.** Strongly agree

| Knowledge Management Capabilities | | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| **Technology** | Technology such as hardware, software and network infrastructure in the institution are being used efficiently to support all the processes in this area and technology is currently being implemented. | | | | | |
| **Structure** | The institution structure allows all knowledge to be used and shared easily without any obstacles. Somehow, it's been designed with a complex structure that's difficult to use and the knowledge. | | | | | |
| **Culture** | The institution culture permits the project team members to exchange and share the knowledge between themselves over the institution during these processes or there are some trammels stopping sharing the knowledge. | | | | | |
| **Knowledge Acquisition** | As capability in your institution is used through this area. Acquisition of Knowledge is done by extracting, structuring, organizing it from human experts and create it from the existing knowledge. | | | | | |
| **Knowledge Conversion** | Tacit and Explicit Knowledge are the main types of knowledge in your institution and they are converted in order to obtain the benefit of it and store it in knowledge repository to gain the higher level of maturity. | | | | | |
| **Knowledge Application** | Knowledge is available and assisting in making decision and used in performing the project tasks through direction and routines in your institution. | | | | | |
| **Knowledge Protection** | Knowledge protection aims to stop people outside the institution from acquiring knowledge and also granting rights that empower project team members to promote their knowledge and control its uses in your institution. | | | | | |

## Institution's Project Management Maturity:

This section is adopted from P3M3 Self-Assessment Questionnaire. Please answer all the nine questions and make sure to check the most appropriate answer based on your experience, the choices are rated according to likert scale from the lowest level strongly disagree to the highest level strongly agree.

1. **Our organization can be best characterized as having**
   - [ ] Processes are not usually documented, there are no, or only a few, process descriptions.
   - [ ] The organization is able to demonstrate the basic management practices have been established.

[ ] Management and technical processes are documented, standardized and integrated to some extent with other business processes.
[ ] The organization demonstrates mature behavior though defined processes that are quantitatively managed.
[ ] The organization is focused on optimization of its quantitatively managed processes to take into account changing business and externals factors. It is able to anticipate future capacity demands and capability requirements to meet delivery challenges.

**2. Our management control is best described by:**

[ ] Project management terminology is used by some members of the organization but not consistently and possibly not understood by all stakeholders. Projects are conducted and managed according to individual preferences.
[ ] The concept of project management will have been grasped by the organization, and there may be local experts, such as experienced project managers, working on key projects.
[ ] There is a centrally defined and documented approach to a project management life cycle and controls, and it is applied in all projects by capable staff who support projects teams.
[ ] Project management is seen as a key tool for the delivery mechanism of change. Within the project environment the focus is on improvement of delivery through measurement and analysis performance.
[ ] Management controls ensure that the project approach delivers the change objectives of the organization. Acceptance of project management as the optimal approach to change delivery is organization-wide. There is evidence of continual improvement.

**3. Our benefits management is best described by:**

[ ] There is some recognition that the concept of benefits can be differentiated from project outputs.
[ ] Benefits are recognized as an element with project business cases. There may be some documentation regarding who is responsible for particular benefits and their realization, but this is unlikely to be followed through or consistent.
[ ] There is centrally managed and consistent framework for defining and tracking the realization of benefits arising from project outputs.
[ ] Benefits management is embedded within the project approach and there is a focus on delivery of business performance from project outputs. Project performance metrics are collected and analyzed.
[ ] Benefit Management is embedded with the organizational approach to change and is assessed as part of the development of organizational strategy. Business performance metrics linked to, and underpin, the recognition of benefits realization. There is evidence of continual improvement.

**4. Our financial management is best described by:**

[ ] There is little or no financial control at project level. There is a lack of accountability and monitoring of project expenditure.
[ ] Project business cases are produced in various forms and the better and more formal cases will present the rationale on which to obtain organizational commitment to the project. Overall cost of the project is not monitored or fully accounted for.

[ ] There are centrally established standards for the preparation of business cases and processes for their management throughout the project life cycle. Project managers monitor costs and expenditure in accordance with organizational guidelines and procedures, with defined interfaces with other financial functions within the organization.

[ ] The organization is able to prioritize investment opportunities effectively in relation to the availability of funds and other resources. Project budgets are managed effectively and project performance against cost is monitored and compared.

[ ] Project financial controls are fully integrated with those of the organization. Cost estimation techniques used at the project level are continually reviewed in terms of actual versus estimate comparisons to improve estimation throughout the organization. There is evidence of continual improvement.

**5. Our approach to Stakeholder engagement is best described by:**

[ ] Stakeholder engagement and communication is rarely used by projects as an element of the delivery toolkit.

[ ] Some projects will be communicated to stakeholders, but this is linked more to the personal initiative of project managers than to a structured approach being deployed by the organization.

[ ] There is a centrally managed and consistent approach to stakeholder engagement and communications used by all projects.

[ ] Sophisticated techniques are used to analyze and engage the project stakeholder environment effectively, and quantitative information is used to underpin the assessment of effectiveness.

[ ] Communications are being optimized from extensive knowledge of the stakeholder environment, to enable the projects to achieve their objectives. There is evidence of continual improvement.

**6. Our Risk Management is best described by:**

[ ] There is minimal evidence of risk management being used to any beneficial effect on projects. There may be evidence of risks being documented but little evidence of active management.

[ ] Risk management is recognized and used on projects, but there are inconsistent approaches which result in different levels of commitment and effectiveness.

[ ] Project risk management is based on a centrally defined process that is cognizant of the organization's policy for the management of risks and is used consistently.

[ ] Project risk management is working effectively, is embedded, and the value of risk management can be demonstrated. There is evidence of opportunity management and management of risk aggregation.

[ ] Risk management is embedded in the organizational culture and underpins all decision-making within projects. There is evidence of continual improvement.

**7. We deliver Organizational Governance by:**

[ ] Some informal governance of projects exists but has undefined links to broader organizational controls. Roles are unlikely to be formally defined.

[ ] Project management from an organizational perspective is beginning to take shape but with ad hoc controls and no clear strategic control. Roles and responsibilities will be inconsistent, as will reporting lines.

[ ] Centrally defined organizational controls are applied consistently to all projects, with decision-making structures in place and linked to organizational governance.

[ ] There will be clearly aligned project decision-making processes that adopt and integrate with broader organizational governance and which are transparent to those involved. Project management responsibilities are embedded within broader role descriptions.

[ ] The governance arrangements for projects are a core aspect of organizational control, with demonstrable reporting lines to Executive Board level and with clear ownership and control responsibilities embedded within the organization. There is evidence of continual improvement.

**8. Our Resource Management is best described by:**

[ ] There is some recognition within the organization of the need to manage resources effectively to enable successful delivery of projects, but little evidence of resource acquisition, planning or management.

[ ] Resources are being deployed across the organization and individual projects have an approach to resource acquisition, planning or management. However there is little evidence of consistency of approach.

[ ] The organization has a centrally defined and adopted set of procedures and management processes for acquiring, planning and managing project resources.

[ ] Resource management for projects is considered at a strategic level within the organization. There is evidence of resource capacity management, through capacity planning, in order to meet project delivery needs.

[ ] Resources are deployed optimally. There is clear evidence of load balancing and the effective use of both internal and external resources across all projects. There is evidence of continual improvement.

**9. What is best described your organization:**

[ ] Recognize projects and run them differently from its ongoing business. (Projects may be run informally with no standard process or tracking system).

[ ] Ensure that each project is run with its own processes and procedures to a minimum specified standard. (There may be limited consistency or coordination between projects).

[ ] Have its own centrally controlled project processes and individual projects can flex within these processes to suit the particular project.

[ ] Obtain and retain specific measurements on its project management performance and run a quality management organization to better predict future performance.

[ ] Undertake continuous process improvement with proactive problem and technology management for projects in order to improve its ability to depict performance over time and optimize processes.

----------**END OF SURVEY**----------

Thank you for participating in the survey

**APPENDIX B**
**ARABIC ASSESSMENT QUESTIONNAIRE**

## تقييم نضج إدارة المشاريع من خلال قدرات إدارة المعرفة في مؤسسات التعليم العالي في اليمن

عزيزي،

نحن نجري دراسة إستقصائية على تقييم مستوى نضج إدارة المشاريع من خلال قدرات إدارة المعرفة في مؤسسات التعليم العالي في اليمن. إذا كنت واحدا من أصحاب المصلحة في المشروع وكنت دائما المعنيَ في العمليات والمشاريع في مؤسستك، نود أن ندعوك للمشاركة في هذه الدراسة. في الأساس الغرض من الدراسة تقييم مستوى نضج المشروع من خلال قدرات إدارة المعرفة لمؤسسات التعليم العالي في اليمن. ونحن مهتمون في أفكارك والتقييم والخبرة في المجالات التسعة لإدارة المشروع.

هذه الاستبيانات الواردة أدناه متوسط مستوى النضج لتقييم ذاتي تم التوصل إليه في مجالات إدارة المشاريع، والتي مؤسستك تدير من خلال قدرات إدارة المعرفة. فهي توفر لك فرصة لتقييم نفسك في كل مجالات إدارة المشاريع من اختيارك، ما هو المستوى الذي تم التوصل إلى القدرة على إدارة المعرفة في تحقيق النضج المطلوب في كل مجالات إدارة المشاريع.

يرجى وضع علامة (√) حيث الجواب الأنسب أو كتابة تصنيف وفقا لذلك. ويُنصح الإجابة على الأسئلة التي تعتمد على المعرفة والخبرة في إدارة المشاريع. ونحن نقدر ذلك كثيرا إذا كان بمقدورك أن تجيب على الأسئلة بعناية حيث وأن المعلومات التي تقدمها سوف تؤثر على دقة ونجاح هذا البحث. وسوف يستغرق حوالي 20 دقيقة لإكمال الاستبيان. سيتم التعامل مع جميع الإجابات بمنتهى السرية ولن تستخدم إلا لأغراض الدراسة الأكاديمية فقط.

أشكركم على تعاونكم في الوقت المستغرق في الإجابة على هذا الاستبيان. إذا كان لديكم أي أسئلة بخصوص هذا البحث، يمكنكم مخاطبتنا على adnan2ali@gmail.com


**عدنان الغيل**
مرشح شهادة دكتوراه
كلية الإدارة الصناعية
جامعة باهانج الماليزية

**الدكتور / ليو ياو**
نائب عميد (بحوث والدراسات العليا)
كلية الإدارة الصناعية
جامعة باهانج الماليزية

---

## القسم الأول: المعلومات السكانية

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### أ. خلفية المجيب

1. **ما هو جنسك؟**
( ) ذكر ( ) أنثى

2. **الفئة العمرية؟**
( ) 18-25 ( ) 26-35 ( ) 36-50 ( ) 51-65 ( ) أكثر من 66

3. **ما هي جامعتك؟**
( ) جامعة صنعاء ( ) جامعة حضرموت ( ) جامعة تعز
( ) جامعة ذمار ( ) جامعة حجة ( ) جامعة عدن
( ) جامعة الحديدة ( ) جامعة إب ( ) جامعة عمران للتكنولوجيا
( ) جامعة البيضاء

4. **ما هو مستواك الأعلى التعليمي؟**
( ) درجة الدكتوراه ( ) درجة الماجستير
( ) درجة البكالوريوس ( ) شهادة مهنية
( ) غير ذلك (( يرجى التحديد )) :.....

5. **كم عدد سنوات العمل في الخبرة لديك في إدارة المشاريع؟**
( ) أقل من سنتين ( ) 6-10 سنوات
( ) أكثر من 21 سنة ( ) 3-5 سنوات
( ) 11-20 سنة

6. **ما هو منصبك أو لقبك في مؤسستك؟**
( ) الرئيس ( ) عميد الكلية
( ) مدير المشروع ( ) عضر فريق العمل
( ) المشرف العام ( ) غير ذلك (( يرجى التحديد )):.....

7. **هل أنت المسؤول أو تشارك في أي مهام أو عمليات إدارة المشاريع في مؤسستك؟**
( ) نعم ( ) لا

### ب. خلفية المؤسسة في إدارة المشاريع

1. **كم عدد المشاريع التي تمكنت من مؤسستكم؟**
( ) 5 مشاريع أو أقل ( ) 5-10 مشروع
( ) 15-20 مشروع ( ) أكثر من 10 مشاريع.

2. **كم عدد أعضاء فريق المشروع الذين يعملون حاليا لكل مشروع في مؤسستكم؟**
( ) 5 مشاريع أو أقل ( ) 5-10 مشروع
( ) أكثر من 10 مشاريع

3. **ما هو السبب الرئيسي لفشل المشاريع في مؤسستكم؟**

( ) نقص من الموارد ( ) نطاق المشروع واسع جدا

( ) الخبرة الرديئة في إدارة المشاريع ( ) الوقت غير كافٍ

( ) غير ذلك :.....

4. **برأيك وخبراتك, هل دمج إدارة المعرفة مع إدارة المشروع سوف يجعل مؤسستك تحقق مستوى أعلى من النضج في إدارة المشاريع؟**

( ) نعم ( ) لا

لماذا؟ الأسباب من فضلك

.....

.....

## القسم الثاني: قدرات إدارة المعرفة وإدارة المشاريع

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**<u>ملاحظة:</u> يستخدم مصطلح النضج ليعني كحالة حيث وان المنظمة في حالة ممتازة لتحقيق أهدافها والوصول إلى الكمال المنشود والمخطط لها.**

هذه الاستبيانات تتكون من خمسة مستويات في نضج إدارة المشاريع لكل القدرات والتي تم تصنيفها على أساس النموذج المقترح، (المستوى 1) وهو أدنى النضج، حيث (المستوى 5) هو الأعلى ويتم قياس كل مستوى بـ **مقياس ليكرت**

6. **<u>المستوى 1:</u>** لم تُنشأ قدرات إدارة المعرفة، لا وجود للمعايير والنضج في هذا المستوى.

7. **<u>المستوى 2:</u>** بعض من ممارسات قدرات إدارة المعرفة والمعايير في حالة العمل على نحو اختبار موارد المشروع ولكن ليس عبر المؤسسة.
8. **<u>المستوى 3:</u>** ممارسات قدرات إدارة المعرفة والمعايير وضعت وغالبا ما تستخدم في المؤسسة.

9. **<u>المستوى 4:</u>** تُدار قدرات إدارة المعرفة وتستخدم كاملة خلال دورة حياة المشروع وحتى إنجازه.

10. **<u>المستوى 5:</u>** التحسين المستمر فيما يتعلق بكل قدرة إدارة المعرفة من خلال كفاءة جمع واستخدام وهلاك من البيانات التي تم الحصول عليها من مستوى 4.

**إدارة تكامل المشروع** (بمعنى اخر، ميثاق المشروع ووضع خطة إدارة المشروع وتوجيهها وإدارة العمل في المشروع ورصد وعمل مشروع مراقبة, مراقبة عملية تغيير متكاملة وثيقة المشروع / المرحلة ). يرجى وضع علامة (√) على المستوى المناسب لك أن تقيم كل من الإمكانات التالية. ويستند هذا التقييم على مقياس يتراوح من مستوى 1 إلى مستوى 5.

**1.لا أوافق بشدة.  2. لا أوافق.  3. طبيعي.  4. موافق.  5. موافق بشدة.**

| | قدرات إدارة المعرفة | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| التكنولوجيا | التكنولوجيا مثل الأجهزة والبرمجيات وشبكة البنية التحتية في المؤسسة تستخدم بكفاءة لدعم جميع العمليات في هذا المجال، ويجري حاليا تنفيذ التكنولوجيا. | | | | | |
| الهيكل | يسمح هيكل المؤسسة لكل المعرفة التي يمكن استخدامها وتبادلها بسهولة دون أي عقبات. بطريقة أو بأخرى، تم تصميمه مع هيكل معقد من الصعب استخدامه ومعرفته. | | | | | |
| الثقافة | ثقافة المؤسسة تسمح لأعضاء فريق المشرع بتبادل وتقاسم المعرفة بين أنفسهم في المؤسسة خلال هذه العمليات أو أن هناك بعض العوائق مما تؤدي إلى إيقاف المشاركة. | | | | | |
| اكتساب المعرفة | كما يتم استخدام القدرة في مؤسستكم من خلال هذا المجال. يتم اكتساب المعرفة عن طريق استخراج وهيكلة وتنظيم ذلك من خبراء حقوق الإنسان وإنشائه من المعارف الموجودة. | | | | | |
| نوع المعرفة | المعرفة الضمنية والصريحة هي الأنواع الرئيسية من المعرفة في مؤسستك ويتم تحويلها من أجل الحصول على منفعة منها، وتخزينها في مستودع المعرفة للحصول على مستوى أعلى من النضج. | | | | | |
| تطبيق المعرفة | هنا، المعرفة متاحة والتي تساعد في اتخاذ القرارات، وتستخدم في أداء مهام المشروع من خلال التوجيه والإجراءات في مؤسستك. | | | | | |
| حماية المعرفة | تهدف حماية المعرفة إلى منع الناس من خارج المؤسسة من الحصول على المعرفة، وكذلك منح الحقوق التي تمكن أعضاء فريق المشروع لتعزيز معارفهم والسيطرة على استخداماتها في مؤسستك. | | | | | |

**إدارة نطاق المشروع** (أي خطة إدارة نطاق، وجمع المتطلبات، تحديد نطاق، إنشاء هيكل تجزئة العمل والتحقق من صحة نطاق والسيطرة على نطاق). يرجى وضع علامة (√) على المستوى المناسب لك أن تقيم كل من الإمكانات التالية. ويستند هذا التقييم على مقياس يتراوح من مستوى 1 إلى مستوى 5.

**1. لا أوافق بشدة.  2. لا أوافق.  3. طبيعي.  4. موافق.  5. موافق بشدة.**

| | قدرات إدارة المعرفة | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| التكنولوجيا | التكنولوجيا مثل الأجهزة والبرمجيات وشبكة البنية التحتية في المؤسسة تستخدم بكفاءة لدعم جميع العمليات في هذا المجال، ويجري حاليا تنفيذ التكنولوجيا. | | | | | |
| الهيكل | يسمح هيكل المؤسسة لكل المعرفة التي يمكن استخدامها وتبادلها بسهولة دون أي عقبات. بطريقة أو بأخرى، تم تصميمه مع هيكل معقد من الصعب استخدامه ومعرفته. | | | | | |
| الثقافة | ثقافة المؤسسة تسمح لأعضاء فريق المشرع بتبادل وتقاسم المعرفة بين أنفسهم في المؤسسة خلال هذه العمليات أو أن هناك بعض العوائق مما تؤدي إلى إيقاف المشاركة. | | | | | |
| اكتساب المعرفة | كما يتم استخدام القدرة في مؤسستكم من خلال هذا المجال. يتم اكتساب المعرفة عن طريق استخراج وهيكلة وتنظيم ذلك من خبراء حقوق الإنسان وإنشائه من المعارف الموجودة. | | | | | |
| نوع المعرفة | المعرفة الضمنية والصريحة هي الأنواع الرئيسية من المعرفة في مؤسستك ويتم تحويلها من أجل الحصول على منفعة منها، وتخزينها في مستودع المعرفة للحصول على مستوى أعلى من النضج. | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| تطبيق المعرفة | هنا، المعرفة متاحة والتي تساعد في اتخاذ القرارات، وتستخدم في أداء مهام المشروع من خلال التوجيه والإجراءات في مؤسستك. | | | | | |
| حماية المعرفة | تهدف حماية المعرفة إلى منع الناس من خارج المؤسسة من الحصول على المعرفة، وكذلك منح الحقوق التي تمكن أعضاء فريق المشروع لتعزيز معارفهم والسيطرة على استخداماتها في مؤسستك. | | | | | |

**مشروع إدارة الوقت** (أي خطة إدارة الجدول الزمني، وتحديد الأنشطة وتقدير موارد النشاط، تقدير فترات النشاط وتطوير الجدول الزمني والتحكم بالجدول الزمني). يرجى وضع علامة (√) على المستوى المناسب لك أن تقيم كل من الإمكانات التالية. ويستند هذا التقييم على مقياس يتراوح من مستوى 1 إلى مستوى 5.

**1. لا أوافق بشدة.** **2. لا أوافق.** **3. طبيعي.** **4. موافق.** **5. موافق بشدة.**

| | **قدرات إدارة المعرفة** | **1** | **2** | **3** | **4** | **5** |
|---|---|---|---|---|---|---|
| التكنولوجيا | التكنولوجيا مثل الأجهزة والبرمجيات وشبكة البنية التحتية في المؤسسة تستخدم بكفاءة لدعم جميع العمليات في هذا المجال، ويجري حاليا تنفيذ التكنولوجيا. | | | | | |
| الهيكل | يسمح هيكل المؤسسة لكل المعرفة التي يمكن استخدامها وتبادلها بسهولة دون أي عقبات. بطريقة أو بأخرى، تم تصميمه مع هيكل معقد من الصعب استخدامه ومعرفته. | | | | | |
| الثقافة | ثقافة المؤسسة تسمح لأعضاء فريق المشرع بتبادل وتقاسم المعرفة بين أنفسهم في المؤسسة خلال هذه العمليات أو أن هناك بعض العوائق مما تؤدي إلى إيقاف المشاركة. | | | | | |
| اكتساب المعرفة | كما يتم استخدام القدرة في مؤسستكم من خلال هذا المجال. يتم اكتساب المعرفة عن طريق استخراج وهيكلة وتنظيم ذلك من خبراء حقوق الإنسان وإنشائه من المعارف الموجودة. | | | | | |
| تحويل المعرفة | المعرفة الضمنية والصريحة هي الأنواع الرئيسية من المعرفة في مؤسستك ويتم تحويلها من أجل الحصول على منفعة منها، وتخزينها في مستودع المعرفة للحصول على مستوى أعلى من النضج. | | | | | |
| تطبيق المعرفة | هنا، المعرفة متاحة والتي تساعد في اتخاذ القرارات، وتستخدم في أداء مهام المشروع من خلال التوجيه والإجراءات في مؤسستك. | | | | | |
| حماية المعرفة | تهدف حماية المعرفة إلى منع الناس من خارج المؤسسة من الحصول على المعرفة، وكذلك منح الحقوق التي تمكن أعضاء فريق المشروع لتعزيز معارفهم والسيطرة على استخداماتها في مؤسستك. | | | | | |

**إدارة تكلفة المشروع** (أي خطة إدارة التكاليف، تقدير التكاليف، وتحديد تكاليف الميزانية ومراقبتها). يرجى وضع علامة (√) على المستوى المناسب لك أن تقيم كل من الإمكانات التالية. ويستند هذا التقييم على مقياس يتراوح من مستوى 1 إلى مستوى 5.

**1. لا أوافق بشدة.** **2. لا أوافق.** **3. طبيعي.** **4. موافق.** **5. موافق بشدة.**

| | **قدرات إدارة المعرفة** | **1** | **2** | **3** | **4** | **5** |
|---|---|---|---|---|---|---|
| التكنولوجيا | التكنولوجيا مثل الأجهزة والبرمجيات وشبكة البنية التحتية في المؤسسة تستخدم بكفاءة لدعم جميع العمليات في هذا المجال، ويجري حاليا تنفيذ التكنولوجيا. | | | | | |
| الهيكل | يسمح هيكل المؤسسة لكل المعرفة التي يمكن استخدامها وتبادلها بسهولة دون أي عقبات. بطريقة أو بأخرى، تم تصميمه مع هيكل معقد من الصعب استخدامه ومعرفته. | | | | | |
| الثقافة | ثقافة المؤسسة تسمح لأعضاء فريق المشرع بتبادل وتقاسم المعرفة بين أنفسهم في المؤسسة خلال هذه العمليات أو أن هناك بعض العوائق مما تؤدي إلى إيقاف المشاركة. | | | | | |

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|---|---|---|---|---|---|---|
| اكتساب المعرفة | كما يتم استخدام القدرة في مؤسستكم من خلال هذا المجال. يتم اكتساب المعرفة عن طريق استخراج وهيكلة وتنظيم ذلك من خبراء حقوق الإنسان وإنشائه من المعارف الموجودة. | | | | | |
| تحويل المعرفة | المعرفة الضمنية والصريحة هي الأنواع الرئيسية من المعرفة في مؤسستك ويتم تحويلها من أجل الحصول على منفعة منها، وتخزينها في مستودع المعرفة للحصول على مستوى أعلى من النضج. | | | | | |
| تطبيق المعرفة | هنا، المعرفة متاحة والتي تساعد في اتخاذ القرارات، وتستخدم في أداء مهام المشروع من خلال التوجيه والإجراءات في مؤسستك. | | | | | |
| حماية المعرفة | تهدف حماية المعرفة إلى منع الناس من خارج المؤسسة من الحصول على المعرفة، وكذلك منح الحقوق التي تمكن أعضاء فريق المشروع لتعزيز معارفهم والسيطرة على استخداماتها في مؤسستك. | | | | | |

**إدارة جودة المشروع** (أي خطة إدارة الجودة، تنفيذ ضمان الجودة (QA) وتنفيذ مراقبة الجودة (QC)). يرجى وضع علامة (√) على المستوى المناسب لك أن تقيم كل من الإمكانات التالية. ويستند هذا التقييم على مقياس يتراوح من مستوى 1 إلى مستوى 5.

**1. لا أوافق بشدة. 2. لا أوافق. 3. طبيعي. 4. موافق. 5. موافق بشدة.**

| | **قدرات إدارة المعرفة** | **1** | **2** | **3** | **4** | **5** |
|---|---|---|---|---|---|---|
| التكنولوجيا | التكنولوجيا مثل الأجهزة والبرمجيات وشبكة البنية التحتية في المؤسسة تستخدم بكفاءة لدعم جميع العمليات في هذا المجال، ويجري حاليا تنفيذ التكنولوجيا. | | | | | |
| الهيكل | يسمح هيكل المؤسسة لكل المعرفة التي يمكن استخدامها وتبادلها بسهولة دون أي عقبات. بطريقة أو بأخرى، تم تصميمه مع هيكل معقد من الصعب استخدامه ومعرفته. | | | | | |
| الثقافة | ثقافة المؤسسة تسمح لأعضاء فريق المشرع بتبادل وتقاسم المعرفة بين أنفسهم في المؤسسة خلال هذه العمليات أو أن هناك بعض العوائق مما تؤدي إلى إيقاف المشاركة. | | | | | |
| اكتساب المعرفة | كما يتم استخدام القدرة في مؤسستكم من خلال هذا المجال. يتم اكتساب المعرفة عن طريق استخراج وهيكلة وتنظيم ذلك من خبراء حقوق الإنسان وإنشائه من المعارف الموجودة. | | | | | |
| تحويل المعرفة | المعرفة الضمنية والصريحة هي الأنواع الرئيسية من المعرفة في مؤسستك ويتم تحويلها من أجل الحصول على منفعة منها، وتخزينها في مستودع المعرفة للحصول على مستوى أعلى من النضج. | | | | | |
| تطبيق المعرفة | هنا، المعرفة متاحة والتي تساعد في اتخاذ القرارات، وتستخدم في أداء مهام المشروع من خلال التوجيه والإجراءات في مؤسستك. | | | | | |
| حماية المعرفة | تهدف حماية المعرفة إلى منع الناس من خارج المؤسسة من الحصول على المعرفة، وكذلك منح الحقوق التي تمكن أعضاء فريق المشروع لتعزيز معارفهم والسيطرة على استخداماتها في مؤسستك. | | | | | |

**مشروع إدارة الموارد البشرية** (أي خطة إدارة الموارد البشرية، اكتساب فريق المشروع، تطوير فريق المشروع وإدارة فريق المشروع). يرجى وضع علامة (√) على المستوى المناسب لك أن تقيم كل من الإمكانات التالية. ويستند هذا التقييم على مقياس يتراوح من مستوى 1 إلى مستوى 5.

**1. لا أوافق بشدة. 2. لا أوافق. 3. طبيعي. 4. موافق. 5. موافق بشدة.**

| | **قدرات إدارة المعرفة** | **1** | **2** | **3** | **4** | **5** |
|---|---|---|---|---|---|---|
| التكنولوجيا | التكنولوجيا مثل الأجهزة والبرمجيات وشبكة البنية التحتية في المؤسسة تستخدم بكفاءة لدعم جميع العمليات في هذا المجال، ويجري حاليا تنفيذ التكنولوجيا. | | | | | |

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| الهيكل | يسمح هيكل المؤسسة لكل المعرفة التي يمكن استخدامها وتبادلها بسهولة دون أي عقبات. بطريقة أو بأخرى، تم تصميمه مع هيكل معقد من الصعب استخدامه ومعرفته. | | | | | |
| الثقافة | ثقافة المؤسسة تسمح لأعضاء فريق المشرع بتبادل وتقاسم المعرفة بين أنفسهم في المؤسسة خلال هذه العمليات أو أن هناك بعض العوائق مما تؤدي إلى إيقاف المشاركة. | | | | | |
| اكتساب المعرفة | كما يتم استخدام القدرة في مؤسستكم من خلال هذا المجال. يتم اكتساب المعرفة عن طريق استخراج وهيكلة وتنظيم ذلك من خبراء حقوق الإنسان وإنشائه من المعارف الموجودة. | | | | | |
| تحويل المعرفة | المعرفة الضمنية والصريحة هي الأنواع الرئيسية من المعرفة في مؤسستك ويتم تحويلها من أجل الحصول على منفعة منها، وتخزينها في مستودع المعرفة للحصول على مستوى أعلى من النضج. | | | | | |
| تطبيق المعرفة | هنا، المعرفة متاحة والتي تساعد في اتخاذ القرارات، وتستخدم في أداء مهام المشروع من خلال التوجيه والإجراءات في مؤسستك. | | | | | |
| حماية المعرفة | تهدف حماية المعرفة إلى منع الناس من خارج المؤسسة من الحصول على المعرفة، وكذلك منح الحقوق التي تمكن أعضاء فريق المشروع لتعزيز معارفهم والسيطرة على استخداماتها في مؤسستك. | | | | | |

**إدارة اتصالات المشروع** (أي خطة إدارة الاتصالات، إدارة الاتصالات واتصالات التحكم). يرجى وضع علامة (√) على المستوى المناسب لك أن تقيم كل من الإمكانات التالية. ويستند هذا التقييم على مقياس يتراوح من مستوى 1 إلى مستوى 5.

**1. لا أوافق بشدة.** **2. لا أوافق.** **3. طبيعي.** **4. موافق.** **5. موافق بشدة.**

| | **قدرات إدارة المعرفة** | **1** | **2** | **3** | **4** | **5** |
|---|---|---|---|---|---|---|
| التكنولوجيا | التكنولوجيا مثل الأجهزة والبرمجيات وشبكة البنية التحتية في المؤسسة تستخدم بكفاءة لدعم جميع العمليات في هذا المجال، ويجري حاليا تنفيذ التكنولوجيا. | | | | | |
| الهيكل | يسمح هيكل المؤسسة لكل المعرفة التي يمكن استخدامها وتبادلها بسهولة دون أي عقبات. بطريقة أو بأخرى، تم تصميمه مع هيكل معقد من الصعب استخدامه ومعرفته. | | | | | |
| الثقافة | ثقافة المؤسسة تسمح لأعضاء فريق المشرع بتبادل وتقاسم المعرفة بين أنفسهم في المؤسسة خلال هذه العمليات أو أن هناك بعض العوائق مما تؤدي إلى إيقاف المشاركة. | | | | | |
| اكتساب المعرفة | كما يتم استخدام القدرة في مؤسستكم من خلال هذا المجال. يتم اكتساب المعرفة عن طريق استخراج وهيكلة وتنظيم ذلك من خبراء حقوق الإنسان وإنشائه من المعارف الموجودة. | | | | | |
| تحويل المعرفة | المعرفة الضمنية والصريحة هي الأنواع الرئيسية من المعرفة في مؤسستك ويتم تحويلها من أجل الحصول على منفعة منها، وتخزينها في مستودع المعرفة للحصول على مستوى أعلى من النضج. | | | | | |
| تطبيق المعرفة | هنا، المعرفة متاحة والتي تساعد في اتخاذ القرارات، وتستخدم في أداء مهام المشروع من خلال التوجيه والإجراءات في مؤسستك. | | | | | |
| حماية المعرفة | تهدف حماية المعرفة إلى منع الناس من خارج المؤسسة من الحصول على المعرفة، وكذلك منح الحقوق التي تمكن أعضاء فريق المشروع لتعزيز معارفهم والسيطرة على استخداماتها في مؤسستك. | | | | | |

**إدارة مخاطر المشروع** (أي خطة إدارة المخاطر، وتحديد المخاطر، وأداء تحليل المخاطر النوعية، وإجراء التحليل الكمي للخطر، خطر ردود الخطة ومراقبة المخاطر). يرجى وضع علامة (√) على المستوى المناسب لك أن تقيم كل من الإمكانات التالية. ويستند هذا التقييم على مقياس يتراوح من مستوى 1 إلى مستوى 5.

**1. لا أوافق بشدة.** **2. لا أوافق.** **3. طبيعي.** **4. موافق.** **5. موافق بشدة.**

| | **قدرات إدارة المعرفة** | **1** | **2** | **3** | **4** | **5** |
|---|---|---|---|---|---|---|
| **التكنولوجيا** | التكنولوجيا مثل الأجهزة والبرمجيات وشبكة البنية التحتية في المؤسسة تستخدم بكفاءة لدعم جميع العمليات في هذا المجال، ويجري حاليا تنفيذ التكنولوجيا. | | | | | |
| **الهيكل** | يسمح هيكل المؤسسة لكل المعرفة التي يمكن استخدامها وتبادلها بسهولة دون أي عقبات. بطريقة أو بأخرى، تم تصميمه مع هيكل معقد من الصعب استخدامه ومعرفته. | | | | | |
| **الثقافة** | ثقافة المؤسسة تسمح لأعضاء فريق المشرع بتبادل وتقاسم المعرفة بين أنفسهم في المؤسسة خلال هذه العمليات أو أن هناك بعض العوائق مما تؤدي إلى إيقاف المشاركة. | | | | | |
| **اكتساب المعرفة** | كما يتم استخدام القدرة في مؤسستكم من خلال هذا المجال. يتم اكتساب المعرفة عن طريق استخراج وهيكلة وتنظيم ذلك من خبراء حقوق الإنسان وإنشائه من المعارف الموجودة. | | | | | |
| **تحويل المعرفة** | المعرفة الضمنية والصريحة هي الأنواع الرئيسية من المعرفة في مؤسستك ويتم تحويلها من أجل الحصول على منفعة منها، وتخزينها في مستودع المعرفة للحصول على مستوى أعلى من النضج. | | | | | |
| **تطبيق المعرفة** | هنا، المعرفة متاحة والتي تساعد في اتخاذ القرارات، وتستخدم في أداء مهام المشروع من خلال التوجيه والإجراءات في مؤسستك. | | | | | |
| **حماية المعرفة** | تهدف حماية المعرفة إلى منع الناس من خارج المؤسسة من الحصول على المعرفة، وكذلك منح الحقوق التي تمكن أعضاء فريق المشروع لتعزيز معارفهم والسيطرة على استخداماتها في مؤسستك. | | | | | |

**إدارة مخاطر المشروع** (أي خطة إدارة المخاطر، وتحديد المخاطر، وأداء تحليل المخاطر النوعية، وإجراء التحليل الكمي للخطر، خطر ردود الخطة ومراقبة المخاطر). يرجى وضع علامة (√) على المستوى المناسب لك أن تقيم كل من الإمكانات التالية. ويستند هذا التقييم على مقياس يتراوح من مستوى 1 إلى مستوى 5.

**1. لا أوافق بشدة.** **2. لا أوافق.** **3. طبيعي.** **4. موافق.** **5. موافق بشدة.**

| | **قدرات إدارة المعرفة** | **1** | **2** | **3** | **4** | **5** |
|---|---|---|---|---|---|---|
| **التكنولوجيا** | التكنولوجيا مثل الأجهزة والبرمجيات وشبكة البنية التحتية في المؤسسة تستخدم بكفاءة لدعم جميع العمليات في هذا المجال، ويجري حاليا تنفيذ التكنولوجيا. | | | | | |
| **الهيكل** | يسمح هيكل المؤسسة لكل المعرفة التي يمكن استخدامها وتبادلها بسهولة دون أي عقبات. بطريقة أو بأخرى، تم تصميمه مع هيكل معقد من الصعب استخدامه ومعرفته. | | | | | |
| **الثقافة** | ثقافة المؤسسة تسمح لأعضاء فريق المشرع بتبادل وتقاسم المعرفة بين أنفسهم في المؤسسة خلال هذه العمليات أو أن هناك بعض العوائق مما تؤدي إلى إيقاف المشاركة. | | | | | |
| **اكتساب المعرفة** | كما يتم استخدام القدرة في مؤسستكم من خلال هذا المجال. يتم اكتساب المعرفة عن طريق استخراج وهيكلة وتنظيم ذلك من خبراء حقوق الإنسان وإنشائه من المعارف الموجودة. | | | | | |
| **تحويل المعرفة** | المعرفة الضمنية والصريحة هي الأنواع الرئيسية من المعرفة في مؤسستك ويتم تحويلها من أجل الحصول على منفعة منها، وتخزينها في مستودع المعرفة للحصول على مستوى أعلى من النضج. | | | | | |

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|---|---|---|---|---|---|---|
| تطبيق المعرفة | هنا، المعرفة متاحة والتي تساعد في اتخاذ القرارات، وتستخدم في أداء مهام المشروع من خلال التوجيه والإجراءات في مؤسستك. | | | | | |
| حماية المعرفة | تهدف حماية المعرفة إلى منع الناس من خارج المؤسسة من الحصول على المعرفة، وكذلك منح الحقوق التي تمكن أعضاء فريق المشروع لتعزيز معارفهم والسيطرة على استخداماتها في مؤسستك. | | | | | |

**إدارة مخاطر المشروع** (أي خطة إدارة المخاطر، وتحديد المخاطر، وأداء تحليل المخاطر النوعية، وإجراء التحليل الكمي للخطر، خطر ردود الخطة ومراقبة المخاطر). يرجى وضع علامة (√) على المستوى المناسب لك أن تقيم كل من الإمكانات التالية. ويستند هذا التقييم على مقياس يتراوح من مستوى 1 إلى مستوى 5.

**1. لا أوافق بشدة.** **2. لا أوافق.** **3. طبيعي.** **4. موافق.** **5. موافق بشدة.**

| | **قدرات إدارة المعرفة** | **1** | **2** | **3** | **4** | **5** |
|---|---|---|---|---|---|---|
| التكنولوجيا | التكنولوجيا مثل الأجهزة والبرمجيات وشبكة البنية التحتية في المؤسسة تستخدم بكفاءة لدعم جميع العمليات في هذا المجال، ويجري حاليا تنفيذ التكنولوجيا. | | | | | |
| الهيكل | يسمح هيكل المؤسسة لكل المعرفة التي يمكن استخدامها وتبادلها بسهولة دون أي عقبات. بطريقة أو بأخرى، تم تصميمه مع هيكل معقد من الصعب استخدامه ومعرفته. | | | | | |
| الثقافة | ثقافة المؤسسة تسمح لأعضاء فريق المشرع بتبادل وتقاسم المعرفة بين أنفسهم في المؤسسة خلال هذه العمليات أو أن هناك بعض العوائق مما تؤدي إلى إيقاف المشاركة. | | | | | |
| اكتساب المعرفة | كما يتم استخدام القدرة في مؤسستكم من خلال هذا المجال. يتم اكتساب المعرفة عن طريق استخراج وهيكلة وتنظيم ذلك من خبراء حقوق الإنسان وإنشائه من المعارف الموجودة. | | | | | |
| تحويل المعرفة | المعرفة الضمنية والصريحة هي الأنواع الرئيسية من المعرفة في مؤسستك ويتم تحويلها من أجل الحصول على منفعة منها، وتخزينها في مستودع المعرفة للحصول على مستوى أعلى من النضج. | | | | | |
| تطبيق المعرفة | هنا، المعرفة متاحة والتي تساعد في اتخاذ القرارات، وتستخدم في أداء مهام المشروع من خلال التوجيه والإجراءات في مؤسستك. | | | | | |
| حماية المعرفة | تهدف حماية المعرفة إلى منع الناس من خارج المؤسسة من الحصول على المعرفة، وكذلك منح الحقوق التي تمكن أعضاء فريق المشروع لتعزيز معارفهم والسيطرة على استخداماتها في مؤسستك. | | | | | |

**إدارة مشروع المشتريات** (أي خطة إدارة المشتريات، إدارة المشتريات والسيطرة على المشتريات ووثيقة المشتريات). يرجى وضع علامة (√) على المستوى المناسب لك أن تقيم كل من الإمكانات التالية. ويستند هذا التقييم على مقياس يتراوح من مستوى 1 إلى مستوى 5.

**1. لا أوافق بشدة.** **2. لا أوافق.** **3. طبيعي.** **4. موافق.** **5. موافق بشدة.**

| | **قدرات إدارة المعرفة** | **1** | **2** | **3** | **4** | **5** |
|---|---|---|---|---|---|---|
| التكنولوجيا | التكنولوجيا مثل الأجهزة والبرمجيات وشبكة البنية التحتية في المؤسسة تستخدم بكفاءة لدعم جميع العمليات في هذا المجال، ويجري حاليا تنفيذ التكنولوجيا. | | | | | |
| الهيكل | يسمح هيكل المؤسسة لكل المعرفة التي يمكن استخدامها وتبادلها بسهولة دون أي عقبات. بطريقة أو بأخرى، تم تصميمه مع هيكل معقد من الصعب استخدامه ومعرفته. | | | | | |
| الثقافة | ثقافة المؤسسة تسمح لأعضاء فريق المشرع بتبادل وتقاسم المعرفة بين أنفسهم في المؤسسة خلال هذه العمليات أو أن هناك بعض العوائق مما تؤدي إلى إيقاف المشاركة. | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| اكتساب المعرفة | كما يتم استخدام القدرة في مؤسستكم من خلال هذا المجال. يتم اكتساب المعرفة عن طريق استخراج وهيكلة وتنظيم ذلك من خبراء حقوق الإنسان وإنشائه من المعارف الموجودة. | | | | | |
| تحويل المعرفة | المعرفة الضمنية والصريحة هي الأنواع الرئيسية من المعرفة في مؤسستك ويتم تحويلها من أجل الحصول على منفعة منها، وتخزينها في مستودع المعرفة للحصول على مستوى أعلى من النضج. | | | | | |
| تطبيق المعرفة | هنا، المعرفة متاحة والتي تساعد في اتخاذ القرارات، وتستخدم في أداء مهام المشروع من خلال التوجيه والإجراءات في مؤسستك. | | | | | |
| حماية المعرفة | تهدف حماية المعرفة إلى منع الناس من خارج المؤسسة من الحصول على المعرفة، وكذلك منح الحقوق التي تمكن أعضاء فريق المشروع لتعزيز معارفهم والسيطرة على استخداماتها في مؤسستك. | | | | | |

**مشروع إدارة أصحاب المصلحة في المشروع** (أي تحديد أصحاب المصلحة، خطة إدارة أصحاب المصلحة، إدارة أصحاب مصلحة الارتباط والسيطرة على أصحاب مصلحة الارتباط.) يرجى وضع علامة (√) على المستوى المناسب لك أن تقيم كل من الإمكانات التالية. ويستند هذا التقييم على مقياس يتراوح من مستوى 1 إلى مستوى 5.

**1. لا أوافق بشدة.** **2. لا أوافق.** **3. طبيعي.** **4. موافق.** **5. موافق بشدة.**

| | **قدرات إدارة المعرفة** | **1** | **2** | **3** | **4** | **5** |
|---|---|---|---|---|---|---|
| التكنولوجيا | التكنولوجيا مثل الأجهزة والبرمجيات وشبكة البنية التحتية في المؤسسة تستخدم بكفاءة لدعم جميع العمليات في هذا المجال، ويجري حاليا تنفيذ التكنولوجيا. | | | | | |
| الهيكل | يسمح هيكل المؤسسة لكل المعرفة التي يمكن استخدامها وتبادلها بسهولة دون أي عقبات. بطريقة أو بأخرى، تم تصميمه مع هيكل معقد من الصعب استخدامه ومعرفته. | | | | | |
| الثقافة | ثقافة المؤسسة تسمح لأعضاء فريق المشرع بتبادل وتقاسم المعرفة بين أنفسهم في المؤسسة خلال هذه العمليات أو أن هناك بعض العوائق مما تؤدي إلى إيقاف المشاركة. | | | | | |
| اكتساب المعرفة | كما يتم استخدام القدرة في مؤسستكم من خلال هذا المجال. يتم اكتساب المعرفة عن طريق استخراج وهيكلة وتنظيم ذلك من خبراء حقوق الإنسان وإنشائه من المعارف الموجودة. | | | | | |
| تحويل المعرفة | المعرفة الضمنية والصريحة هي الأنواع الرئيسية من المعرفة في مؤسستك ويتم تحويلها من أجل الحصول على منفعة منها، وتخزينها في مستودع المعرفة للحصول على مستوى أعلى من النضج. | | | | | |
| تطبيق المعرفة | هنا، المعرفة متاحة والتي تساعد في اتخاذ القرارات، وتستخدم في أداء مهام المشروع من خلال التوجيه والإجراءات في مؤسستك. | | | | | |
| حماية المعرفة | تهدف حماية المعرفة إلى منع الناس من خارج المؤسسة من الحصول على المعرفة، وكذلك منح الحقوق التي تمكن أعضاء فريق المشروع لتعزيز معارفهم والسيطرة على استخداماتها في مؤسستك. | | | | | |

## نضج إدارة المشاريع بالمؤسسة:

واعتمد هذا القسم من P3M3 استبيان التقييم الذاتي. الرجاء الإجابة على جميع الأسئلة تسعة وتأكد للتحقق من الجواب الأنسب بناء على تجربتك، ويتم تصنيف الاختيارات وفق مقياس ليكرت من أدنى مستوى لست موافق بشدة إلى أعلى مستوى أوافق بشدة.

1. **منظمتنا يمكن أن تكون الأفضل بوصفها لوجود:**

( ) العمليات عادةً غير موثوقة, لا توجد أو ربما عدد قليل من أوصاف العملية.

( ) المنظمة قادرة على إثبات الممارسات الإدارية الأساسية التي أُنشئت.

( ) يتم توثيق الإدارة والعمليات التقنية، موحدة ومتكاملة إلى حد ما مع العمليات التجارية الأخرى.

( ) المنظمة توضح نضوج السلوك على الرغم من العمليات المحددة التي تدار من الناحية الكمية.

( ) تركز المنظمة على تحسين عملياتها المدارة من الناحية الكمية وأن تأخذ في عين الاعتبار تغير العوامل التجارية والخارجية. أنها قادرة على استباق مطالب القدرات ومتطلبات القدرة مستقبلا ولمواجهة تحديات التسليم.

2. **أفضل وصف لرقابتنا الإدارية من قبل:**

( ) يستخدم مصطلح إدارة المشروع من قبل بعض أعضاء المنظمة ولكن ليس بشكل مستمر, وربما لا يفهمها جميع أصحاب المصلحة. وتجرى المشاريع و إدارتها وفقا لتفضيلات فردية.

( ) مفهوم إدارة المشروع سيكون قد تم اغتنامه من قبل المؤسسة, وربما يكون هناك خبراء محليين, مثل مديري المشاريع من ذوي الخبرة, والعمل على المشاريع الرئيسية.

( ) هناك نهج محدد و موثوق لإدارة دورة حياة المشروع و الضوابط, ويتم تطبيقه في جميع المشاريع من قبل موظفين قادرين الذين يدعمون فرق المشروع.

( ) يُنظر إلى إدارة المشروع باعتبارها أداة رئيسية لآلية تسليم التغيير. ضمن بيئة المشروع التركيز علي تحسين التسليم من خلال قياس وتحليل الأداء.

( ) الضوابط الإدارية للتأكد من أن نهج المشروع يسلم أهداف التغيير للمنظمة, قبول إدارة المشاريع والنهج الأمثل لتغيير التسليم على نطاق المنظمة. هناك أدلة على التحسين المستمر.

3. **أفضل وصف لإدارتنا للمشاريع عن طريق:**

( ) هناك بعض الإدراك بأن مفهوم المنافع يمكن أن تكون متباينة من مخرجات المشروع.

( ) يتم التعرف على الفوائد كعنصر من القضايا التجارية للمشروع, قد يكون هناك بعض الوثائق المتعلقة بمن هو المسؤول عن الفوائد الخاصة وتحقيقها, ولكن هذا غير وارد اتباعها مستقيمة أو متسقة.

( ) هناك تدار مركزيا وإطار متسق لتحديد وتتبع تحقيق الفوائد الناشئة عن مخرجات المشروع.

( ) تم تضمين إدارة المنافع في إطار نهج المشروع حيث وهناك تركيز على تقديم أداء الأعمال من مخرجات المشروع. ويتم جمع مقاييس أداء المشروع وتحليلها.

( ) وجزءا لا يتجزأ من إدارة الفائدة مع النهج التنظيمي للتغيير ويتم تقييمها كجزء من تطوير استراتيجية تنظيمية. مقاييس أداء الأعمال المرتبطة، وتدعم، والادراك من تحقيق الفوائد. هناك أدلة على التحسين المستمر.

4. **أفضل وصف للإدارة المالية عن طريق:**

( ) هناك القليل أو انه لا يوجد رقابة مالية على مستوى المشروع. هناك غياب المحاسبة والمراقبة من نفقات المشروع.

( ) حالات الأعمال المشروع تنتج في أشكال مختلفة وعلى نحو أفضل والحالات أكثر رسمية ستقدم الأساس المنطقي الذي تريد الحصول على الالتزام التنظيمي للمشروع. عموما تكلفة المشروع لم ترصد أو استأثرت تماما.

( ) هناك معايير معمول بها مركزياً لإعداد القضايا التجارية والعمليات لإدارتها خلال دورة حياة المشروع. مدراء المشاريع رصد التكاليف والنفقات وفقا للمبادئ التوجيهية التنظيمية والإجراءات، مع واجهات محددة مع وظائف مالية أخرى داخل المنظمة.

( ) المنظمة قادرة على تحديد أولويات الفرص الاستثمارية بشكل فعال فيما يتعلق بتوافر الأموال والموارد الأخرى. وتتم إدارة ميزانيات المشاريع بصورة فعالة ويتم مراقبة أداء المشروع ضد التكاليف ومقارنتها.

( ) يتم دمج الرقابة المالية للمشروع بالكامل مع تلك المنظمة. يتم مراجعة أساليب تقدير التكلفة المستخدمة على مستوى المشروع باستمرار من حيث الفعلية مقابل مقارنات تقدير التحسين في جميع أنحاء المنظمة. هناك أدلة على التحسين المستمر.

5. **أفضل وصف لنهجنا لإشراك أصحاب المصلحة عن طريق:**

( ) ونادرا ما يستخدم إشراك أصحاب المصلحة والاتصالات في المشاريع عنصرا من مجموعة أدوات التسليم.

( ) سوف ترسل بعض المشاريع إلى الجهات المعنية، ولكن هذا يرتبط أكثر بمبادرة شخصية من مديري المشاريع من إلى نهج منظم يتم نشرها من قبل المنظمة.

( ) هناك نهج يدار مركزيا ومتسق لإشراك أصحاب المصلحة والاتصالات المستخدمة من قبل جميع المشاريع.

( ) وتستخدم تقنيات متطورة لتحليل والاشتراك بالبيئة مع أصحاب المصلحة في المشروع بشكل فعال، ويتم استخدام المعلومات الكمية لدعم عمليات تقييم الفعالية.

( ) يتم إجراء تحسين الاتصالات من معرفة واسعة بالبيئة مع أصحاب المصلحة، لتمكين المشاريع الرامية إلى تحقيق أهدافها. وهناك دليل على التحسن المستمر.

6. **أفضل وصف لإدارة المخاطر عن طريق:**

( ) هناك أدلة ضئيلة لإدارة المخاطر التي يجري استخدامها لأي تأثير مفيد على المشاريع. قد يكون هناك دليل على المخاطر التي يجري توثيقها ولكن أدلة تذكر على وجود إدارة فعالة.

( ) إدارة المخاطر هي المعترف بها والمستخدمة في المشاريع، ولكن هناك نهج غير متناسق مما يؤدي إلى مستويات مختلفة من الالتزام والفعالية.

( ) إدارة مخاطر المشروع يستند إلى عملية معرفة مركزياً أن تدرك سياسة المنظمة لإدارة المخاطر ويستخدم باستمرار.

( ) تعمل إدارة مخاطر المشروع بشكل فعال, مضمن, ويمكن أن تظهر قيمة لإدارة المشروع. وهناك أدله على إدارة الفرص إدارة تجميع المخاطر.

( ) تم تضمين إدارة المخاطر في الثقافة التنظيمية, ويدعم جميع عمليات صنع القرار داخل المشروع. هناك أدله على التحسين المستمر.

7. **نحن نقوم بتسليم الحكم التنظيمي بواسطة:**

( ) بعض الحكم غير الرسمي لمشاريع موجود, لكن لديه وصلات غير محددة لضوابط تنظيمية أسرع. من غير المرجح أن تكون الأدوار محددة رسميا.

( ) إدارة المشاريع من منظور تنظيمي بدأت في التبلور ولكن مع وجود ضوابط مخصصه ليس لها سيطرة استراتيجية واضحه. الأدوار والمسؤوليات تكون غير متناسقة، كما في خطوط الإبلاغ.

( ) الضوابط التنظيمية المعرفة مركزياً يتم تطبيقها بصورة متسقة على جميع المشاريع، مع هياكل صنع القرار في مكان ومرتبطة بالحكم التنظيمي.

( ) سوف يكون هناك مشروع الانحياز الواضح في عمليات صنع القرار التي تعتمد وتتكامل مع الحكم التنظيمي الأوسع نطاقا والتي تتسم بالشفافية للأشخاص المعنيين. مسؤوليات إدارة المشروع المضمنة داخل وصف دور أوسع نطاقا.

( ) الترتيبات الإدارية للمشاريع أحد جوانب أساسية للرقابة التنظيمية، مع خطوط الإبلاغ يمكن إثباته على مستوى المجلس التنفيذي ومع مسؤوليات واضحة في الملكية والتحكم المضمن داخل المنظمة. هناك دليل على التحسن المستمر.

8. **أفضل وصف لإدارة المشاريع عن:**

( ) هناك بعض الاعتراف داخل المنظمة من الحاجة إلى إدارة الموارد على نحو فعال لتمكين تسليم الناجح للمشاريع، ولكن القليل من الأدلة على اكتساب الموارد والتخطيط أو الإدارة.

( ) يجري حاليا نشر الموارد عبر المؤسسة والمشاريع الفردية نهجاً للحصول على الموارد، والتخطيط أو الإدارة. ومع ذلك هناك القليل من الأدلة على اتساق النهج.

( ) هذه المنظمة المحددة مركزيا واعتمدت مجموعة من الإجراءات والعمليات الإدارية لاكتساب وتخطيط وإدارة موارد المشروع.

( ) وتعتبر إدارة الموارد للمشاريع على مستوى استراتيجي داخل المنظمة. هناك أدلة إدارة قدرات الموارد، من خلال القدرة على التخطيط، من أجل الوفاء باحتياجات تنفيذ المشاريع.

( ) تم نشر الموارد على النحو الأمثل. وهناك دليل واضح على موازنة تحميل والاستخدام الفعال للموارد الداخلية والخارجية على حد سواء في جميع المشاريع. هناك أدلة على التحسين المستمر.

9. **ما هو أفضل وصف المؤسسة الخاصة بك:**

( ) التعرف على المشاريع وتشغيلها بشكل مختلف من العمل المتواصل. (يمكن تشغيل مشاريع غير رسمي مع أي عملية القياسية أو نظام تتبع).

( ) التأكد من أن كل يتم تشغيل المشروع مع العمليات والإجراءات الخاصة بالحد أدنى المحدد القياسي. (قد يكون هناك اتساق محدودة أو التنسيق بين المشاريع).

( ) تمتلك التحكم المركزي لعمليات المشروع الخاص بها، ويمكن أن المشاريع الفردية تأتي ضمن هذه العمليات لتتناسب مع مشروع معين.

( ) الحصول والاحتفاظ على مقاييس محددة في أداء إدارة المشاريع وتشغيل تنظيم إدارة الجودة لتحسين التنبؤ بالأداء المستقبلي.

( ) إجراء عملية التحسين المستمر مع مشكلة استباقية وإدارة التكنولوجيا للمشاريع من أجل تحسين قدرتها على تصوير الأداء مع مرور الوقت وتحسين العمليات.

---------- نهاية الدراسة الاستقصائية ----------

**شكرا لك على المشاركة في هذه الدراسة الاستقصائية**

**APPENDIX C**
**MEASUREMENT ITEMS**

| Variables | Items Code | EFA Used Items | Deleted Items |
|---|---|---|---|
| Project-related Technology Items | PIM_Tech1 | | PIM_Tech1 |
| | PSM_Tech2 | | PSM_Tech2 |
| | PTM_Tech3 | PTM_Tech3 | |
| | PCM_Tech4 | PQM_Tech5 | |
| | PQM_Tech5 | | PQM_Tech5 |
| | PHRM_Tech6 | | PHRM_Tech6 |
| | PCoM_Tech7 | PCoM_Tech7 | |
| | PRM_Tech8 | | PRM_Tech8 |
| | PProM_Tech9 | | PProM_Tech9 |
| | PSkM_Tech10 | | PSkM_Tech10 |
| Project-based Organizational Structure Items | PIM_St1 | | PIM_St1 |
| | PSM_St2 | | PSM_St2 |
| | PTM_St3 | | PTM_St3 |
| | PCM_St4 | | PCM_St4 |
| | PQM_St5 | | PQM_St5 |
| | PHRM_St6 | | PHRM_St6 |
| | PCoM_St7 | PCoM_St7 | |
| | PRM_St8 | PProM_St9 | |
| | PProM_St9 | PRM_St8 | |
| | PSkM_St10 | | PSkM_St10 |
| Project-oriented Organizational Culture Items | PIM_Cul1 | PIM_Cul1 | |
| | PSM_Cul2 | PSM_Cul2 | |
| | PTM_Cul3 | PTM_Cul3 | |
| | PCM_Cul4 | | PCM_Cul4 |
| | PQM_Cul5 | PQM_Cul5 | |
| | PHRM_Cul6 | PHRM_Cul6 | |
| | PCoM_Cul7 | PCoM_Cul7 | |
| | PRM_Cul8 | PRM_Cul8 | |
| | PProM_Cul9 | | PProM_Cul9 |
| | PSkM_Cul10 | PSkM_Cul10 | |
| Project Knowledge Acquisition Items | PIM_Acq1 | PIM_Acq1 | |
| | PSM_Acq2 | | PSM_Acq2 |
| | PTM_Acq3 | PTM_Acq3 | |
| | PCM_Acq4 | | PCM_Acq4 |
| | PQM_Acq5 | PQM_Acq5 | |
| | PHRM_Acq6 | | PHRM_Acq6 |
| | PCoM_Acq7 | | PCoM_Acq7 |
| | PProM_Acq8 | | PProM_Acq8 |
| | PSkM_Acq9 | | PSkM_Acq9 |

| Variables | Items Code | EFA Used Items | Deleted Items |
|---|---|---|---|
| Project Knowledge Conversion Items | PRM_Acq10 | | PRM_Acq10 |
| | PIM_Conv1 | | PIM_Conv1 |
| | PTM_Conv2 | | PTM_Conv2 |
| | PSM_Conv3 | | PSM_Conv3 |
| | PCM_Conv4 | | PCM_Conv4 |
| | PQM_Conv5 | | PQM_Conv5 |
| | PCoM_Conv6 | | PCoM_Conv6 |
| | PHRM_Conv7 | | PHRM_Conv7 |
| | PRM_Conv8 | PRM_Conv8 | |
| | PProM_Conv9 | PProM_Conv9 | |
| | PSkM_Conv10 | PSkM_Conv10 | |
| Project Knowledge Application Items | PIM_App1 | | PIM_App1 |
| | PTM_App2 | | PTM_App2 |
| | PSM_App3 | | PSM_App3 |
| | PCM_App4 | PCM_App4 | |
| | PQM_App5 | | PQM_App5 |
| | PHRM_App6 | PHRM_App6 | |
| | PCoM_App7 | | PCoM_App7 |
| | PRM_App8 | PRM_App8 | |
| | PProM_App9 | | PProM_App9 |
| | PSkM_App10 | | PSkM_App10 |
| Knowledge Protection Items | PIM_Pro1 | | PIM_Pro1 |
| | PSM_Pro2 | | PSM_Pro2 |
| | PTM_Pro3 | | PTM_Pro3 |
| | PCM_Pro4 | | PCM_Pro4 |
| | PQM_Pro5 | | PQM_Pro5 |
| | PHRM_Pro6 | | PHRM_Pro6 |
| | PCoM_Pro7 | PCoM_Pro7 | |
| | PRM_Pro8 | PRM_Pro8 | |
| | PProM_Pro9 | PProM_Pro9 | |
| | PSkM_Pro10 | PSkM_Pro10 | |
| Project Management Maturity Items | DV_Org1 | DV_Org1 | |
| | DV_Mag_Control2 | DV_Mag_Control2 | |
| | DV_Benefits_Mag3 | DV_Benefits_Mag3 | |
| | DV_Financial_Mag4 | DV_Financial_Mag4 | |
| | DV_Stakeholder_Eng5 | | DV_Stakeholder_Eng5 |
| | DV_Risk_Mag6 | | DV_Risk_Mag6 |
| | DV_Org_Gov7 | | DV_Org_Gov7 |
| | DV_Rsrce_Mag8 | | DV_Rsrce_Mag8 |
| | DV_Org_Practice9 | | DV_Org_Practice9 |

PIM = Project Integration Management
PSM = Project Scope Management
PTM = Project Time Management
PCM = Project Cost Management
PQM = Project Quality Management
PHRM = Project HR Management
PCoM = Project Communication Management
PRM = Project Risk Management
PProM = Project Procurement Management
PSkM = Project Stakeholders Management

**APPENDIX D**
**TEST OF NORMALITY**

| | Variable | N | | Skewness | Kurtosis |
|---|---|---|---|---|---|
| | | Valid | Missing | | |
| Project-related Technology | PIM_Tech1 | 352 | 0 | -.464 | -.643 |
| | PSM_Tech2 | 352 | 0 | -.677 | .638 |
| | PTM_Tech3 | 352 | 0 | -.746 | .850 |
| | PCM_Tech4 | 352 | 0 | -.609 | .707 |
| | PQM_Tech5 | 352 | 0 | -.795 | .881 |
| | PHRM_Tech6 | 352 | 0 | -.374 | .300 |
| | PCoM_Tech7 | 352 | 0 | -.767 | .829 |
| | PRM_Tech8 | 352 | 0 | .014 | -.123 |
| | PProM_Tech9 | 352 | 0 | -.895 | 1.195 |
| | PSkM_Tech10 | 352 | 0 | .270 | -.999 |
| Project-based Organizational Structure | PIM_St1 | 352 | 0 | -.518 | .187 |
| | PSM_St2 | 352 | 0 | -.679 | .398 |
| | PTM_St3 | 352 | 0 | -.740 | .850 |
| | PCM_St4 | 352 | 0 | -.603 | .391 |
| | PQM_St5 | 352 | 0 | -.502 | .288 |
| | PHRM_St6 | 352 | 0 | -.693 | .613 |
| | PCoM_St7 | 352 | 0 | -.712 | 1.148 |
| | PRM_St8 | 352 | 0 | -.901 | .895 |
| | PProM_St9 | 352 | 0 | -.808 | 1.131 |
| | PSkM_St10 | 352 | 0 | -.309 | -.256 |
| Project-oriented Organizational Culture | PIM_Cul1 | 352 | 0 | .384 | -.719 |
| | PSM_Cul2 | 352 | 0 | .404 | -.589 |
| | PTM_Cul3 | 352 | 0 | .537 | -.430 |
| | PCM_Cul4 | 352 | 0 | .395 | -.657 |
| | PQM_Cul5 | 352 | 0 | .554 | -.457 |
| | PHRM_Cul6 | 352 | 0 | .519 | -.514 |
| | PCoM_Cul7 | 352 | 0 | .519 | -.397 |
| | PRM_Cul8 | 352 | 0 | .614 | -.324 |
| | PProM_Cul9 | 352 | 0 | .454 | -.576 |
| | PSkM_Cul10 | 352 | 0 | .464 | -.617 |
| Project Knowledge Acquisition | PIM_Acq1 | 352 | 0 | -.370 | .084 |
| | PSM_Acq2 | 352 | 0 | -.364 | .061 |
| | PTM_Acq3 | 352 | 0 | -.305 | -.172 |
| | PCM_Acq4 | 352 | 0 | -.267 | -.049 |
| | PQM_Acq5 | 352 | 0 | -.244 | -.142 |
| | PHRM_Acq6 | 352 | 0 | -.309 | -.112 |
| | PCoM_Acq7 | 352 | 0 | -.378 | -.068 |

| | Variable | N | | Skewness | Kurtosis |
|---|---|---|---|---|---|
| | | Valid | Missing | | |
| Project Knowledge Conversion | PProM_Acq8 | 352 | 0 | -.669 | .666 |
| | PSkM_Acq9 | 352 | 0 | -.481 | -.093 |
| | PRM_Acq10 | 352 | 0 | -.689 | .412 |
| | PIM_Conv1 | 352 | 0 | -.436 | -.264 |
| | PTM_Conv2 | 352 | 0 | -.404 | -.513 |
| | PSM_Conv3 | 352 | 0 | -.436 | -.381 |
| | PCM_Conv4 | 352 | 0 | -.493 | -.363 |
| | PQM_Conv5 | 352 | 0 | -.143 | -.677 |
| | PCoM_Conv6 | 352 | 0 | .174 | -1.070 |
| | PHRM_Conv7 | 352 | 0 | -.125 | -.700 |
| | PRM_Conv8 | 352 | 0 | -.544 | -.514 |
| | PProM_Conv9 | 352 | 0 | -.566 | -.601 |
| | PSkM_Conv10 | 352 | 0 | -.533 | -.732 |
| Project Knowledge Application | PIM_App1 | 352 | 0 | -.162 | -.069 |
| | PTM_App2 | 352 | 0 | -.466 | -.650 |
| | PSM_App3 | 352 | 0 | -.694 | .631 |
| | PCM_App4 | 352 | 0 | -.755 | .864 |
| | PQM_App5 | 352 | 0 | -.607 | .669 |
| | PHRM_App6 | 352 | 0 | -.805 | .899 |
| | PCoM_App7 | 352 | 0 | -.393 | .294 |
| | PRM_App8 | 352 | 0 | -.776 | .845 |
| | PProM_App9 | 352 | 0 | -.417 | .371 |
| | PSkM_App10 | 352 | 0 | -.267 | .319 |
| Project Knowledge Protection | PIM_Pro1 | 352 | 0 | -.876 | 2.318 |
| | PSM_Pro2 | 352 | 0 | -.521 | .732 |
| | PTM_Pro3 | 352 | 0 | -.579 | .842 |
| | PCM_Pro4 | 352 | 0 | .384 | -.719 |
| | PQM_Pro5 | 352 | 0 | .404 | -.589 |
| | PHRM_Pro6 | 352 | 0 | .537 | -.430 |
| | PCoM_Pro7 | 352 | 0 | .374 | -.740 |
| | PRM_Pro8 | 352 | 0 | .412 | -.589 |
| | PProM_Pro9 | 352 | 0 | .537 | -.430 |
| | PSkM_Pro10 | 352 | 0 | .403 | -.658 |
| Project Management Maturity | DV_Org1 | 352 | 0 | .377 | -.733 |
| | DV_Mag_Control2 | 352 | 0 | .420 | -.580 |
| | DV_Benefits_Mag3 | 352 | 0 | .547 | -.435 |
| | DV_Financial_Mag4 | 352 | 0 | .413 | -.635 |
| | DV_Stakeholder_Eng5 | 352 | 0 | .404 | -.589 |
| | DV_Risk_Mag6 | 352 | 0 | .530 | -.441 |
| | DV_Org_Gov7 | 352 | 0 | .406 | -.642 |

| Variable | N | | Skewness | Kurtosis |
|---|---|---|---|---|
| | Valid | Missing | | |
| DV_Rsrce_Mag8 | 352 | 0 | .562 | -.446 |
| DV_Org_Practice9 | 352 | 0 | .509 | -.540 |

**APPENDIX E**
**KNOWLEDGE MANAGEMENT CAPABILITIES - PROJECT MANAGEMENT ASSESSMENT MATRIX**

| Project Management Areas | Initial | Planed | Organizational Standardization | Managed | Continuous Improvement |
|---|---|---|---|---|---|
| Project-related Technology | No established Technology practices or standards. Technology infrastructure is ad hoc and individual project teams follow non-technological practices. | The technology exists in the organizations and being used in the project phases, but these is still informal practices is not using a technology infrastructure. | Technology infrastructure is one of the organizational standard and now is utilized by most project management teams in the organization and are fully being used for integrate knowledge into project. | Organization has a technology which can deliver relevant (requested knowledge by users) & timely (response to organization's members within a short time) knowledge provision(e.g. email & hand phone) Organization has technologies which allow tracking knowledge about its activities. | Improvement procedures utilized the technology infrastructure for project management areas. Lessons learned are examined and used to improve documented processes. |
| Project-based Organizational Structure | No established Project-based Organizational Structure or standards. Structure infrastructure is ad hoc and individual project teams follow informal Project-based Organizational Structure practices. | Project-based Organizational Structure at this level is partially designed with unintended structure between all members for sharing knowledge across internal organizational boundaries. | Project-based Organizational Structure is designed a standard for Conversation and discussion which is the first step toward effective collaboration and effective acquisition and sharing of knowledge. | Project-based Organizational Structure is now fully designed for flexibility so that it encourages sharing & collaboration very well across boundaries within the organization. | Improvement procedures utilized the Project-based Organizational Structure infrastructure for project management areas. Lessons learned are used to improve documented processes. |

| | Initial | Planed | Organizational Standardization | Managed | Continuous Improvement |
|---|---|---|---|---|---|
| Project-oriented Organizational Culture | Culture doesn't have any role to achieve project management goals. | Members in the organization are sharing their knowledge and experiences but not all things that must be shared. Culture is important view of organization toward its goal | The culture is still on a standardized based of the project environment and documenting the organizational behaviour during the project. | The Culture is considered the most important view of organization toward its goal as well as the management type and methods to achieve goal. That indicated the culture is now managed. | Improvement procedures in the organizations utilized the culture infrastructure and the lessons learned are being used to improve the PM processes. |
| Project Knowledge Acquisition | No established Project Knowledge Acquisition or standards. Project Knowledge Acquisition process is ad hoc and individual project teams are not following/using such ways for Project Knowledge Acquisition. | Knowledge members will have problems from lack of knowledge distribution within organization. Members do not use any techniques to acquire knowledge. It planned to have the knowledge acquired in the project. | Members of organization find existing knowledge on time because the knowledge within organization is integrated and recorded completely Organization is now following newest techniques to acquire knowledge and using anew standardization process | Members of organization make full use of existing knowledge in organization to acquire new knowledge. Organization uses newest techniques to acquire knowledge such as data mining (Data mining is the process of extracting patterns from data.) | Improvement procedures utilized the Project Knowledge Acquisition process for project management areas. Lessons learned are examined and used to improve documented processes. |

| | Initial | Planed | Organizational Standardization | Managed | Continuous Improvement |
|---|---|---|---|---|---|
| Project Knowledge Conversion | No established Project Knowledge Conversion or standards. Project Knowledge Conversion process is ad hoc and individual project teams are not following/using such ways for Project Knowledge Conversion. | Interaction between tacit and explicit very rarely happens within organization. Members are planned to follow order of spiral of Project Knowledge Conversion. | Organization use standardized ways for conversion the knowledge, there is interaction between tacit and explicit and also interchange to each other. | Project Knowledge Conversion process is being managed and now is used efficiently. Conversion of tacit and explicit knowledge is managed. | Improvement procedures utilized the Project Knowledge Conversion process for project management areas. Lessons learned are examined and used to improve documented processes. |
| Project Knowledge Application | No established Project Knowledge Application or standards. Project Knowledge Application process is ad hoc and in not exist in the organization. | Members initially know how to use past decisions, experience, successes, and failures which can help them to create and apply knowledge | Organization has standardized process on applying the knowledge. Members integrate knowledge repositories and use external and internal knowledge. | At this level, for applying knowledge, organization must be interactive (means to allow the integration and possible capture, analysis or even explication of tacit knowledge of the system's users) | Improvement procedures utilized the Project Knowledge Application process for project management areas. Lessons learned are examined and used to improve documented processes. |

| | Initial | Planed | Organizational Standardization | Managed | Continuous Improvement |
|---|---|---|---|---|---|
| Project Knowledge Protection | No established Knowledge Protection or standards. Knowledge protection process is ad hoc and individual project teams are not following/using such ways for protecting the Knowledge. | There are planned procedures to secure knowledge and sometimes unauthorized knowledge is communicated over an unauthorized channel Members are not accountable for their breaches. | Organizations started to use a standard protection systems to protect their knowledge form authorized access and illegal distribution. And provide procedures in place to secure knowledge devices and communication equipment. | Organizations are now fully managing the knowledge protection, in addition providing training program to educate an organizational member what is acceptable behaviour in terms of using knowledge of organization. | Improvement procedures utilized the Knowledge Protection process for project management areas. Lessons learned are examined and used to improve documented processes. |

## APPENDIX E
## PUBLICATION LIST

- Alghail, A. A., Yao, L. and Kie, C. J. (2017) 'Importance of Project-oriented Organizational Culture in Knowledge Management Processes', *Global Journal For Research Analysis*, 6(6), pp. 400–403.

- Alghail, A. A., Yao, L. and Kie, C. J. (2017) 'The Effect of Knowledge Management Capabilities on Project Management Success', in *The 4 th National Graduate Conference Universiti Tenaga Nasional*, pp. 392–379.

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- Alghail, A. A., Yao, L. and Kie, C. J. (2017) 'Fundamental Guidelines for Integrating Knowledge Management Capabilities into Project Management'. International Journal of Economic Perspectives (ISSN:1307-1637). – Pending Publishing.

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