DEFINING EARLY FACILITIES MANAGEMENT INVOLVEMENT USING THE CONCEPTS OF PERFORMANCE MANAGEMENT

By

Sindile Melikhaya Nkala

A research report submitted to the Faculty of Engineering and the Built Environment, University of the Witwatersrand, Johannesburg, in partial fulfilment of the requirements for the degree of Master of Science in Building (Project Management)

Johannesburg 2015

DECLARATION

I, Sindile Melikhaya Nkala, declare that this research report is my own work except as indicated in the references and acknowledgements. It is submitted in partial fulfilment of the requirements for the award of the degree of Master of Science in Building (Project Management) at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination to this or any other university.

Sindile Melikhaya Nkala

Signed at Johannesburg

On the August day of 2015

ABSTRACT

Successful implementation of whole lifecycle management (WLCM) for facilities depends upon the seamless flow of information between the development and operational stages of facilities, which in turn depends upon the ability of the project manager to integrate various requirements of project stakeholders (Edum-Fotwe, et al., 2003); (Meng, 2013); (PMI, 2008). Traditionally, design is separated from the facilities management (FM) stage, and concepts such as early FM involvement are advocated as instruments that can be used to achieve integration between these stages (Meng, 2013). Early FM involvement is the integration of FM practitioners in the design stage and thus, allowing for valuable FM information to be included at an early stage of development. However, most of the available academic literature on early FM involvement either focus on the significance of early FM involvement without specifying the actual framework, similarly where frameworks are defined, only focus in one particular function of FM such as maintainability, without regard for operability, serviceability and other aspects of WLCM (Liu & Issa, 2013); (Meng, 2013). Therefore, the basis for this research was founded on the realisation of the silo approach between project management (PM) and FM stages, and lack of comprehensive frameworks for early FM involvement, resulting in facilities that are costly to maintain and operate. This research sought to provide a comprehensive performance management framework (PMF) for early FM involvement, here after called the PMF, within the South African context.

The PMF was developed using the concept of performance management. Performance management provides a good basis as a suitable means to deliver on early FM requirements. According to Amaratunga (2001:166) performance management is a process of assessing the progress towards achieving pre-determined goals including the information on the efficiency with which resources are transformed into goods and services, the quality of those output and outcomes, the effectiveness of organisational operations in terms of their specific contributions to organisational objectives. The pragmatic approach was adopted as the research philosophy. The qualitative information for the research was gathered by reviewing the relevant academic literature resulting in hypotheses being generated in order to develop the PMF. The quantitative study was used to test and validate these hypotheses and the proposed PMF, by conducting empirical studies (through survey questionnaire and oral interviews). The first hypothesis sought to establish the current status of FM knowledge generation and management thereof, which can be used at early FM involvement. The second hypothesis sought to probe the need for the proposed PMF and establish KPIs that would constitute this PMF.

Respondents in the engineering and built environment (EBE) agreed that the FM industry is in a position to generate FM knowledge which is crucial for early FM involvement. Respondents also agreed that there is a need for the proposed PMF. In total, 34 KPIs were established and validated based on the professional opinions obtained from the respondents.

The significance of the study lies in the observation that the definition of project success remains a vague and relative concept, which makes it difficult to assess the project success or failure. The development of the proposed PMF will provide a baseline for success measurement in a scientific manner. Traditionally, time, cost and quality are the primary indicators of performance in construction projects, but this is just a framework and does not provide the exact measurements within each category. The proposed PMF will provide for actual indicators, specific to FM requirements in a structured approach.

Keywords: Early Facilities Management Involvement, Facility Management, Performance Management, Project Management, Whole Lifecycle Management, South Africa.

DEDICATION

This research is dedicated to my parents without whom I wouldn't have made it this far in my academic achievements, both my mother, Belina Nomelikhaya Nkala and, my farther Samuel Makhabeni Nkala, who has passed on.

ACKNOWLEDGEMENTS

I would like to express my sincerest appreciation and gratitude to all the persons and organisations listed below.

- My supervisor, Dr Oluwayomi Babatunde, for the outstanding academic support and assistance throughout the development and writing of this report.

- The South African Facilities Management Association (SAFMA), for allowing me access to their members. In particular, I wish to thank Ms Kim Veltman for the responses and advices provided on how to reach out to their members.

- All the respondents and their organisations for their continued support throughout this process without which the quality of the results for this research would have been compromised.

- Finally, but most importantly to my wife Malehlohonolo Nkala and my children Asanda and Khanyisile Nkala for their assistance and understanding shown during this research.

Table of Contents

LIST OF FIGURES

LIST OF TABLES

ACRONYMS

BE	Built Environment
BIM	Building Information Modelling
BSC	Balanced Scorecard
CAFM	Computer Aided Facilities Management
CBE	Council for the Built Environment
CESA	Consulting Engineers South Africa
CSF	Critical Success Factors
CPM	Construction Project Management
EBE	Engineering and the Built Environment
ECSA	Engineering Council of South Africa
FM	Facilities Management
FMO	Facilities Management Organisations
IFMA	International Facilities Management Association
IT	Information Technology
KPA	Key Performance Area
KPI	Key Performance Indicator
PDP	Project Development Process
PI	Performance Indicator
PMI	Project Management Institute
PMO	Project Management Organisation
PM	Project Management
PMF	Performance Management Framework
PMS	Performance Management System
SA	South Africa
SACAPSA	South African Council for the Architectural Profession
SACPCMP	South African Council for the Project and Construction Project Management
SAFMA	South African Facilities Management Association
STATSA	Statistics South Africa

CHAPTER 1: INTRODUCTION

1.1. Purpose of the study

The practice of Facilities Management (FM) is rapidly gaining momentum in South Africa following on from the well-established FM practices in developed countries. However, "the successful deployment of FM functions depends upon the ability to identify, communicate and manage opportunities at an earliest possible time, simply called early FM involvement" (Edum-Fotwe *et al*., 2003:43). According to Meng (2013:500-501), the concept of involving FM practitioners in the early development stage of the facility has received an increasing attention from practitioners and researchers in the last decade. This makes it possible to incorporate the FM experience and knowledge in the development stage of the facility and thereby, avoiding potential problems such as, lack of maintainability, operability and serviceability.

Traditionally, design is separated from the FM stage, and concept such as early FM involvement is used to achieve integration between these stages (Meng, 2013). However, most of the available academic literature on early FM involvement either focus on the significance of early FM involvement without specifying the actual requirements, similarly where frameworks are defined, only focus in one particular function of FM such as maintainability, without regard for operability, serviceability and other aspects of the whole lifecycle management (WLCM) (Liu & Issa, 2013); (Meng, 2013). Therefore, the basis for this research was founded on the realisation of the persisting silo approach between the management of PM and FM stages, and lack of comprehensive frameworks for early FM involvement, resulting in facilities that are costly to maintain and operate. This research sought to provide a comprehensive framework for early FM involvement within the South African context. The framework for early FM involvement was developed using the concept of performance management. The concept of performance management provides a good basis as a suitable means to deliver on early FM requirements. According to Amaratunga (2001:166), performance management is described as a process of assessing the progress towards achieving pre-determined goals, including the information on the efficiency with which resources are transformed into goods and services, the quality of those output and outcomes, the effectiveness of organisational operations in terms of their specific contributions to organisational objectives.

It is intended that the proposed performance management framework (PMF) will be used to guide the FM practitioners and project teams of the actual requirements for FM that should be considered during the design stage.

Various models and platforms have been developed that seek to integrate the early FM requirements in the PM stage, and notably, the most recognised and recent platform include the Building Information Model (BIM). According to Underwood and Isikdag (2012), the philosophy of BIM is founded on four dimensions in relation to the management of building information and can be summarised as enabling;

(i). model based management,
(ii). shared building information which provide,
(iii). meaningful data about a building / facility in a,
(iv). standardised way.

BIM provides for a centralised information management system throughout the lifecycle of the facility. Many BIM developers have proprietary systems that seek to meet the requirements as envisaged by the BIM philosophy, through centralisation and

standardisation of information that covers a wide range of requirements from different stakeholders. Therefore, the results of this research may also be used to define the actual required information within the BIM standardised information structure. However, organisations that have not as yet adopted BIM may use the results of this research to highlight key areas of attention during the design and development stage.

The proposed PMF would not rely on whether an organisation uses BIM or not, but shall be generally applicable in guiding the project teams with regard to the requirements for early FM involvement. Most of the project management organisations (PMOs) have a standardised project delivery process (PDP) that is used as a guideline to project teams, and it is envisaged that this framework will be incorporated in their PDP in order to provide for guidelines that would enhance the long term performance requirements of facilities during the operational stage. Thus, the PMOs can adequately cover the early FM requirements by introducing this PMF in their PDPs or otherwise.

1.2. Context of the study

The holistic view of FM typically involves looking at the whole lifecycle of the facility which includes development, operation and disposal stages (Meng & Minogue, 2011). All these stages are interdepended and have different strategic and management requirements, and sometimes the same emphasis on certain management aspects of the facility, such as customer satisfaction and supporting organisational strategy (Hallgren *et al*., 2012; Morris, 2010). In the development stage (i.e. PM stage), the emphasis is on delivering the project successfully. Success in this instance is depended upon satisfying the needs of various stakeholders which are in most cases conflicting. Traditionally, the success measure of the PM stage would include “time, budget, to scope” with little regard for operational success (Haponava & Al-Jibouri, 2009). In recent times, the PM success is defined more broadly and extend far beyond the PM stage and include areas like strategy support, environment, technology, commercial, and people (Marawa & Zairi, 2009); (Morris, 2010). Similarly, the operational stage (i.e. FM stage) deals with the optimum use of the facility, which includes the coordination of services comprising of soft services (cleaning, security, utility services and space optimisation) and hard services (operation, maintenance and disposal) of the facility. Success measure at the operational stage would also include factors associated with customer satisfaction which according to Amaratunga (2001) revolves around time, budget, performance, and recently of supporting corporate strategy (and thus providing a competitive advantage). In summary, both PM and FM share similar goals in most aspects, therefore, the success of FM depends on the success of the PM, hence FM should be seen to span the whole lifecycle of facility from development to operational stages.

Although both stages of the facility’s lifecycle have similar goals in most aspects, that of achieving budget, set performance target, customer satisfaction and supporting corporate strategy, the silo approach in management of these distinct stages affect long term sustainability, and increasing the risk of poor performance, customer discontent, and failed corporate strategies. And it is this perceived fragmentation that has led to this research proposal into developing a standardised PMF that seeks to define early FM involvement. It is also argued that most of the management gaps seen in the whole lifecycle management of facilities may be traced to persisting disconnects between “planning, design and delivery” (in the PM phase) and “operation, maintenance and overall Management” (in “FM phase”) (Mohan, 2011). Mohan (2011) further argues that such shortfalls are evident in the information-knowledge gaps, and also between the teams working in silos within each domain leading to ill-informed decisions.

The proposed PMF would seek to link the development of facilities, as well as to “feedback” FM knowledge from practice, to the planning, design and construction processes.

Conversely, there is a great deal of research which advocate for early FM involvement during the development stage, however, do not provide for the necessary frameworks (Ying, et al., 2013). Bosch and Pearce (2003) capitalised on the evidence that sustainable design and construction contributes to the creation of facilities that are energy efficient, cost less over their life cycle and improves worker productivity. It has also been suggested that early engagement of FM would contribute to reducing the need for major repairs and alterations that would otherwise occur at the operational phase (Ying, et al., 2013). And with this in mind, it may be argued that the PM stage is best placed as a strategic stage for the integration of FM by ensuring that the planning and the design stage covers the performance requirements of FM at an early stage in the life cycle of the facility. It has long been recognised that the importance of integration between PM and FM is a requirement in achieving both the short and long term goals of both the customer and the end user throughout the lifecycle of the facility, which will be the ultimate measure of success.

1.3. Problem statement

The persisting knowledge gaps in the whole lifecycle management of facilities, from PM to FM is well documented (Mohan, 2011). This knowledge gaps may lead to buildings that fail to support the FM strategy and with high operational and maintenance costs during the FM stage, resulting in major repairs and lost FM strategies and opportunities.

1.4. Research Objectives

- To develop a PMF that defines FM objectives at an early stage of facility development. This will ensure that project teams are well conversant with the delivery requirements from the FM perspective. Thus, the end of the PM cycle should not lead to the beginning of failed FM strategies during the operational stage of the facility. FM is a relatively new and thriving industry in South Africa and there is a requirement to ensure long term sustainability by entrenching FM through well planned and manageable facilities.

- To develop relevant KPIs that will enhance the practice of performance management in the EBE. Traditionally, construction projects are measured in terms of time, cost and quality. However, this is just a framework that does not provide the actual KPIs within each category of the framework. The proposed PMF provide KPIs specific to FM and can be used with some of the standard forms of contracts used in South Africa.

1.5. Research Question

This research has both the literature and empirical questions as discussed below:

1. Literature Question

   What would be the appropriate PMF to satisfy the requirements of early FM involvement at the PM stage? This enquiry sought to identify KPIs within which early FM requirements could be defined. As a result the relevant academic literature review was conducted in order to answer this question.

2. Empirical Question – the empirical question is threefold:

    - Firstly, to determine the need for the proposed early FM framework. This exercise probed the need for having a standardised PMF to define early FM requirements as proposed by this research,

    - Secondly, what would be the critical attributes of this framework? This was done to prove the KPIs identified in the literature, by obtaining professional opinions among the EBE professionals including FM practitioners. The research participants were requested to rank the importance of the identified KPIs in order to validate the literature findings.

    - And lastly, but most importantly, how will the performance targets be set up, based on the proposed PMF? This question probed the current status of FM's body of knowledge and the importance of knowledge generation and management during the FM stage within the South African context.

1.6. Significance of the study

- The definition of project success remains a vague and relative concept, which makes it difficult to assess the project success or failure. The development of PMF for early FM involvement will provide a baseline for success measurement in a scientific manner. Traditionally, time, cost and quality are the primary indicators of performance in construction projects. However, the proposed framework will provide for actual indicators specific to FM requirements in a structured approach.

- Stakeholder's value management is one of the critical aspects in PM, and by considering FM requirements at an early stage of design could potentially reduce the efforts of maintenance and operational challenges during the FM stage of the facility.

- The consideration and inclusion of FM requirements in the PDP has the potential to lower the cost of procurement due to reduction in design alteration and rework, provision of facilities that are better suited to the needs of the end user, and facilities that are easy to run, maintain, control and manage.

- It is well documented that performance management has been widely used to improve the performance of organisations (De Waal, 2007). While performance management is well documented and practiced in different sectors of the economy, its implementation in FM poses a different challenge mainly due to lack of integration of the whole lifecycle of facilities (Mohan, 2011). Factors associated with challenges of performance management in the FM stage can be fed back, and dealt with, appropriately at an early stage of development. Therefore, the results of this study will have practical significance in the implementation of PMS in FM.

- And lastly, but most concerning, according to Hallgren, et al., (2012) PM may be losing its relevance due to excessive generalisation and standardisation. In contrast with other fields of medicine and law, many PM practitioners are not obliged to be certificated, either through professional or statute bodies, and their knowledge of PM is mostly from practice with limited use of PM's body of knowledge.

  Similarly, Drion, et al, (2012) raises similar sentiments regarding the lack of definitive FM scope. Without clear description of the nature, scope and definition of FM, available FM frameworks may be inappropriate.

This observed dilution of PM knowledge, and lack of consensus on what constitute FM, has a number of unintended consequences, which can be associated with the observed silo approach between development and operational stages of the facility. The proposed PMF may compensate for some of the observed dilution of the PM knowledge, by inclusion of the FM requirements in the PDPs of the PMOs, within the defined FM scope as is done in this research.

1.7. Delimitations of the study

- This was a study about early FM involvement, using performance management within the project management processes. The aim was to identify KPIs in the PM environment that would satisfy the FM requirements during the operational stage.

- The focus of this study was on the development of PMF for new facilities. In case of existing facilities, the PMF may be used to identify risks associated with the facility by systematically assessing the facility needs as defined in the PMF, and thus allowing for informed and appropriate response.

- FM is an emerging field in South Africa, hence the availability of relevant information was considered a major limitation. As a result, comparison with the available literature from developed countries was limited. The South African Facilities Management Association (SAFMA) is a relatively new organisation and does not necessarily have enough information to be included in this research. However, SAFMA provided a good source for FM knowledge in South Africa.

- The study was not about the concept of BIM; however, the proposed framework may provide guidelines to BIM managers with regard to the requirements of information structure related to the facility that is relevant at the FM stage.

1.8. Assumptions

- Performance management by definition is an act of measurement and management, enabling informed decisions to be taken and appropriate action implemented and monitored. Therefore, when implemented correctly it is assumed that it does in fact improve the performance of organisations, including South African organisations. Most of the academic literature available is based on developed countries, and it was assumed that successful implementation of performance management in developing countries like South Africa would also yield positive results. The proposed PMF is one element of performance management (i.e. measurement), with the other element being management (which is not within the scope of this research). Therefore, it was assumed that when the proposed PMF is implemented with proper management, will yield positive results.

- This research sought not to deal with issues of stakeholder identification and management in projects. However, departed from the assumption that FM is one of the definite stakeholders in any construction project. There are various models cited in Aaltonen (2011) in arriving to a model that provides a systematic method of determining and classifying project stakeholders. The model defines four types of stakeholders which includes:

    (i). Latent stakeholders – low salient stakeholders;
    (ii). Expectant stakeholders– expecting something;
    (iii). Definite stakeholders – critical stakeholders;

- Lack of formal PM training, regulation and compulsory certification, results in the relevance loss of PM due to informal practices. This results in poor management of competing project requirements from various project stakeholders and leading to silo approach between various stages of facility's lifecycle. Ideally, the requirements of FM should be delivered upon during the PM stage, with proper engagement of various stakeholders. Therefore, the use of the proposed PMF for early FM involvement may provide some compensation for loss of PM knowledge, and alleviate the perceived silo approach between PM and FM.

- In addition to the assumption above (i.e. PM relevance loss), it was assumed that the PM stage can be separated from and does not make adequate provisions for the FM stage in the development of a facility.

- Standardising and codifying of management practices, in particular project management and facilities management as is done by Project Management Institute (PMI) and International Facility Management Association's (IFMA) provided a sound basis for the development and implementation of the proposed PMF. This is supported by the fact that these are international organisations with vast experience and knowledge in the practice of process based management. Therefore, for the purpose of this research it is assumed that PMI and IFMA's knowledge in the field of PM and FM respectively will form the basis of body of knowledge for this research.

  PMI provides guidelines and standardisation of PM through the Project Management Body of Knowledge (PMBOK), nine knowledge areas, and associated project stages.

  IFMA highlights eleven key knowledge areas in FM and provides extensive resources with regard to FM practice. Although SAFMA has embarked in a process to professionalise the area of FM in South Africa, the process of knowledge production and management is still in its early stages compared to other FM associations, such as IFMA, in developed countries.

- Some of the respondent may not necessarily be conversant with the critical aspects of PMS. Therefore, it was assumed that in such cases the respondent would mainly reflect normal perspective and experience.

1.9. Definitions of terms

1.9.1. Facility

According to IFMA (2012), facility means something that is built, installed or established to serve a purpose. Therefore the same definition was adopted for this research.

1.9.2. Performance management framework

According to De Waal (2007), a performance management system (PMS) is premised on two elements, namely:

- Structure - The structure deals with the system (framework, platform) and definitions of KPAs and KPIs (based on objectives and targets) used to implement a PMS. It provides the basis for measurement, and

- Culture - defines management styles, competencies, organisational norms (human element). Therefore culture provides the basis for appropriate action to be taken based on the performance indicators.

Taking this description into account, the proposed PMF will seek to provide a framework for measurement in order to enable the project managers and facility managers to take appropriate actions in relation to early FM requirements. The act of appropriate action being taken by both project managers and facility managers constitute management. Therefore, the proposed PMF and act of management will constitute a PMS. In essence the proposed PMF is the structural part of a PMS and similarly the act of management is the cultural part of the PMS.

1.9.3. Key Performance Area, Key Performance Indicator and Performance Indicator

For the purpose of this research the structural part of a PMS is made up of three key elements. These elements constitute the proposed PMF and are defined based on the goals and objectives (some of the research literature refer to objectives as critical success factors (CSFs) of the PMS). The following definitions are provided for the three elements of the PMS structure.

- Key performance area (KPA) – this identifies and define a key area for performance management based on the objective to be achieved,
- Key performance indicator (KPI) – this identifies and define KPIs within the associated KPA. The KPI measures the unit of interest to determine progress towards the desired target.
- Performance indicator (PI) – this identifies and define the actual performance measure within the associated KPI. In some instances there may be only one PI within associated KPI, and in such instances the KPI and PI refer to the same entity being measured.

The KPIs can be measured with or without targets. In instances where there is no target, the KPI can be used to monitor an entity of interest to gather crucial information about the activity. Where the targets are set, the KPI can be used to measure progress towards attaining a set target.

CHAPTER 2: LITERATURE REVIEW

2.1. Introduction

This section contextualised the study by reviewing the available literatures around the main problem identified in the preceding section. The main problem that the research sought to address was the development of PMF for early FM involvement, in order to alleviate the perceived fragmentation between PM and FM.

2.2. Defining the structure of early FM involvement

According to Khaled and Richard (2013), the asset lifecycle comprises of the four succession stages:

- *Acquire,* all activities undertaken in technical and financial analysis, justification, planning and management of asset acquisition.
- *Deploy*, all activities associated with the installation, testing and commissioning.
- *Operate and Maintain,* all activities involved in most effectively maintaining asset availability, longevity and capability; and
- *Retire,* all activities involved in the disposal of assets.

Essentially, these stages represent the whole lifecycle and can be grouped under both PM and FM as follows:

Project Management

- Acquire
- Deploy

Facilities Management

- Operate and Maintain
- Retire

Khaled and Richard (2013) further argue that management control of each stage is facilitated by planning and controlling activities that takes place at the following three levels:

1) Strategy formulation activities.
2) Management control activities.
3) Task control activities.

Based on this whole lifecycle structure, five literature review topics were identified in order to answer the research questions:

1. *Facilities Management,*

   The literature review around FM sought to define in general, the scope and FM functions, in order to develop the PMF around this scope.

2. *Performance Management.*

   The concept of performance management was reviewed in order to establish its significance in relation to information management and attainment of goals. The challenges of the implementation of performance management were also reviewed in order to forecast, and avoid possible impediments with the implementation of the proposed PMF.

3. *Performance Management in FM.*

   The literature review around performance management in FM was intended to identify the KPIs used at the operational stage of FM. From these FM KPIs, the KPIs that are likely to be affected by activities that happen at the PM stage were identified and extracted to form the basis for early FM requirements.

4. *Project Management,*

   The objective of literature review around PM sought to understand the project management processes, with the ultimate goal of integrating the proposed PMF in the PM processes.

5. *Available Early FM involvement frameworks*

   Available literature on frameworks for early FM involvement was also reviewed and discussed, with the intention of incorporating some aspects of available frameworks into the proposed PMF where applicable.

2.2.1. Facilities Management

According to Drion *et al.* (2012), the discipline of FM has been in existence for over 40 years and yet there is no agreed definition of what the profession is all about. In most cases, it has conventionally been regarded in the “old fashion” sense of cleaning, repairs and maintenance. A decade ago, FM responsibilities broadened to encompass buying, selling, developing and adapting stock to meet wants of owners regarding finance, space, location, quality and so on (Drion, et al., 2012). Recently terms like supporting corporate strategy are associated with FM. This lack of generalised definition of FM complicates the standardisation of PMS in both the operational stage of facility and early FM involvement. According to Amaratunga and Baldry 2003, at the end, the contribution made by FM is judged by organisational stakeholders over a wide variety of performance metrics. Amaratunga and Baldry (2003) further argue that FM may be seen to contribute to organisations in many ways, including strategy, culture, control of resources, service delivery, supply-chain management, and perhaps most importantly the management of change.

According to Lepkova and Zukaite-Jefimoviene (2012:1-2), FM is a relatively new discipline that has developed around 1978, when the Herman Miller Corporation, hosted a conference on “Facilities Impact on Productivity”. The authors’ further state that as a discipline FM emerged out of practice, just as the great established professions did.

Matthew and Michael (2009) suggest that FM emerged with the integration of three main strands of activity: property management, property operations and maintenance and office administration. The authors further define FM as the “integrated management of the workplace to enhance the performance of the organisation” and the management of

premises and services required to accommodate and support the core business activities of a client organisation, while constantly adding value to the stakeholders.

IFMA (2012) simply defines FM as "the practise of coordinating the people and the work of organisation into the physical workplace". And for the purpose of this research the definition of IFMA was adopted. IFMA (2008) has also identified 11 core competencies in FM (discussed in details later in Section 2.2.4.2).

Although SAFMA argues that the definition of FM is always evolving and that many people and organisations have different views, nonetheless, it provides the following definition:

"Facilities management is an enabler of sustainable enterprise performance through the whole life management of productive workplaces and effective business support services." (SAFMA, 2010).

Elemica (2012) defines integrated FM as "the method for large-scope, long-term, complex, multi-service provider transactions. The organisation taking care about the integral delivery and management of the facility services is under one contract, and is responsible for the quality and cost of the services".

The ensuing table depicts the developments in FM as captured by Elemica (2012):

Table 2.1. Developments in FM in Europe (Elemica, 2012)

Developments in FM over time			
Year	**1980**	**1990**	**2000**
Service	Single Service	Multiple Service	Integrated Facilities Management (IFM)
Stage	Increased outsourcing	Bundling of services	Integration of services, performance based contracts, value added services
Risk Transfer →			
Added Value →			

It can be observed from these definitions that the key words are the "workplace and people", with the ultimate goal of organisational success. Therefore, in broad terms, FM is about providing quality workplace, which allows employees to perform optimally, resulting in organisational success. However, it is argued that the actual work required to provide quality workplace will be defined by the context of the organisation. In other words, the performance indicators within each KPI will represent the context of the organisation. However, the framework as defined by the KPIs will be generally applicable.

In recent times, many projects in the construction industry tend to move from design and build, to design, build and maintain. This inclusion of maintenance depicts a clear move towards FM concept. Traditionally, project management is viewed as an entity that encompasses planning, design and, construction (Mohan, 2011). These entities are in most cases segmented and managed independently, rendering them as operations in silos, with poor management of information flow through. At the end of the PM cycle the facility would be handed over to FM, Figure 2.1 illustrates this process:

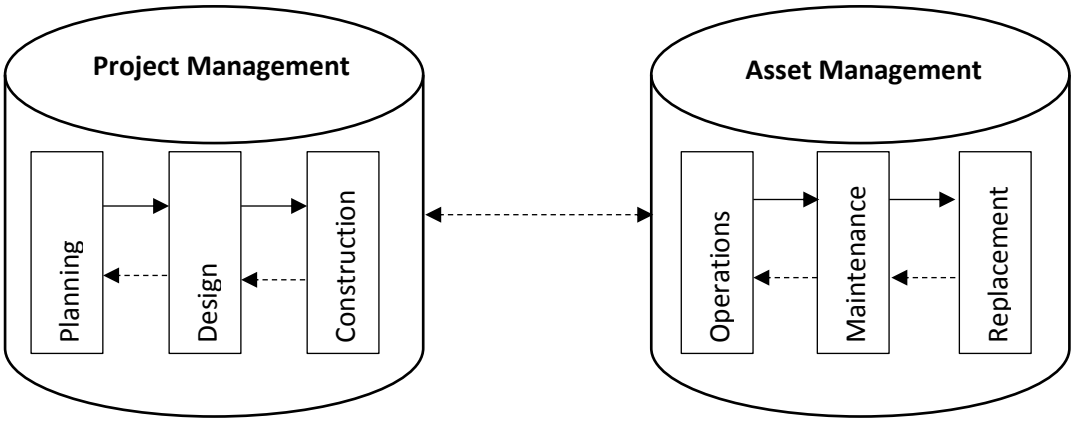

Figure 2.1 Traditional life cycle management of facilities [Source: (Mohan, 2011)]

Mohan (2011) argues that lately, there is a move towards integrated lifecycle management of facilities (design, build and maintain or operate) and technologies such as Building Information Management (BIM) are advocated to achieve this seamless information flow. Figure 2.2 illustrate this concept:

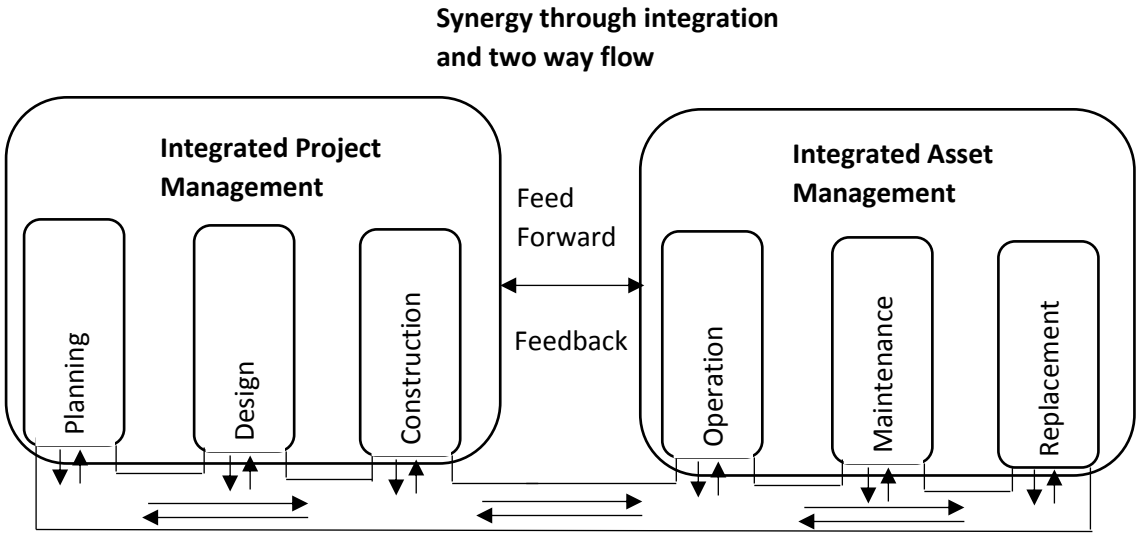

Figure 2.2. Integrated lifecycle management of facilities [Source: (Mohan, 2011)]

These developments further illustrate the challenges of standardising performance management within the FM environment, and also considering the fact that projects are unique. Therefore, FM should not be seen as an activity that only start during the operational stage of the facility; rather, it should be seen as an activity that spans the pre and post construction phases of a development, hence the proposal to define the structure of FM involvement during the project management stage.

2.2.1.1. FM in South Africa

In 2010, the South African FM market was found to be made up of 30% outsourced and 70% in-house (Khasebe, 2013). At the time, the outsourced FM market was mainly characterised by fourteen (14) major companies with the top tier three companies contributing 47.6% of FM revenue as listed in Table 2.2 (Frost & Sullivan, 2012).

Table 2.2. FM organisations associated with SAFMA (Frost & Sullivan, 2012)

Major FMS Companies in SA		
Tier 1	**Tier 2**	**Tier 3**
Drake and Scull	Broll	BKS
Johnsons Control International (JCI)	Colliers International	SFT
Total Facilities Management Company (TFMC)	ESS	Bosasa
	Motseng	Afroteq
	WSP	Maxima Global
		J.I

Frost and Sullivan (2012) identified the following market factors which are driving the FM market in South Africa:

- Cost benefits of outsourcing FM service.
- The need for companies to focus on core business.
- Infrastructure development in the commercial and public sectors.
- Increased focus on energy management and green buildings.

Despite the promising outlook of outsourced FM market in South Africa, Singh (2013:23) notes high failure rates in FM globally:

- Estimated 13% to 25% of outsourced contracts are brought in-house within the first two years,
- Companies tend to replace 80% of their service providers in the first three years,
- Service providers turn over 40% of their contracts each year, on average.

Although there may be a variety of explanations to the observed high failure rates, one way of improving the success rate in the FM industry is by successfully implementing a PMS that caters for the whole lifecycle of the facility. Performance management is one of the basic requirements for competitiveness and success of organisations (De Waal, 2007).

A survey by Deloitte and Touché Human Capital Corporation Survey, (2001) showed that 85% of South African organisations are using some form of PMS. Some perspectives on the use of PMS in South Africa are provided below as per the findings of this survey:

- 85% of South African companies have a PMS.
- 95% of these companies have a strong commitment of the Chief Executive Officer (CEO).
- In 94% of these organisations, there is a formal communication strategy regarding the PMS and process.
- Only 51% of the surveyed companies believe employees and managers are adequately educated and trained in PMS.
- 37% use the Balanced Scorecard methodology.
- 86% allow employees to jointly set targets and objectives with the manager.
- 91% have clear PMS policies, procedures and systems in place.

This study shows that most of the South African companies embrace the importance of having a PMS, and as results the concepts introduced by this research would be familiar to most FM organisations in South Africa.

2.2.1.2. Conclusions

Background and developments in FM were discussed with the intention to define and scope the FM activities for the purpose of this research. Developments in FM from a simple cleaning to integrated service provider were illustrated, and for the purpose of this research FM is considered to encompass all the integrated services. These services include maintenance and maintenance projects, overall building management (space, occupancy, utilities, and appearance), security, parking, waste and environmental management.

Analysis of lifecycle management in FM was also discussed to illustrate the perceived silo approach as identified by various authors (Edum-Fotwe, et al., 2003; Mohan, 2011; Ying, et al., 2013). Developments in South Africa's FM industry were also discussed and the following findings made; that most organisations in South Africa use some sort of a PMS. The significance of this finding is that the FM organisations in South Africa are in a position to gather FM knowledge that can be used to set up the performance indicators during the early FM involvement. Knowledge generation and management are critical for successful implementation of the proposed PMF.

2.2.2. Performance Management

In order to contextualise performance management, this section was divided into four (4) sub topics which included:

- Performance Management and PMS.
- Cultural aspects of performance management.
- Human resource and performance management.
- Performance management in developing countries.

2.2.2.1. Performance Management and PMS

The literatures around performance management suggest that the concept of performance management has been around and implemented over three decades. It has been widely accepted to improve the performance of organisations in many instances (Amaratunga & Baldry, 2003; De Waal & Counet, 2009). These include using performance management to track the organisation's progress towards attaining its mission and can give insights, as to whether and if so, which control mechanism to choose. Amaratunga and Baldry (2003) list four potential benefits that can arise as a result of having an appropriate PMS:

- Satisfying customers; and according to Amaratunga and Baldry (2002) customer satisfaction revolves around time, cost and quality.
- Monitoring progress;
- Benchmarking processes and activities; and
- Driving change.

Performance is a multidimensional concept that refers to both aspects of executing the given work and achieving the planned results (Adhikari, 2010). Adhikari (2010) argues that the requirements of the term "performance" should be defined in terms of the strongest linkage to the strategic goals of the organisation, customer satisfaction, and economic contributions. This assertion suggests that performance management cannot be separated from FM. As discussed in Section 2.2.1, the ultimate goal of FM is linked to organisational success, and as per the definition of performance management, the organisational success can be achieved through performance management.

According to Neely *et al.* (1995) performance measurement is synonymous with the process of quantifying action, where measurement is taken as the process of quantification and action correlates with performance. Similarly, performance management is also defined as the process by which a company manages its performance, in which it should be in line with its corporate and functional strategies and objectives (Bititci *et al*., 2006).

According to Nel *et al.* (2008: 492) "performance management can be defined as a holistic approach and process towards the effective management of individuals and groups to ensure their shared goals, as well as that of organisational strategic objective, are achieved".

Amaratunga and Baldry (2002) break the concept into two entities, performance measurement and management. Performance measurement is described as "a process of assessing the progress towards achieving pre-determined goals, including the information on the efficiency with which resources are transformed into goods and services, the quality of those output and outcomes, the effectiveness of organisational operations in terms of their specific contributions to organisational objectives". Similarly, performance management is defined "as the use of performance measurement information to effect positive change in organisational culture, systems and processes". According to Amaratunga and Baldry (2002) as well as Radnor and McGuire (2004), in some of the academic literature the terms, "performance management" and "performance measurements", are used interchangeably. However, the authors note that performance measurement is an act of measuring, and performance management uses the outcomes of measurement to manage performance. Therefore, both performance measurement and performance management constitute a PMS. For the purpose of this research, the term performance management means both the act of measuring and management.

According to De Waal (2007) a PMS is premised on two crucial aspects that include structure and culture as shown in Figure 2.3. The structure deals with the system and definition of KPAs and KPIs (and associated objectives and targets) used to implement PMS, whilst the culture deals with management style, competencies, organisational norms (human element). In view of this, the proposed PMF is specifically related to the structural side of PMS, since it seeks to define the structure of the early FM involvement. Some of the standard forms of construction contracts make provision for the use of PMS, and the proposed PMF may be used to manage the project deliverables to the benefit of FM stage.

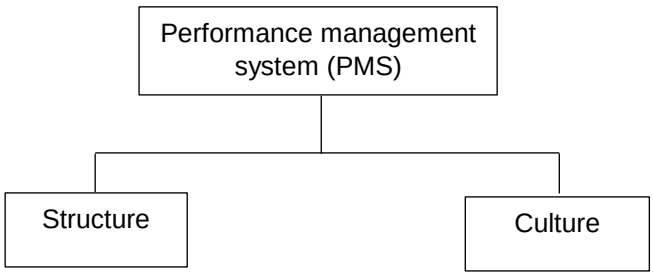

Figure 2.3. Performance management system [Source: (De Waal, 2007)]

The development of all PMSs is done in three management stages that include, strategy, planning, monitoring, and control of process performance (Khaled & Richard, 2013; Blasini & Leist, 2013). This can be represented graphically as shown in Figure 2.4:

Within this framework there are various performance models and information technology (IT) platforms that are intended to achieve a particular function in the overall performance management of an organisation, and the models may include the following examples:

- Balance Score Card (Kaplan, 1992) – a performance management framework.
- Six sigma – a process improvement model by statistical defects control and elimination.
- Computer Aided Facilities Management (CAFM).
- BIM - Whole life cycle management model.
- PMI - Project management Model (PMI, 2008).

And platforms may include propriety systems such as:

- SAP.
- Oracle.
- Microsoft Office.
- Revit.
- Primavera, Microsoft Projects etc.

At the heart of these systems (i.e. models and platforms) is information management, which according to (Atkin & Brooks, 2009) is the lifeblood of FM.

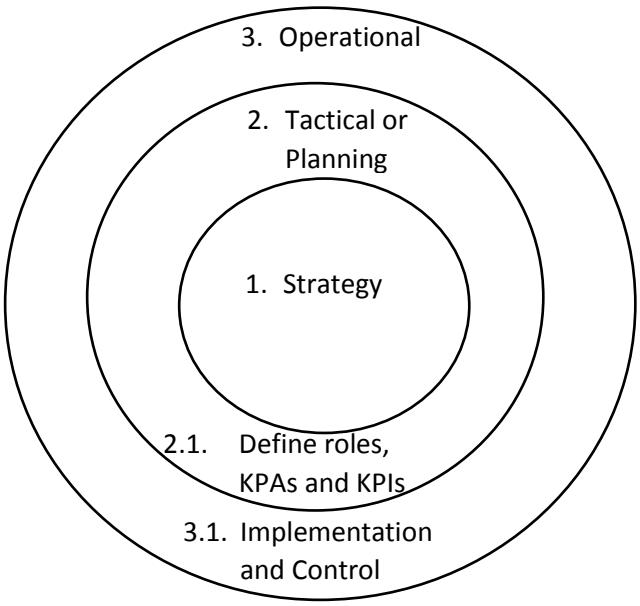

Figure 2.4. Performance management system development

Numerous studies have been conducted to identify factors affecting the successful implementation of performance management, De Waal and Counet (2009) identified and ranked 31 factors affecting the implementation of PMS, and (Blasini & Leist, 2013) identified 11 success factors in process performance management. The findings of the studies indicate that most PMS fail mainly, due to the failure of organisations to meet the cultural aspect of PMS. Furthermore, the following conclusion can be drawn from these studies; one entity of PMS complements the other, in other words the PMS structure (i.e. models and

platforms) complements organisational culture (i.e. management styles, skill, etc.) and vice versa.

In summary, performance management is a process of defining clear objectives and targets for the organisation which include the individuals and teams, and the regular review of actual achievement. It should also be noted that the term is strongly linked to the strategic goals of the organisation.

2.2.2.2. Cultural aspects of performance management

According to De Waal (2007) and Bitchi *et al*. (2004) in trying to understand the problems associated with the implementation of PMS, it is critical to understand that it happens within the context of organisational culture. Culture guides and shapes the behaviour and attitude of all employees (Bititci, et al., 2006). In a Ghanaian case study conducted by Ohemeng (2009), the author argues that the implementation of PMS is affected by institutional and capacity constraints such as culture, fragmentation, public apathy and leadership support, and suggests that "if organisational structure is not adapted to its context, then opportunities are lost, costs rise, and the maintenance of the organisation is threatened". These observations imply that organisational culture plays a significant role in problems associated with the implementation and use of PMS.

Bititci *et al*. (2006:1331) further note that a "paternalistic culture can lead to the successful implementation of a PMS"; however, does not suggest that this is the only culture which may lead to the successful implementation of a PMS. The opposite is also true; whilst organisational culture affects performance management, "it is also affected by performance management" (Bititci *et al.*, 2006:1344).

Bititci *et al.*, 2006 also note that performance management "helps to design the desired organisational culture, and it is a driving force for a participative culture". To support the observations made by Bititci *et al*. (2006) on the importance of culture in performance management, De Waal and Counet (2009:379) also argue that one of the reasons for failure in implementing a PMS is that "some organisations lack a performance management culture". This happens when there is no culture focused on achieving results and continuous improvement, and in such a context performance management is not used to achieve better performance (De Waal & Counet, 2009). Various organisational cultures are observed within the work environment and each have associated management style as explained in Bititci *et al*. (2006:1334-1335):

1. *"The role culture* (corresponding management style: logic orientated – technical expert), people perform their work out of respect to their contractual obligations which is backed by sanctions and personal loyalty to the organisation. In this case, the employees accord the status to their leader out of respect for the office the leader occupies. Leaders in this context do what they are authorised to do, and leaders are usually experts in their field. In this cultural context, "leadership is invisible, impersonal and evasive".

2. *The achievement culture* (corresponding management style: mixed task and people orientated - consultative) provides an environment where employees perform their work because they are satisfied in the excellence of their work and their personal commitment to the task or goal. The power base of a leader in this culture is the expertise of the leader and followers accord the status out of recognition of the contribution of the leader. The appropriate management style within the achievement culture is consultative and rational achiever. In this culture there is an assumption

that employees are motivated and need encouragement to continuously achieve high performance.

3. *The power culture* (corresponding management style: output orientated - Authoritative) is said to be associated with an authoritative management style. In organisations where this culture prevails, “employees perform their work because of hope for reward, fear for punishment or loyalty to powerful individuals or leaders”.

4. *Support culture* (Corresponding management style: employee orientated – “A good boss”, participative, democratic). In support culture work is performed out of enjoyment of the activity for its own sake and concern and respect for the needs and values of the other persons involved. Here leaders need to have personal charisma that symbolizes esteemed values”.

In conclusion, it is suggested that the organisational culture drives the management style, which in turn will influence the PMS. All these three concepts (organisational culture, management style and PMS) are said to be interlinked. Therefore, the implementation of the proposed PMF for early FM involvement will be implemented within a particular organisational culture and it would be crucial that the project team identify the cultural factors that may hamper the successful implementation and appropriate action taken as early as possible.

2.2.2.3. Human Resource and performance management

Having discussed the organisational culture, human resource development (HRD) follows naturally as it is one of the primary factors that drive organisational culture. It is reported that approximately 70 percent of performance management initiatives fail during the implementation stage (De Waal & Counet, 2009). The authors argue that this failure basically results from the inability to meet the behavioural requirements on the part of people in the organisations to get started. De Waal (2007) argues that “therefore it is imperative that organisations pay attention to the instrumental and the behavioural side of performance management”. According to Adhikari (2010) performance management and HRD are somehow interrelated. These findings suggest that, lack of HRD will arguably lead to the failure of PMS, and with this in mind it would be crucial that the project team identify suitable candidates for the administration of the proposed PMF for early FM involvement in order to ensure successful implementation. Alternatively, resources must be allocated at the beginning of the project to implement early FM involvement.

On the other hand, De Waal (2004) notes that management style has a great influence in helping the employee deliver the desired results, and thus have serious implications for the effective implementation of a PMS. The author further notes that if management style is restricted to steering only, the result will be a directive style without much regard for the importance of individual responsibility. According to Nel *et al*. (2008), management style is a way in which management is practiced in the organisation and how it impacts on the performance of employees. Bititci *et al.* (2006) further notes that a “combination of result-oriented steering and coaching by management equals the style of result oriented”. Therefore, for an organisation to successfully implement a PMS and improve performance management, the manager’s management style is required to address three components, and they consist of visible commitment, clear steering and provision of support, (Bitchi, et al., 2004).

2.2.2.4. Performance management in developing countries

De Waal (2007), argues that only a few scholars doubt whether existing western management practices can work in emerging markets, and it has long been recognised that culture is a major source of differences in measurement and reporting standards and methods. On the other hand, Ohemeng (2009) warns of the dangers of internationalisation and one size fits all approach. The author notes that the environment (with structural and contextual variables such as culture) is an essential element in the success of policies and reforms. The implication of this argument is that the available early FM models cannot be adopted without modifications to suit the local context of where they are being applied, hence the study within the South African context.

De Waal (2007), further notes that the overall lack of management skills and expertise in developing countries (including South Africa) often makes it not viable to develop complex structures such as sophisticated PMS. Therefore, according to De Waal (2007) developing countries concentrate more on introducing and copying tools and systems from the western world which are not always best suited to local circumstances and this raises the question of whether western techniques like performance management are suitable for developing countries. De Waal (2007) further argues that there is no question that in theory, adopting management practices which have proven to be effective is a better alternative for an organisation than investing limited and scarce resources in efforts which do not amount to much more than “reinventing the wheel”. However, the author further comment that the context where these techniques are implemented should be considered as the different socio-cultural environment of developing countries may lead to different results as compared to those of the developed western countries where these techniques are developed.

Most developing countries which have tried to implement performance management have mainly focused on employee performance appraisals and yet institutional performance stretches beyond employee performance (De Waal, 2007).

2.2.3. Hypothesis 1 (H1)

This section discussed both the concepts of FM and performance management.

FM like many other areas of management has developed out of practice. It has evolved from a simple practice of cleaning, repairs and maintenance to a highly sophisticated area of integrated FM, which is said to support corporate strategies (Elemica, 2012). In recent times, modern FM also forms part of the project delivery process, in PPP contracts. And according to Atkin and Brooks (2009), at the heart of FM success is information management.

Performance management on the other hand is a management tool that allows an act of measurement and informed decision making based on the measurement data. It enables organisation to generate crucial information about organisational activities and thus allowing for appropriate actions to be taken towards the achievement of planned goals.

Based on these observations, it is hypothesised that the successful deployment of the proposed PMF for early FM involvement will be depended upon the ability of FM organisations to generate FM knowledge that can be used to define the requirements for early FM involvement. And performance management is one way of generating the FM knowledge.

2.2.4. Performance Management in FM

This section will be divided into structural as well and cultural aspects of performance management in FM.

2.2.4.1. Structure of performance management in FM

According to Amaratunga and Baldry (2002) previous studies in performance management tend to measure profitability, economics and environmental issues and recently issues on sustainability but there is lacking of studies that focus on performance purely from the FM perspective. Amaratunga and Baldry (2002) further argues that there are also limited KPIs or incorrect KPIs that can be used in FM, and also the frameworks tested based on the measures from other indicators are too general for FM service specification. Although there are many performance measurement techniques available for facilities, Amaratunga and Baldry (2002) argues that "most of the facilities related measurement tools are, either lead to a great deal of confusion about the reasons for performance indices and performance measures or that there are too many performance indices (especially in terms of cost) in the FM market, looking only at wider issues, which fail to link core business issues with those of facilities". The authors further argue that performance measurement techniques available in general management literature have not been fully transformed into FM literature, emphasising the research need in performance measurement in FM. However, the research by Amaratunga and Baldry (2002) found that KPIs in FM can be categorised into four categories as follows:

- Customer focus;
- FM internal processes,
- Learning and growth; and
- Financial implications

Meng and Minogue (2011) conducted a research to determine the most used PMS in FM, and according to their findings, a preferred measurement model among FM organisations is the BSC and KPIs.

The BSC is said to be a strategic performance management tool premised on four perspectives (Kaplan & Norton, 1992); (Perkins, et al., 2014). These perspectives are defined as follows:

Customer perspective

This perspective deals with the customer requirements (expectations and needs) and performance measures are set to monitor and manage delivery of these requirements. And these performance measures typically include time, cost and quality (Amaratunga, 2001).

Internal business perspective

This perspective provides a framework for the organisation to focus on the effectiveness of internal processes. Performance indicators used are those that have the greatest impact on operation of the business, and these may include cycle time, productivity, cost and time among others.

Innovation and Learning perspective

This perspective provides the organisation with the framework to consider its performance and how good it is at adapting to change brought about by global competition. As a result

the measures tend to focus on employee satisfaction and development, and the monitoring of new products or services with the emphasis being placed on innovation.

Financial perspective

According to Perkins *et al.* (2014) the financial perspective is traditionally the main measure for organisations. The author further argues that the other three perspectives in the BSC can be considered the drivers of future performance, whereas the financial perspective can be considered as a check of past performance, allowing managers and executive to consider the bottom-line impact of any changes made (Perkins, et al., 2014). Perkins *et al*. (2014) further notes that by achieving the objectives laid out in the other perspectives can only benefit the company when translated into improved sales or market share, reduced operating expenses or a higher asset turnover.

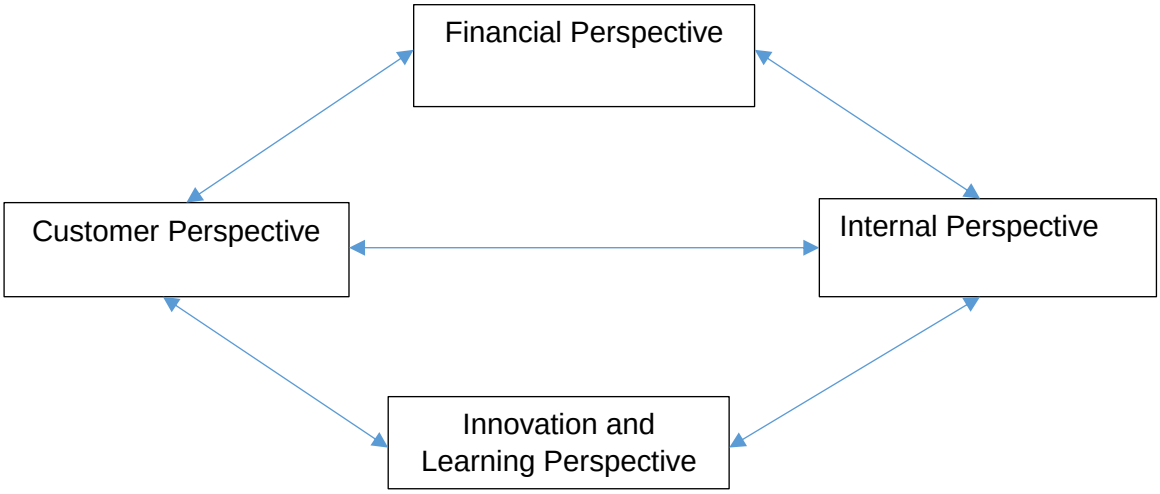

Figure 2.5. Balanced Score Card Model [Source: (Kaplan & Norton, 1992); (Perkins, et al., 2014)]

In another study conducted by Lavy *et al*. (2010:448-456), the findings of the study categorises a number of KPIs used in FM into four main groups which include:

Financial indicators

"All financial-related indicators (revenue, costs and profit) are grouped under this category and express costs and expenditure of the facility, the buildings, and their systems and components. As already discussed in the preceding sections, these indicators are different than KPIs in other categories as they provide prompt assessment of financial performance and can be utilized for short- as well as long-term decision making by the various management levels in the facility. These financial KPIs represent performance in terms of currency expended per unit area, person, or output/product" (Lavy, et al., 2010).

Physical indicators

"All KPIs indicating the physical condition of the building or a facility under study are classified under this category. This category represents the physical state of a building in terms of appropriateness (how well the building supports the desired function), quality of space (spatial, environmental, and psychological issues), accessibility (site, location, and handicap accessibility), and resource consumption (energy, water, and material). This category contains qualitative as well as quantitative indicator" (Lavy, et al., 2010).

Functional indicators

"All KPIs listed under the category of functional indicators measure the functioning performance of a building or a facility by evaluating aspects related to organizational or business mission, space, employees, and other supportive facilities. Overused and underused spaces can very well express the state of space utilization in a building, while productivity and turnover rate can determine occupants' satisfaction with the building or facility" (Lavy, et al., 2010).

Survey-based indicators

"All KPIs that cannot be quantified or that are collected by communicating the opinions of respondents are grouped in the category of survey-based indicators. Surveys typically use a questionnaire in which the questions depend on the type of study being performed. Respondents could include building occupants, such as full and part-time employees, or transient occupants, like customers or visitors, and/or any other respondents, as required by the study" (Lavy, et al., 2010).

In a different study conducted by Lam *et al*. (2010:293-294) identifies six categories for classification of KPIs in building maintenance projects. The categories are defined as follows:

Time:

This category lists all the time related indicators and measures the degree to which a particular project completion is within allocated duration.

Cost:

This category lists all the cost related indicators and measure the degree to which a particular project completion is within the allocated budget.

Quality:

This category lists all the indicators that measure the degree to which a particular project meets the established requirements of material and workmanship. It is also expressed in terms of technical specification, function and appearance.

Safety:

This category lists all the safety indicators established for a particular project and reports on the degree to which the project completion is without major accidents of injuries.

Functionality:

This category measures the degree of performance variation from the listed specification.

Environmental friendliness:

This is a measure of waste generation and is quantified in terms of the difference between the amount of the total delivery of materials to the site and the amount of work completed.

Lastly, in another study conducted in health care FM by Shohet (2006:346-350), 11 KPIs were identified and classified into four categories as shown:

Asset Development:

This category list KPIs associated with the physical and operational requirements of the facility. The built area, occupancy (wear and tear) and conditions of facility are defined under this category.

Organisation and management:

This category examines all the human resource management aspects and external factors that impact on organisational activities. Occupancy, outsourcing of FM activities, span of management activities and maintenance organisational structure are defined under this category.

Performance management:

Indicators related to building performance, such as the overall state of the building and associated facilities are defined under this category.

Maintenance efficiency:

Indicators associated with maintenance expenditure and the overall maintenance costs in relation to the output of the facility are defined under this category.

Important observations can be made regarding the categorisation and definition of KPIs in FM. It is clear that different authors have different ways of presenting FM KPIs, however, the common theme across all categorisation, is the measurement of financial performance, maintenance performance, and operational performance. Therefore, the impact of design on these categories of performance management in FM must be considered during the design stage. It was the intention of this research to define these aspects, with the use of the proposed PMF. The decision on facility layout and location, material and equipment selection and information management have huge impact in FM performance management.

A summary of other categorisation of FM KPIs is given in Table 2.3, and these categories were considered in developing the proposed PMF for early FM involvement.

Table 2.3. Comparison of FM performance categories, adapted from Lavy *et al*. (2010)

Source	Categories				
	Financial	**Functional**	**Physical**	**Survey based**	
Kaplan and Norton (1992)	Financial implications	FM internal processes Learning and Growth		Customer's relations	
Massheder and Finch (1998)	Business	Acquisition Disposal	Portfolio Building performance		
Hinks and McNay (1999)	Business benefits	Space Equipment Change Consultancy	Maintenance and service	Environment General	
Ho *et al.* (2000)		Safety and security Size and use of facility	Ground and environment Energy consumption Maintenance Parking Refurbishment		
Amaratunga and Baldry (2003)	Financial implications	FM internal processes Learning and Growth		Customer's relations	
Gumbus (2005)	Financial implications	Operational Learning and Growth		Customer's relations	
Augenbroe and Park (2005)			Energy Lighting Maintenance	Thermal comfort	
Sohet (2006)		Organisation and Performance management	Asset Development Maintenance efficiency		
Lavy *et al*. (2010)	Financial	Functional	Physical	Survey based	
Lam *et al*. (2010)	Cost	Functional	Quality Environment Safety		Time
Meng and Minogue (2011)[1]	Financial Perspective	Internal processes Innovation and learning		Customer perspective	

This section discusses the actual KPIs as presented in Lavy *et al* (2010). The reason for discussing FM KPIs as presented by Lavy *et al* (2010) in details is based on the comprehensive nature of FM professionals consulted in various FM markets. The professionals consulted are involved in FM activities that include education, health care, office buildings, federal organisations, and oil industry. Moreover, Lavy et al. (2014) part 2 derives mathematical expressions for these KPIs, which makes it possible to link the KPIs with their mathematical models. It was also noted that most of the KPIs discussed in other studies also form part of the KPI list in Lavy *et al*. (2010). Additional KPIs not included in the list as presented by Lavy *et al*. (2010) were discussed separately and also considered for the proposed PMF.

Tables 2.4 to2.7, presents the FM KPIs as identified and categorised by Lavy *et al*. (2010). The KPIs are categorised into four categories of financial indicators, physical indicators, functional indicators and survey based indicators. From these tables the KPIs that are perceived to be influenced, and that can be managed at an early stage of facility development, were then identified for the proposed PMF. Other KPIs from other authors as identified in Table 2.3 were also considered for the proposed PMF, although not discussed herein.

Table 2.4. Financial Indicators (Lavy *et al*. 2010, 2014 part 1)

Indicators	Descriptions	Units
Operating costs	All operational costs related to facility, such as insurance, air-conditioning, ventilation, overhead and wages, energy, fire protection, lifts and escalators, repair and maintenance, security, cleaning and garbage, sundries, and other expenses and fees	$US (or equivalent) per: (1) Unit area; (2) Person; (3) Employee; or (4) Product
Occupancy costs	Total cost associated with building occupancy, from building occupation to disposal. It includes real estate and personal property taxes, insurance for the building and its contents, depreciation and amortization costs, etc. This may also be considered a subset of "operating costs"	$US (or equivalent) per: Unit area; Person; Employee; or Product
Utility costs	Monthly or annual cost of utilities, including electricity, fuel oil, gas, steam, water, sewage, etc.	$US (or equivalent) per unit area
Capital costs	All costs required to purchase and extend building property, to procure plant and equipment, and to operate the business or organization	$US (or equivalent) per employee
Building maintenance cost	Costs for labour (in-house or contracted-out) and materials required for building monitoring, inspection, repairs, maintenance, and response to service requests	$US (or equivalent) per unit area
Grounds-keeping cost	Costs for labour (in house or contracted-out) and materials required for landscaping, storm water management, and parking lot or garage maintenance	$US (or equivalent) per unit area
Custodial and janitorial cost	Costs for labour, personnel, supplies, and equipment used for providing janitorial and custodial services	$US (or equivalent) per unit area
Deferred maintenance, and deferred maintenance backlog	Maintenance cost of property, plant and equipment that is postponed from a facility's operating budget cycle due to financial constraints. It is measured by conducting condition assessment surveys of existing property, plant and equipment, and by determining the amount of funds required to restore back to a condition of "as good as new"	$US (or equivalent)
Capital renewal	The budget required for performing major renovations in the building, its systems, subsystems, and components	$US (or equivalent)
Maintenance efficiency indicators (MEI)	Indicates the efficiency with which maintenance activities are implemented	MEI values can be divided into three ranges: low, reasonable, and high, based on the actual investment in maintenance, compared to the actual performance of the building
Facility condition index (FCI)	Represented by the ratio between the total cost of deficiencies to the CRV, or by the ratio between the costs of Deferred Maintenance to the CRV	Percentage of CRV
Churn rate and churn costs	Represents the process of moving a group of employees and/or equipment within a period of time (per month or year)	Expressed as percentage of total average employees in a specific time period or in currency ($US or equivalent)

Table 2.5. Physical indicators (Lavy *et al*. 2010, 2014 part 1)

Indicators	Descriptions	Units
Building physical condition – quantitative: Building Performance Index (BPI)	Indicates the physical-functional state or condition of a facility in terms of building components, systems and processes	Measured as a 100-point scale where a score greater than 80 points represents the building and its performance as good or very good; a score of 70 to 80 points indicates marginal condition, which requires some preventive maintenance measures; a score of 60 to 70 points indicates the deterioration of the building components and system, which requires preventive and breakdown maintenance; a score of less than 60 points indicates poor condition of the building
Building physical condition – qualitative: general building maintenance in: (1) building physical condition; (2) sanitary, plumbing and storm water; (3) mechanical services; and (4) lighting and electrical	Includes maintenance in terms of routine repairs, major and minor repairs and replacements in: (1) building; (2) sanitary, plumbing and storm water systems; (3) mechanical systems; and (4) lighting and electrical systems	Measured on a scale of good, fair, poor, and unsatisfactory based on condition assessment
Property and real estate	Includes real estate area and provides an estimate of owned versus leased area in order to know what fraction is owned and what is leased	Area in sq. ft. and fraction of leased or owned area in % of total real estate
Waste	Total waste generated for disposal, waste to landfill, hazardous waste, cost of waste disposal, and amount of waste recycled or reused	Volume per year or month, $US (or equivalent) per year or month, ton per month & $US (or equivalent) per month; reused or recycled waste: percentage of total waste generated; disposal cost: $US (or equivalent) per volume
Health and safety	Includes an estimation of condition of employees' health and safety and organization's compliance with applicable codes related to the health and safety of employees	Employees' number of accidents per year, number of lost work hours, number of workers' compensation claims
Indoor environmental quality (IEQ)	Measured in terms of indoor pollutants, noise, light, and ventilation; thermal comfort: air temperature, mean radiant temperature, humidity, and air speed; indoor air quality: fresh air distribution, restriction of mass pollution (gases, vapours, micro-organisms, smoke, dust, etc.); day lighting and views: views and natural day light through windows.	Each parameter is measured in its respective units of measurement

CONT': Indicators	Descriptions	Units
Accessibility for disabled	Provision for disabled and preparedness of facility to accommodate special needs of handicapped people	Measured on the basis of level of accessibility of the facility for disabled individuals
Resource consumption – energy: (1) energy use: total facility energy use; or building energy use; (2) net energy consumption; (3) annual energy consumption; (4) total natural gas consumption; (5) building electrical consumption; or (6) building electrical demand, demand intensity, or peak electricity demand	(1) Total energy consumed by entire facility, including stored fuels or gases; energy consumed in the process of heating, ventilation, and air conditioning, lighting, domestic hot water, plug loads, and other building energy use. This does not include process energy (energy consumed in manufacturing, industrial, or commercial activities) (2) Total facility energy use minus facility energy production (includes energy production and energy savings as a result of using energy star rated equipment and employing energy efficient efforts) (3) Total consumption of energy per year (4) Total natural gas consumed by the facility (5) Total building electricity consumption (6) Building electrical demand is the maximum amount of electricity that a building consumes at a given time Demand intensity is the maximum electricity consumption per unit area at a given time.	(1) kWh, Btu or Joules (2) kWh, Btu or Joules (3) kWh or kVA, kWh or kVA per unit area per hour, or kWh or kVA per person per hour (4) kBtu per unit area, kBtu per person, or therms per year (5) kW or kVA (6) kWh; kW per sq.ft. or kVA per sq. ft.; kW or kVA
Resource consumption – water: (1) water consumption; or (2) net water consumption	(1) Total building water use (2) Total water consumption minus reused, recycled and treated water	Volume per month, volume per product
Resource consumption – materials: (1) material consumption, (2) or net material consumption	(1) Quantity of total material used in the process of operation and/or production (2) Total material consumption minus waste, reused, and recycled material	Cubic feet or tons or any appropriate unit of weight
Security	Describes the condition of security and effectiveness of security measures in the facility or organization	Number of security incidents per year
Site and location	Characteristics of facility's site in terms of size, location, safety, sound and quality, accessibility, contours, preservation and development	Points are given on the basis of: Size: length to width ratio; location: proximity to homes and other community facilities; safety, sound and quality: site is away from dangerous facilities like freeways, railroads, dams, airports, industries, traffic intersections and electric lines, level of external noise; accessibility: good vehicular and pedestrian connections; contours: slopes allowing minimal modification of site; utilities: proper utilities connections.

Table 2.6. Functional indicators (Lavy *et al*., 2010, 2014 part 1)

Indicators	Descriptions	Units
Productivity	Measures productivity in terms of: (1) occupant turnover rate; (2) absenteeism; or (3) occupants' satisfaction and self-rated productivity	(1) turnovers per year (2) absentees per year, or (3) survey-based data
Parking	Availability of parking spaces	Number of parking spaces per person
Space utilization	Measures over-used and under-used spaces, adequacy of space, and proper space management	Survey-based data
Employee or occupant's turnover rate	It is the ratio of number of employees turned over in a period of time to the total average number of employees in that period	Ratio (number of employees turned over to the total average number of employees in a given period of time) and number of turnovers per year
Mission and vision, and Mission Dependency Index (MDI)	Facility's preparedness to fulfil its mission. MDI indicates priority of mission in projects and funding	MDI is measured using a 100- point scale, usually represented by the following colours: blue (0-40), green (40-55), yellow (55-70), orange (70- 85), and red (85-100, most critical)
Adequacy of space	Suitability of space for the proper functioning of the facility. Sufficiency of space for various building operations, maintenance, equipment, and other supportive systems	Survey-based data

Table 2.7. Survey based indicators (Lavy, *et al*., 2010, 2014 part 1)

Indicators	Descriptions	Units
Customer/building occupants' satisfaction with products or services	Measures the ability to deliver quality products and services to customers, effectiveness of their delivery, timeliness, and overall customer satisfaction with building, building services, and building systems	Customer survey-based data
Community satisfaction and participation	Community involvement, interaction and favourability, and satisfaction among the community	Survey-based data
Learning environment, educational suitability, and appropriateness of facility for its function	Appropriateness of a facility to perform its functions in terms of functional, spatial, and psychological aspects	Survey-based data
Appearance	Exterior and interior visual qualities, harmony with surroundings, scale and proportion of spaces, and visual stimulation of the facility	Survey-based data

In summary, FM's KPIs as identified by Lavy *et al*. (2010) were presented and categorised into financial, physical, functional and survey categories. Based on these KPIs, the following observations were made under each category:

Financial perspective, under this category the following financial KPIs can be managed at the design stage, and include: capital cost, operational cost, occupancy cost, maintenance cost, utility cost, disposal cost and residual value. These KPIs can be used to define the financial model of the facility, the viability and FM strategy. Informed financial decisions can be taken at an early stage of the facility development.

Physical perspective, under this category the following physical KPIs can be managed at the design stage, and include: built area, site location, resource consumption (energy and water), security, quality of life, accessibility, equipment and material selection, health and safety, environment, and convenience. These are quality KPIs and can allow for objective measurements and management to be made as per the FM requirements.

Functional perspectives, under this category the following functional KPIs can be managed at the design stage, and include: space utilisation, adequacy of space and parking. Similarly, these are also quality KPIs and can allow for objective measurements to be made.

Survey based, social impact, appearance, and lessons learned (appropriateness of facility for various activities). Corporate social responsibility and image can also be managed at the development stage, and lessons learned will be invaluable.

Therefore, these KPIs were considered for the proposed PMF in addition to other KPIs as presented by other authors in Table 3 (namely, categorisation of KPIs by various authors).

2.2.4.2. Cultural Aspect of performance management in FM (Knowledge Area)

IFMA (2008) defines 11 core competencies that FM practitioners should possess, and these are shown in Table 2.8:

Table 2.8. IFMA's 11 core FM competencies (IFMA, 2008)

Key knowledge area	Description of required processes
Communication	Communication plans and process for both internal and external stakeholders
Emergency Preparedness and Business	Emergency and risk management plans and procedures
Environmental Stewardship and Sustainability	Sustainable management of built and natural environment
Finance and Business	Strategic plans, budgets, financial analyses, procurement
Human Factors	Healthful and save environment, security, FM employee development
Leadership and Strategy	Strategic planning, organise, staff and lead organisation
Operations and Maintenance	Building operations and maintenance, occupant services
Project Management	Oversight and management of all projects and related contracts
Quality	Best practices, process improvements, audits and measurements
Real Estate and Property Management	Real estate planning, acquisition and disposition
Technology	FM technology, workplace management systems

2.2.4.3. Conclusions

This section has presented both the structural and cultural aspects of performance management in FM. The structural aspect of performance management has identified categorisation of KPIs which are employed in FM. The cultural aspect of performance management in FM identified the required competencies as per IFMA (2008).

In conclusion, which ever method is used to implement a PMS at the FM stage, the information and experience gathered can be used to define and set PI within each defined KPIs that can be used at the development stage. Thus, the importance of implementing PMS at the FM stage is also as crucial because it can provide analytical information that can be used to set the requirements for early FM involvement.

2.2.5. Project Management

According to Morris (2010:144) the term "project management" was first used by the United State Air Force in 1953. Further developments in the field of PM are provided below as depicted in Morris (2010:144):

- "Fondalh, at the University of California, Berkeley, invented precedence diagrams.
- Resource scheduling was the result of academic work.
- Risk management has benefited significantly from university research.
- The quality movement has a strong research background (e.g. Deming).
- Relationship-based procurement comes from a similar background and has continued to benefit from research
- Knowledge management and organisational learning have a very strong research background. Information technology tools clearly do too, though predominantly from the private sector. Most of our "people" knowledge is research based. And the studies of major projects and of project success and failure have had a major impact, as with say "optimism bias" on public sector funding practice or my own "management of projects" paradigm and the influence that has had on the Association for Project Management (APM) body of knowledge and the International Project Management Association (IPMA) competency baseline model".

However, Morris (2010) argues that there is no single theory of project management; instead there are several theoretical frameworks which might be appropriate for the issue at hand. Furthermore, many of the causes of project's success or failure lie at the beginning; the way the projects are developed and defined – its goals and strategy, choice of technology, approach to risk, and contracting policy. This is particularly important for the implementation of the proposed PMF, without proper definition of the goals and objectives with regard to early FM deliverables, the use of the performance indicators may become irrelevant and confusing.

According to Hallgren *et al*. (2012) the PMI is acknowledged as the pioneering group worldwide for bringing professionalism to the area of project management. The PMI in their endeavour to advance the development of project management put together a standalone body of knowledge document in 1987, and after consultations and revisions, the first edition of PMBOK guide was published by PMI in 1996, and subsequent editions were published in 2004, 2008 and 2013 (third, fourth and fifth respectively).

The PMBOK is a set of standards (management best practices that are common to projects) and describes the sum of knowledge within the profession of project management. The body of knowledge rests with practitioners and academics that apply and advance it (PMI, 2000).

PMI defines project management as the "application of knowledge, skills, tools and techniques to project activities to meet project requirements, where a project is a temporary endeavour with a finite completion date undertaken to create a unique product or service (PMI, 2008)". In an effort to codify PM as a profession, the PMI has published the PMBOK (Robert, et al., 2000). By considering PM as defined by PMI, it can be taken as a PMS made of two crucial aspects, structure (project stages) and culture (knowledge areas):

2.2.5.1. Structure of performance management in project management

Traditionally, performance management in PM is implemented in terms of the PM triangle made up of cost, quality and time. To comply with the competing requirements of the PM's performance management triangle, PMI produced PMBOK. The PMBOK guide defines the subset that is generally accepted as good practice within which the project should be implemented. These are process based, in that it is suggested that projects should be broken-down into process based phases (Parker, et al., 2013); (PMI, 2008).

The five phases, according to PMI (2008) are defined as follows:

1. *Initiation* – refers to all activities dedicated on ensuring that realistic business needs will be achieved. Project stakeholders that will ensure project success are also identified;

2. *Planning* – all the activities undertaken to establish the total scope of the project, define and refine the purpose, and develop the course of action required to meet the project objectives.

3. *Execution* – implementation of activities and measurement of progress as identified in the planning phase in order to meet the strategic objectives and goals of the project.

4. *Controlling* – all the steps taken to track and review project's progress and performance when measured against the initial planning specification.

5. *Close Out* – all the steps taken to formally complete the project.

The breakdown of projects into phases provides a unique opportunity to phase in the proposed PMF for early FM involvement into the project schedule. In other words, each phase would have unique FM deliverable that can be defined and monitored.

2.2.5.2. Cultural aspect of performance management in project management

Project Management Institute (PMI) developed a PM model around nine knowledge areas. However, PMI recommends that although the PMBOK is generally accepted and there is widespread consensus regarding the value and usefulness of the nine knowledge areas, the knowledge and practices described cannot be applied uniformly on all projects. The ultimate responsibility in determining the appropriate requirements for a given project lies with the project management team (Carton, et al., 2008). Table 2.9 lists these knowledge areas:

It can be argued that in order to ensure that the FM requirements are met at the PM stage, the project manager must be able to apply PM's body of knowledge and the inherent qualities required, would be those as defined in PMI (2008). However, it is not within the scope of this research to test for the required competencies to successfully implement and deliver the project within the FM requirements.

Table 2.9. PMI nine knowledge areas (PMI, 2008)

Knowledge area	Description of required processes
Project integration management	Ensures that various elements of the project are properly coordinated
Project scope management	Includes all of the work required, and only the work required, to complete the project successfully
Project time management	Ensures timely completion of the project
Project cost management	Ensures that the project is completed within the approved budget
Project quality management	Ensures that the project will satisfy the needs for which it was undertaken
Project human resource management	Makes the most effective use of people involved with the project
Project communications management	Ensures timely and appropriate generation, collection, dissemination, storage, and ultimate disposition of project information
Project risk management	Is concerned with identifying, analysing, and responding to project risk
Project procurement management	Involves acquiring goods and services from outside the performing organisation

Bryde (2003) argues that the starting point for modelling PM performance is by making the distinction between project performance and project manager's performance. The project may be successful despite poor PM and vice versa (Bryde, 2003). Morris (2010) also makes similar observation and argues that project success is more important than project manager's success. This observation makes a clear distinction between structural and cultural aspects of performance management in the project environment. The following can be drawn from this argument:

- Under certain circumstances the project deliverables can be achieved by properly developing and defining the project goals and objectives, choice of technology, approach to risk and contracting policy (delivery method). This forms the basis of the structural part of project management, which seeks to define the structure required to implement the project.
- Under certain circumstances the knowledge and experience of the project manager plays critical role in the project success.

These observations are important for the proposed PMF, in the first instance, it is implied that once the early FM deliverables are established, modelled and scheduled in the project processes, it is possible to deliver the project successfully without much input from the project manager. Alternatively, the ability of the project manager to apply the PM knowledge is also important under certain circumstances. Therefore, the need to define project processes (or deliverables), as the proposed PMF seeks to do, is important and the ability of the project manager to apply the PM knowledge and models to integrate the project deliverable is also important in some instances.

In developing the Project Management Performance Assessment (PMPA) model, Bryde (2003) adopted a quality management concept in the form of European Foundation for Quality Management (EFQM) model to form PMPA model as shown below:

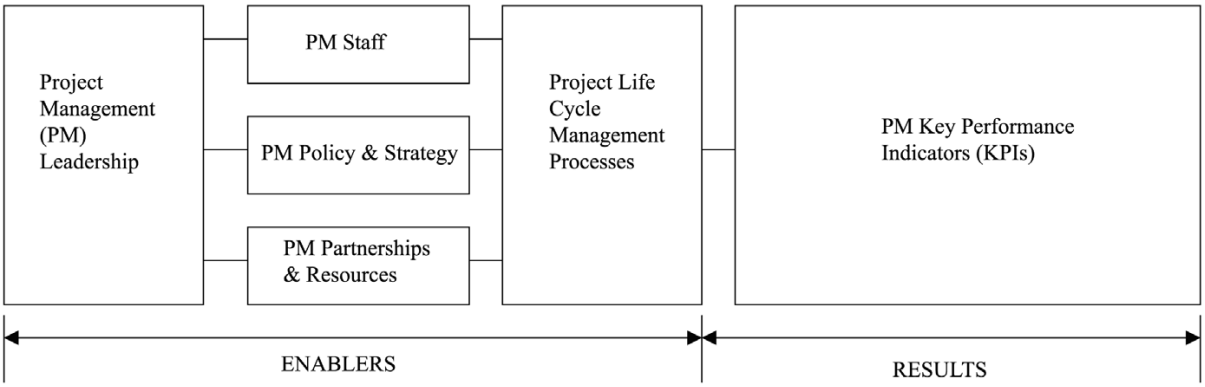

Figure 2.6. PMPA model [Source: (Bryde, 2003)]

Bryde (2003) studied PM practices in organisations and obtained the attitude and opinions of those involved in projects against the six criteria as set out in the PMPA model, and the potential of the model as a tool to assess PM performance was explored.

The survey results of the study shows different characteristics of PM performance against each of the six elements of the project management performance assessment (PMPA) model as summarised below (Bryde, 2003):

1. *"PM leadership:*

   Findings:

   - level of awareness of broad role of projects in managing all types of change;
   - degree to which project involvement influences a pm focus on "hard" projects at the expense of "soft" projects;
   - level of development of some features of a "projects culture";
   - ability to counter ripple effect of the absence of one feature of a projects culture on the existence of another feature; and
   - degree to which project environment hinders development of projects culture.

   Discussions

   These findings show that the ability of the project manager to provide leadership in terms of cultivating the correct performance culture and integrating the requirements from all the stakeholders is crucial. No amount of models can take away the role played by the project manager, especially when it comes to performance measurement and management as already discussed.

2. *PM staff:*

   Findings

   - level of recognition of the role of PM, related processes in increasing capability of PM staff; and
   - existence and operation of processes for developing and evaluating PM staff.

   Discussions

   It is important to realise that the project outputs are delivered upon by people. The importance of selecting the right team for the task at hand cannot be ignored. As already discussed, 70 percent of performance management systems fail, impart due

to the failure to manage the cultural aspect PMS, which include human resource development. Therefore, it is important that measures are put in place to evaluate human resources capabilities in order to identify areas of development, and allowing appropriate intervention to be made.

3. *PM policy and strategy:*

   Findings

   - level of recognition of need for continuous PM awareness raising and selling;
   - degree to which PM is introduced in a planned, formal fashion; and
   - ability to recognise and overcome PM-specific barriers to change.

   Discussions

   Once the goals and objectives of the project are defined, the PM policies and strategies can be determined. Again, as discussed, FM and performance management are linked to organisational goals. Similarly, PM should be linked to goals that can be objectively measured, and the proposed PMF identifies and defines these goals, related to FM.

4. *PM partnerships and resources:*

   Findings

   - degree to which partnerships are formed with project stakeholders, including internal customers and suppliers; and
   - existence and operation of processes for formalising the involvement of project stakeholders.

   Discussions

   The involvement of FM at the development stage of any facility requires partnerships to be formed in a meaningful way, in order to allow for the exchange of information. Plans for engagement must be developed in order to define the rules and set up processes of engagement.

5. *Project life cycle management processes:*

   Findings

   - character and uses of models of critical business process through the project life cycle;
   - ability to recognise role of life cycle models in developing features of a projects culture and to counter ripple effect of absence of particular process on the development of a projects culture;
   - design and operation of processes and written procedures covering all stages of the project life cycle, including pre- and post-implementation stages; and
   - degree to which processes and procedures are updated and benchmarked.

Discussions

The project processes as defined by PMI should cater for the inclusion of early FM requirements, as is defined by the proposed PMF. Although there may be other PM models, for the purpose of this research the PMI model is adopted, as already discussed. Most of the South African PM organisations also adopt the same model. Should it be desirable to use other models this will not have any impact since all these models are "phase" based with associated processes. The proposed PMF provides the project manager with the model to define early FM requirements.

6. *PM KPIs:*

Findings

- degree to which methods are developed to manage the important PM KPIs;
- ability to link methods for managing project objectives to the delivery of project benefits post-implementation;
- design and operation of methods for measuring stakeholder perceptions; and
- ability to develop methods against a wide range of KPIs, in particular those relating to increases in organisation capability".

Discussions

This research sought to define the KPIs for early FM involvement. It is anticipated that these KPIs will also form part of the PM's KPIs and that the project team will develop methods to link these KPIs with other project objectives.

In summary, this model provides an integrated approach towards assessing the overall PM capability; both the structure and culture are catered for in the model. Furthermore, as discussed in each element of the model, these elements can be considered for successful implementation of the proposed PMF in projects.

2.2.5.3. Conclusions

This section discussed the literature review around PM. The background and developments in PM were discussed. Performance management in PM was also discussed with a clear distinction being made between the required project manager's attributes and available project management models. The ultimate goal is to integrate the proposed early FM involvement PMF in the overall PM models and processes.

2.2.6. Available Early FM involvement frameworks

This section sought to explore some of the available frameworks for early FM involvement.

2.2.6.1. Barriers model (Meng, 2013)

Meng (2013) alludes to existence of barriers to early FM involvement and provide the model to overcome these barriers. In order to overcome these barriers, Meng (2013) argues that the benefits to key stakeholders must be identified and communicated properly. As shown in the model below, these benefits (measures to overcome barriers) may be represented in terms of KPIs, and for the purpose of this research these KPIs will be as defined in the proposed PMF for early FM involvement. The KPIs can be used to highlight any potential challenges or benefits based on the industry norms obtained either through practice or benchmarking.

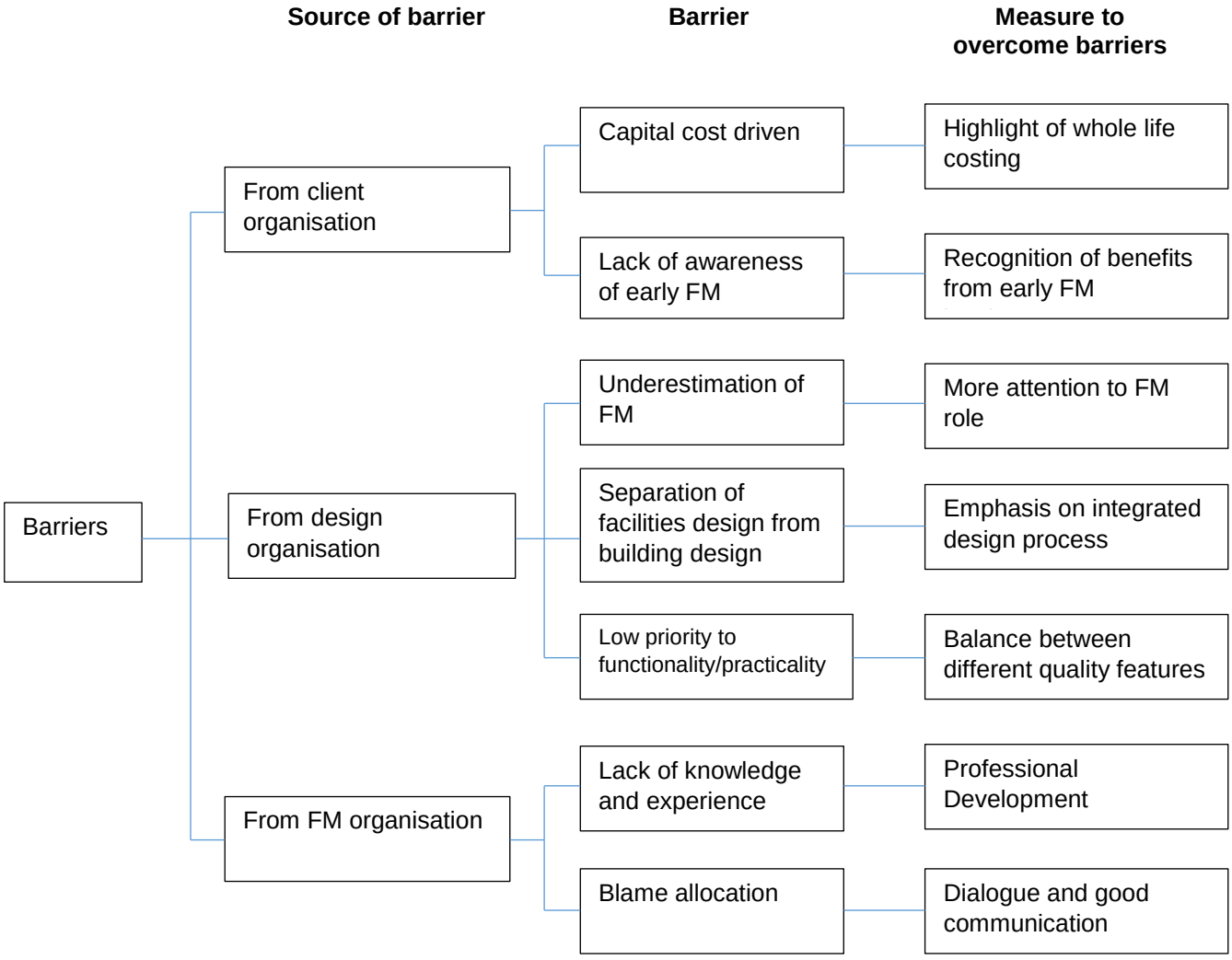

Figure 2.7. Model to overcome the barriers to early FM involvement in design [Source: (Meng, 2013)]

Meng (2013) also identifies the key stakeholders and the benefits when early FM involvement is implemented as follows:

Client

- Reduction in operating and maintenance costs because of the achievement of a better building, which can be operated and maintained more efficiently and effectively;
- More emphasis on the whole life cost rather than focus on the capital cost, especially when a client is the end client;
- Identification and avoidance of potential problems in advance; and
- More likelihood to meet the client's requirements and expectations.

Facility Manager

- Making it easier to operate and maintain facilities and provide services by selecting appropriate materials, equipment, and technical solutions;
- Better knowing whether the FM contract can be fulfilled successfully in the future and what the FM performance outcome will be;
- Minimizing or avoiding residual risks, e.g., the risk in relation to cleaning windows where access is extremely difficult; and
- Collaborating with client and designer and bringing the project team together.

Designer

- Identify design flaws in advance;
- Achieve more accurate results during design;
- Improve the operability, maintainability, and serviceability of designed facilities; and
- Encourage sustainable practice, e.g., energy saving.

Meng (2013) also argues that in theory FM practitioners may get involved in any project, however research shows that some projects are better suited for early FM involvement than others. The results of Meng (2013) show that the Private Finance Initiatives (PFI), which is a form of Public Private Partnerships (PPP), are such projects that lend themselves easily to early FM involvement. This is as a result of the project delivery method used in these arrangements, which include among others, Built Operate Transfer (BOT), Build Own Operate Transfer (BOOT). In PFI projects the project company takes a single point of responsibility for design, construction and operation. The results of the study are presented in Table 2.10:

Table 2.10. Types of projects suitable for Early FM involvement (Meng, 2013)

Comparison	Situations that are more suitable for early FM involvement	Percentage of interviewees who identified suitability (%)
PFI versus non-PFI projects	PFI project	67.7
New build versus refurbishment projects	Refurbishment project	35.5
In-house versus outsourced FM	In-house FM	25.8
End user versus non-end user clients	End user client	19.4
Large and complex versus small and simple projects	Large and complex project	16.1

The model presented by Meng (2013) has its limitations, as its main intended use is to overcome barriers from identified key stakeholders. The challenges for early FM involvement are only limited to general descriptions of “measures to overcome barriers”. Within these general description of “measures to overcome barriers”, there may be a number of issues that can be addressed and will also depend on the experience and knowledge of both the PM and FM practitioners.

2.2.6.2. Engagement of FM in design stage through BIM

According to Ying *et al*. (2013), BIM is an effective tool to engage FM during the design stage. Although the authors acknowledge other FM work such as space planning, the frame work developed only identifies three FM areas:

- Maintenance and repair – decisions made during the design stage affect all aspects of maintenance; therefore, participation of maintenance practitioners during the design stage is crucial (Ying, et al., 2013). Within this area (maintenance and repairs) there may be various elements that can be modelled during the early FM involvement, however only a few are identified in this paper.
- Energy management – different energy savings opportunities may be identified and explored in early design stages (Ying, et al., 2013).
- Commissioning – this ensures that the new building or system begins its life cycle at an optimal productivity. Coordination of information sharing happens in this stage (Ying, et al., 2013).

This framework discusses only three aspects in relation to early FM requirements. There is no clear attempt to define the financial aspects of the facility and actual deliverables within the identified areas.

2.2.6.3. Building Information Modelling

Building Information Modelling (BIM) in its simplest form is 3D Computer Aided Design (CAD) and associated building information used particularly during the design stage to share design information with various stakeholders. Traditionally, building designs were reliant on two dimensional drawings, BIM extends 3D plans to included crucial information such time, cost and building information.

Currently, there is a lot of research literature on the integration of PM and FM stages through the use of BIM (Underwood & Isikdag, 2011); (Ying, et al., 2013); (Whyte, 2012). The philosophy advocates for a central system through which all the lifecycle activities of a building may be managed. The following are some of the acronyms associated with BIM (Liu & Issa, 2013):

- *4D BIM* – the acronym is used to define the extension of 3D CAD to include aspects of time and scheduling information related to the elements in the model.

- *5D BIM* – the acronym is used to define the extension of 4D BIM to include aspects of costs related to the elements in the model. It should be noted that these costs are related to the capital costs of the facility.

- *6D BIM* – is advocated as the lifecycle management model. It links the 3D model with all aspects of lifecycle management information. The information assists FM during the operational stage. However, there is an ongoing research on the implementation of lifecycle management in BIM as discussed.

In general, BIM does make provision for FM requirements to be made, and these include all the building and equipment attributes such as serial numbers, maintenance and operational manuals, equipment data and so on, and these are configured in the BIM during the PM stage and handed over through a centralised model to FM during the operational stage for management. The challenge with available BIM tools is that each developer has its own proprietary structure of information, which poses a challenge of standardisation of FM requirements. However, as already discussed, there is a lot of research being undertaken to address issues associated with BIM and includes the following (Whyte, 2012):

1. *"BIM, lifecycle and sustainability* - In some countries adoption of BIM policy is motivated by reduction in carbon production (environmental impact, waste management). But available digital technologies to address issues of sustainability are not well developed. FM related issues such as as-built, facilities management and maintenance and lifecycle of facility related systems.

2. *BIM in Design and Construction* - research on issues related to the use of BIM at the early stage of design, construction sites such as assembly of buildings on site, construction health and safety.

3. *BIM Technologies* - research on development of new technologies, integration and interoperability of different systems (integration, naming and code checking, semantics, modelling, data capture, Geographic Information System)

4. *Using BIM* - research on the impact of BIM on Economy, Political and social, attitudes and implementation, and education

5. *Professions and BIM* - research on the implication to various professions and the changing roles that may result from the use of BIM."

The research on BIM lifecycle and sustainability management (6D BIM) is closely related to this research. According to Whyte (2012), the research on both sustainability and FM (lifecycle management) addresses assessment of the following:

Sustainability: environmental impact, consideration for waste management, guidance to designers on environmental issues and response to a government strategy for carbon reductions in both the current and future building stock.

FM and lifecycle: the research on this topic addresses issues around as-built drawings, facilities management and maintenance, lifecycle for a particular material such as concrete, building services (e.g. Heating and Ventilation and Air Conditioning (HVAC)), renovation and reconstruction and waste management and minimisation.

Therefore, although BIM is posed to be the future, there are some challenges and ongoing research with its implementation. Its successful deployment requires government involvement through regulation, adoption by the built industry and support from clients and building owners.

2.2.7. Hypothesis 2 (H2)

Various KPIs used in FM were identified and discussed. Available models for early FM involvement were also identified and discussed. The models reviewed in the literature are not comprehensive in covering all the requirements of early FM involvement. Most of the KPIs defined during the operational stage, and that are perceived to be affected at the PM

stage are not included in the early FM models reviewed. In addition, the aspect of BIM that addresses FM and lifecycle management is still under research and development (R&D). Similarly, the adoption of BIM in South Africa is still lacking in comparison to develop countries.

Therefore, it is hypothesised that there is a need for a comprehensive PMF that defines the requirements of early FM involvement within the South African context. According to Lam *et al*. (2010:293-294), numerous authors agree that the traditional success measures in projects, namely, time, cost and, performance (quality, health and safety) still remain relevant. Therefore, the categorisation of the KPIs proposed for the PMF will also adopt the same structure, since the PMF is intended to be used during the PM stage.

The categories defined for the PMF are presented in Table 2.11 and compared with the traditional project management performance management triangle. The categories for the PMF were derived from a combination made from other frameworks as presented in Table 3.

The identified list of KPIs for the proposed PMF is presented in Table 2.12. The KPIs were also determined from the FM models as presented in Table 2.3 and other available early FM models as discussed.

Table 2.11. Categorisation of KPIs for early FM involvement

Traditional Project Management Categories	PMF Categories	Description
Time	*Time*[1]	The degree to which the project is delivered within the schedule. Timely delivery has benefits for both the PM and FM. At the PM stage, timely completion results in less resources being wasted and may be re-allocated to other projects. At the FM stage, timely completion may also result in cost saving.
Costs	*Financial indicators*	These KPIs are associated with the facility costs. These costs can be determined at the design stage and as result enabling FM and the client to adopt the appropriate strategy for the facility.
Performance (Quality, health and safety, environmental and social impact)	*Strategic indicators*	These KPIs set the overall basis for other indicators in other different categories. They define the facility model and performance requirements in general. Therefore, any decision taken under this category will impact on the design and FM strategy.
	Quality indicators	These KPIs are associated with the required quality for the facility.
	Environmental, Safety and Health, Social indicators	These KPIs defines the requirements for operational OHS, environment and social impact.
	Information management	These KPIs defines the requirements for data and information to be used at the operational stage.

Notes:

1. For the purpose of this research time is excluded in the empirical studies (i.e. survey), as it is assumed that time is a critical KPI for both PM and FM stages. It is a one dimensional measurement, in other words unlike other KPIs that are made up of multiple elements, time has only one measure, and has no variation other than the set duration.

Table 2.12. Proposed KPIs for early FM involvement

Category	Indicator	Description	Reference
Strategic	Built Area	As already discussed, the built area of a facility has two opposing effects: On the one hand, increasing the floor area creates a wide basis for the execution of maintenance and decreases the expense per square meter; on the other hand, large structures (high-rise buildings or a large portfolio of buildings spread out over a wide area), create functional and statutory requirements for infrastructures (water reservoirs for water supply and fire protection, security, internal traffic, etc.), which influence the reinstatement value of the facility per square meter and increase maintenance expenditures of the facility. Based on FM experience, the built area can be optimised during the design stage to suite the FM strategy and intended operational requirements.	(Lavy, et al., 2010); (Shohet, 2006)
	Occupancy	This parameter reflects the facility's wear and tear rate. Therefore, this parameter will be used to define the facility design life (material and equipment selection) based on the intended occupancy. Therefore, FM strategy formulation based on lessons learned from practice can have input on material selection and equipment.	(Lavy, et al., 2010); (Shohet, 2006)
	Space planning	Proper space management, this can be influenced at an early stage of facility design to ensure functionality, accessibility and optimisation of the available space.	(Lavy, et al., 2010)

CONT'

	Indicator	Description	Reference
Strategic	Resource consumption – energy: (1) energy use: total facility energy use; or building energy use; (2) net energy consumption; (3) annual energy consumption; (4) total natural gas consumption; (5) building electrical consumption; or (6) building electrical demand, demand intensity, or peak electricity demand	(1) Total energy consumed by the entire facility, including stored fuels or gases; energy consumed in the process of heating, ventilation, and air conditioning, lighting, domestic hot water, plug loads, and other building energy use. This does not include process energy (energy consumed in manufacturing, industrial, or commercial activities) (2) Total facility energy use minus facility energy production (includes energy production and energy savings as a result of using energy star rated equipment and employing energy efficient efforts) (3) Total consumption of energy per year (4) Total natural gas consumed by the facility (5) Total building electricity consumption (6) Building electrical demand is the maximum amount of electricity that a building consumes at a given time Demand intensity is the maximum electricity consumption per unit area at a given time.	(Lavy, et al., 2010); (Shohet, 2006)
	Resource consumption – water: (1) water consumption; or (2) net water consumption	(1) Total building water use (2) Total water consumption minus reused, recycled and treated water	(Lavy, et al., 2010); (Shohet, 2006)
	Parking	Availability of parking space per person/occupant. Depending on the FM strategy, operational challenges with regard to parking can be forecasted and informed decisions made at an early stage of facility development. If parking fees are to be collected, cash generation can also be forecasted	(Lavy, et al., 2010)
	Security	Describes the condition of security and effectiveness of security measures. Depending on the site location and security risk assessment (fire, access, theft, damage to property), informed decisions can be made at an early design stage to determine the level of security required (technology and physical security).	(Lingard, et al., 2013); (Lavy, et al., 2010); (Shohet, 2006)
	Facility design life	This will influence the FM strategy, resources required (personnel, lifecycle costs, tools)	(Shohet, 2006)

CONT'

	Indicator	Description	Reference
Strategic	Site location	*Location*: proximity to homes and other community facilities; *Safety, sound and quality*: site is away from dangerous facilities like freeways, railroads, dams, airports, industries: traffic intersections and electric lines, level of external noise; *Accessibility:* good vehicular and pedestrian connections; *Contours:* slopes allowing minimal modification of site; *Utilities:* proper utilities connections.	(Lavy, et al., 2010)
	Selection of equipment and material	This parameter affects the maintenance efficiency and design life indicators.	(Lavy, et al., 2010); (Shohet, 2006)
	Availability of equipment	Maintainability of equipment within acceptable timeframes is vital in FM contracts. Service level agreement (SLA) revolve around time	(Lavy, et al., 2010)
	Efficiency of equipment	Energy usage and associated costs cannot be ignored. Most organisations are striving to reduce their carbon footprint and drive cost down in order to stay competitive.	(Lavy, et al., 2010)
	Availability of parts	Maintainability of equipment within acceptable timeframes is vital in FM contracts. Service level agreements (SLA) revolve around time, costs, and customer satisfaction.	(Lavy, et al., 2010)

CONT'

Category	Indicator	Description	Reference
Financial indicators (Lifecycle cost analysis)	Capital Cost	All costs required to purchase, upgrade or renovate facilities, to procure plant and equipment, and to operate the business or organization	(Lavy, et al., 2010); (Shohet, 2006)
	Operational Cost	All costs related to facility operation, such as insurance, air-conditioning, ventilation, overhead and wages, energy, fire protection, lifts and escalators, repair and maintenance, security, cleaning and garbage, sundries, and other expenses and fees	(Lavy, et al., 2010); (Shohet, 2006)
	Occupancy Cost	Total cost associated with building occupancy, from building occupation to disposal. It includes real estate and personal property taxes, insurance for the building and its contents, depreciation and amortization costs, etc. This may also be considered a subset of "operating costs"	(Lavy, et al., 2010); (Shohet, 2006)
	Maintenance Cost	Costs for labour (in-house or contracted-out) and materials required for building monitoring, inspection, repairs, maintenance, and response to service requests	(Lavy, et al., 2010); (Davis, et al., 2005); (Shohet, 2006)
	Utility Cost	Monthly or annual cost of utilities, including electricity, fuel oil, gas, steam, water, sewage, etc.	(Lavy, et al., 2010); (Shohet, 2006)
	Disposal Cost	The budget required for decommissioning, demolishing and disposal of the building, its systems, subsystems, and components	(Davis, et al., 2005)
	Residual Value	Anticipated reserve price of the facility at the end of life.	(Davis, et al., 2005)
Quality indicators	Accessibility	The degree with which the facility is accessible and prepared to accommodate various needs of various users (i.e. public, disabled, employees, maintenance personnel, etc.).	(Schraven, et al., 2011); (Lavy, et al., 2010)
	Convenience	This is closely linked with ease of accessibility and minimal use of resources, suitability to its functions. Facilities that are convenient results in high performance and minimal wastage of resources.	(Schraven, et al., 2011)
	Appearance	Exterior and interior visual qualities, harmony with surroundings, scale and proportion of spaces, and visual stimulation of the facility. Appearance of the facility in relation to corporate strategy, e.g. use for marketing purpose, etc.	(Schraven, et al., 2011); (Lavy, et al., 2010)
	Quality of life	The ability to deliver quality products and services to customers, effectiveness of their delivery, timeliness, and overall customer satisfaction with building, building services, and building systems. Characteristics of facility's site in terms of size, location, safety, sound and quality, accessibility, contours, preservation and development.	(Schraven, et al., 2011); (Lavy, et al., 2010)

CONT'

Category	Indicator	Description	Reference
Environmental, Safety and Health, Social indicators	The project team must carry out operational risk assessment and mitigation at a the development stage	Risk management; applicable to both PM and FM risks	(Lingard, et al., 2013); (Lavy, et al., 2010)
	The project team should design for both construction and operational hazard	Design for Construction and Operational hazard.	(Lingard, et al., 2013)
	Environmental impact	Measured in terms of indoor pollutants, noise, light, and ventilation; thermal comfort: air temperature, mean radiant temperature, humidity, and air speed; indoor air quality: fresh air distribution, restriction of mass pollution (gases, vapours, micro-organisms, smoke, dust, etc.); day lighting and views: views and natural day light through windows. Facility that is environmentally friendly and generating minimal wastage	(Schraven, et al., 2011); (Lavy, et al., 2010)
	Social impact	Social benefits	(Lavy, et al., 2010)
Information Management	Maintenance data	Original equipment manufacturer (OEM) maintenance information, required to develop maintenance management strategy.	(Ying, et al., 2013)
	Product data	Unique data that identifies the product.	(Ying, et al., 2013)
	As built information	This information is required to build structure on the IT platform provided for life cycle management	(Ying, et al., 2013)
	Equipment attributes	Equipment location, serial number, name plate	(Ying, et al., 2013)
	Quality of data	This aspects deals with lucidity, reliability, credibility and, usefulness of data.	(Blasini & Leist, 2013)
	Lessons learned from FM practice	Lessons learned from the operational stages that may be valuable.	(Wikipedia, 2014); (Chareonsuk & Chansa-ngavej, 2010)
	Lessons learned from PM practice	Lessons learned from the development stage that may be valuable.	(Wikipedia, 2014); (Chareonsuk & Chansa-ngavej, 2010)

2.3. Conclusions of the Literature Review

This section discussed the literatures around five topics considered to hinder early FM involvement, and therefore, affecting integration between PM and FM. These topics included definition of FM scope, the concept of performance management, performance management in FM with the intention of establish KPIs that can be managed at the design stage, project management and, available early FM models. Two hypotheses were generated from the literatures reviewed:

Hypothesis 1

- FM knowledge and experience forms crucial basis for the proposed PMF. The administration plan for early FM involvement relies heavily on the experience and knowledge gained from FM practice. This information (analytical information) may be generated by successfully implementing a PMS in FM during the operational stage

Hypothesis 2

- Available frameworks for early FM involvement do not comprehensively articulate early FM requirements. Further research as proposed herein is required and the KPIs as presented in Table 2.12 are proposed for this PMF.

CHAPTER 3: RESEARCH METHODOLOGY

3.1. Introduction

In chapter two, the literatures related to the research problem were reviewed, with the intention to generate hypotheses and answer the literature question (i.e. appropriate PMF for FM requirements at PM stage). This section defines the methodology to answer the empirical question and to validate the proposed PMF from the literatures reviewed.

This chapter will also define the strategy, instruments and processes used to gather and analyse data. In this study, "The strategies used" refers mainly to the research design, which is concerned with defining the research paradigm and the methods used in the research. It is generally agreed that there are two main approaches to educational research, quantitative and qualitative (Saunders, et al., 2012).

3.2. Research methodology

The aim of this research was to obtain opinions from the EBE professionals and practitioners on the wider issues that affect early FM involvement, as well as understanding individual experiences' pertaining to performance management in FM, therefore mixed method approach was adopted with the underlying theoretical framework being pragmatic paradigm. Both qualitative and quantitative methods were used in this research as one can make a number of observations and generate hypotheses, and then try to explain the different aspects of the problems in order to come to a practical solution for the problem at hand (Saunders, *et al.,* 2012:126-155).

Qualitative research is often criticised for the subjective nature of its data collection and analysis strategies, it is interpretive in nature, with a particular aim of obtaining in-depth, rich data and an explanation of psychosocial phenomena and social interactions (Saunders, *et al*., 2012:161-169). Two hypotheses were generated based on the qualitative analysis of literature. Although the qualitative research is criticised for subjectivity, the analysis and testing of the hypotheses generated was done using quantitative methodologies in order to eliminate the subjectivity of the qualitative research.

By contrast, quantitative research is associated with a deductive approach, where the focus is on using data to test a theory (Saunders, *et al.,* 2012:126-131). This is particularly important in testing the practicalities and validity of the proposed PMF as determined from the qualitative studies.

3.3. Research Design

Self-administered online survey through questionnaires and open ended interviews (see appendix A) was conducted in order to test and validate the literatures findings (hypotheses) and, to establish the importance and necessity of the proposed PMF. The questionnaire was divided into four sections which included, consent, respondent's demographic profile, ranking of the proposed KPIs, and completion of the interview questions.

The interview questions were developed to deduce the applicability of the proposed KPIs and interpretation of the participant's experience.

3.4. Population and sample

3.4.1 Population

As already discussed in the preceding section, facility's lifecycle is made up of project management (construction) and facility management (operation and disposal), professionals and practitioners in the construction and FM industries were selected as the stakeholders of the proposed PMF and were invited to participate in the research. The integration of both PM and FM stages depends mainly upon these two stakeholders hence the selection. The following observations were made regarding the population in both FM and construction sectors respectively:

According to Frost and Sullivan (2012), the outsourced FM market (in South Africa) in 2010 employed 6395. In 2014 this number was expected to rise to 7460. The population for this sector was obtained from SAFMA as the only recognised FM association in South Africa.

According to the Council for the Built Environment's (CBE) (2012) annual report 2012/2013, professional registrations in the following councils was standing at:

- Engineering Council of South Africa (ECSA) – 41 094
- South African Council for Project and Construction Management Profession (SACPCMP) – 3 192
- South African Council for Architectural Profession (SACAP) – 9 202

These figures include all professionals in the built environment and not necessarily in the construction sector. In order to obtain participants from the construction sector, members from the Green Building Council of South Africa (GBCSA) and Consulting Engineers South Africa (CESA) were sampled.

Interviews were also conducted with four members of two FM organisations to clarify some of the issues that came out of the online surveys with regard to challenges of early FM involvement. The criterion for selection was based on seniority in the organisation and availability.

3.4.2. Sample and sampling method

Saunders *et al.* (2012:259) define sampling as a process of selecting a small group of people to be a representation of the larger population to be studied. The authors argue that sampling offers a valid alternative to census, which may not necessarily provide more useful results than collecting data from a sample that represent the entire population. For practical reasons, and for the purpose of this study, sampling was also preferred as opposed to selecting the entire population in the EBE. This method was deemed suitable given the research objectives, and the following sampling method was used.

Sampling Method

The stratified random sampling method was used for this study in order to reduce the margin of error introduced by the element of respondent's bias and to improve the level of representation from various professions in the EBE. The respondents were drawn from four areas of practice in the EBE which included, construction project management, facilities management, engineering and architectural.

Sample

According to Ghyoot (1994) and Saunders *et al*., (2012:260-266) sampling is a complex matter that requires many considerations. Some of the problems identified include:

- Large samples are prohibitively expensive in terms of time and money.
- The appropriate sample size depends on the purpose of the research and the variability of population characteristics. This variability is often not known beforehand.
- The formulae given in textbooks assume that a simple random sample is taken. This is frequently not the case.
- to illustrate how the purpose of the research affects sample size, Ghyoot (1994:12-14) provides the following examples:

  For the purpose of generating ideas for a new product or obtain feedback from customers, a sample of 30 may be sufficient.

  For the purpose of quantitative analysis, at least a sample of 100 should be obtained, even for calculating only percentages.

  Where subgroups are distinguished, each subgroup is required to have a large enough sample. When variables are to be cross tabulated, then larger samples are required, at least 300 minimum.

Similarly, Saunders *et al*., (2012:265-266) note that statisticians have shown that a sample size of 30 will results in a sampling distribution for the mean that is closed to normal distribution.

As already defined, the purpose of this research is to solicit professional opinions on the proposed PMF, therefore, as suggested by examples in Ghyoot (1994:12-16) and Saunders *et al*., (2012:265-266), a sample size of 30 was deemed probably sufficient for this study. Appropriate distribution sample was then determined by using the formula from Saunders, et al., (2012:269) as follows:

$$n1 = \frac{n \times 100}{re\%} \qquad (1)$$

where;

n1 is the actual sample size required,
n is the minimum sample size,
re% is the estimated response rate expressed as a percentage.

According to Saunders *et al*., (2012:269) when data are collected from secondary sources, the response rate can be as high as 100% since data are collected from existing records. However, estimating the likely response rate from the sample to be surveyed is more difficult and one way of obtaining an estimate is to consider the response rate of a similar survey conducted.

Saunders *et al.,* (2012:269), suggest response rates of between 10 and 50 per cent for postal questionnaire survey. Business surveys had response rates as low as 10 to 20 per cent for postal questionnaires, questionnaire fatigue was found to be the contributory factor.

Therefore, based on these observations a conservative survey response rate of 25% was chosen. And based on this response rate and a minimum of 30 responses as determined (i.e. minimum sample), the required survey distribution was determined as follows:

$$n1 = \frac{30 \times 100}{25\%}$$

= 120

This distribution sample size was divided as follows among the different professions spanning the four areas of practice in the built environment as already discussed:

- Facilities Management - 30 respondents
- Construction Project Management - 30 respondents
- Engineering - 30 respondents
- Architectural - 30 respondents

Therefore, based on the response rate of 25%, a minimum of 30/4 = 7.5 (8) responses is required per each professions to ensure equitable representation.

3.5. The research instrument

The online survey design was used to conduct the research, with the use of closed-ended questionnaire as the main data collection technique supported by individual semi-structured interviews. Consequently a semi-structured questionnaire was adopted

These instruments were chosen for the following reasons:

Questionnaires

The purpose of the questionnaire was to be able to prove the two research hypotheses. Since the purpose of the research was to obtain professional opinions among professionals and practitioners in the EBE, a Likert scale was adopted for the ranking of KPIs. Likert scale is considered an attitude measure with a bipolar response scale, in which respondents are asked to rate the extent to which they agree or disagree with a statement intended to capture positive or negative aspects of the attitude object (Sturgis, et al., 2014). The ranking of KPIs used a five point multiple rating Likert scale, asking the respondent to rate KPIs in terms of their significance, with 5 being very significant, and 1 being very insignificant. Likert scales produce interval data, and are potentially more reliable and provide a greater volume of data than other scales (Cooper & Schindler, 2008)

A sixth scale (i.e. Not Applicable) was introduced in the Likert scale, to afford respondents an opportunity to indicate when the proposed KPI was not applicable in their opinion. A “not applicable” (N/A) option is not considered a neutral response, since a neutral option indicates an equal distribution of an opinion on both sides of the scale. In this instance, a N/A option indicates that the KPI should not be considered for the PMF. Although it may be argued that a less significant rating (i.e. 1) could serve the same purpose, it is the contention of this research that the N/A option will be treated as a missing data and hence would arrive at a different conclusion. This is also done to avoid coercive ranking by the respondents in that the respondents are given the freedom to exercise their opinions when they feel strongly that the KPI is not applicable.

For the purpose of results interpretation, the coding of the Likert scale ranking was as follows:

Rank	*Weighting*
• Strongly disagree	1,
• Disagree	2,
• Neutral	3,
• Agree	4,
• Strongly agree	5.

According to Saunders *et al.* (2012:419-423) and Niomachioma123 (2015) the advantages and disadvantages of questionnaires are listed below:

The advantages of questionnaires

1. Practical
2. Large amounts of information can be collected from a large number of people in a short period of time and in a relatively cost effective way
3. Can be carried out by the researcher or by any number of people with limited affect to its validity and reliability
4. The results of the questionnaires can usually be quickly and easily quantified by either a researcher or through the use of a software package
5. Can be analysed more 'scientifically' and objectively than other forms of research
6. When data has been quantified, it can be used to compare and contrast other research and may be used to measure change
7. Positivists believe that quantitative data can be used to create new theories and / or test existing hypotheses

The disadvantages of questionnaires

1. Is argued to be inadequate to understand some forms of information - i.e. changes of emotions, behaviour, feelings etc.
2. Phenomenologist state that quantitative research is simply an artificial creation by the researcher, as it is asking only a limited amount of information without explanation
3. There is no way to tell how truthful a respondent is being
4. There is no way of telling how much thought a respondent has put in
5. The respondent may be forgetful or not thinking within the full context of the situation
6. People may read differently into each question and therefore reply based on their own interpretation of the question - i.e. what is 'good' to someone may be 'poor' to someone else, therefore there is a level of subjectivity that is not acknowledged
7. There is a level of researcher imposition, meaning that when developing the questionnaire, the researcher is making their own decisions and assumptions as to what is and is not important. Therefore they may be missing something that is of importance

Based on the advantages listed with the use of questionnaires, it was deemed a suitable instrument for this research for practical reasons such as limited time, large amounts of data to be collected and the ease of distribution to prospective respondents.

Some of the disadvantages listed with the use of questionnaires were counteracted by the use of statistical methods of interpreting the results. Weighted average mean was used to determine the mean of the KPIs ranking in order to measure the degree of consensus. Fleiss' kappa was also used to test the reliability of the responses, and thus providing the opportunity to gauge random ranking.

3.6 Procedure for data collection

Before administering the survey, a pilot survey was conducted among four academic colleagues. After responding to the survey, the questionnaires were re-evaluated to correct some of the information in the personnel profile, and interview section. The following issues were found with the pilot survey:

- Additional column was included under the respondent's profile. The column included was the respondent's department. This information was used to determine a link between respondent's position and profession.

- The number of interview questions was increased from two to five. The questions were repeated in a different format whilst testing the same hypotheses. This was done in order to improve the reliability and validity of the responses. An "additional comments" row was also added to provide respondents with an opportunity to provide additional comments which could assist this research.

The survey was administered over the internet; with requests for survey participation being sent via emails as well as web links posted on social networks (in particular LinkedIn accounts) with the research invitation attached.

The list of eligible participants was compiled as per the sample identified, complete with contact details (emails as obtained from the online sites of identified organisations and associations).

Online "Surveymonkey" was adopted as the platform for survey collection and management. This is an online platform available through subscription. Potential respondents were not required to subscribe and were able to access the site via a link that was generated specifically for this survey. Interviews were also conducted to reinforce the survey results. The criterion for selection was based on seniority in the organisation and availability.

Secondary data were obtained from relevant FM associations, company's policies, relevant research literature, seminar papers, annual reports, magazines, newspapers and journals.

3.7. Data analysis and interpretation

Data were collected and uploaded electronically for analysis. Statistical mathematical methods, which included weighted average and Fleiss' kappa methods, were used for analysis and interpretation of the survey responses. Weighted average was used to assess which answer choice was most preferred overall (i.e. proportional representation) and the Fleiss' kappa method was used to assess inter-rater reliability (IRR, also called inter-rater agreement). In this way, the results of the proportional representation were corrected for chance rating and thus improving the reliability of the results.

Fleiss Kappa is said to be a generalised form of Kappa, whereas Cohen Kappa is used to measure inter-rater agreement when there are two raters, Feiss' Kappa is an extension of Cohen Kappa where there are more than two raters. However, according to Gwet (2011), Fleiss' generalised kappa is not a Kappa but a generalised version of Scott's pi coefficient. To support this argument, Gwet (2011) suggests that the Fleiss' coefficient does not reduce to kappa when the number of raters is reduced to two. However, Gwet (2011) does not dispute that Fleiss kappa can be used to measure inter-rater agreement where there are more than two raters. Therefore, Fleiss kappa was used to measure IRR for this research as there were more than two raters.

The formula to calculate Fleiss kappa is as follows, where factors;

"1 – $P_e$bar" gives the degree of agreement that is attainable above chance, and
"Pbar – $P_e$bar" gives the degree of agreement actually achieved

$$k = \frac{Pbar - Pebar}{(1 - Pebar)} \quad (2)$$

The following interpretation was used to assess the results:

The weighted average per each KPI was calculated as follows where:

w = weighted ranked position
x = response count for chosen answer

$$Weighted\ Average = \frac{x1w1 + x2w2 + x3w3 \ldots\ldots xnwn}{Total\ response\ count} \quad (3)$$

With the average score being determined as 3 (i.e. {1+2+3+4+5}/5). Therefore, any ranking above three will be interpreted as positive.

And the Fleiss kappa was interpreted based on Table 3.1.

Table 3.1. Interpretation of Fleiss kappa

K	Interpretation
< 0	Poor agreement
0.01 – 0.20	Slight agreement
0.21 – 0.40	Fair agreement
0.41 – 0.60	Moderate agreement
0.61 – 0.80	Substantial agreement
0.81 – 1.00	Almost perfect agreement

It should be noted that there are debates among researchers about the interpretation of this table (Gwet, 2011).

3.8. Limitations of the study

- The results obtained were more reflective of the organisations and individual respondents involved and not necessarily the whole FM and built industry.
- Lack of local FM information and maturity is seen as one of the greatest limitation for this study.

3.9. Validity and reliability

It is noted that the two elements are interdepended and crucial in determining the quality of the results. Although reliability can be achieved without validity, the opposite is not the case. This can be explained as follows; although the respondents may be reliable in their response, the entity being measured or tested may not necessarily be correctly defined. As a result, throughout the development of the survey these facts were always considered.

3.9.1. Validity

The validity of the results is addressed by the following:

- *Hypothesis 1*: online survey was used to obtain opinions from the respondents. Based on these responses, follow up interviews were conducted with four executives from two companies in order to probe the hypotheses extensively and understand the practical implications of the research proposal. The executives were interviewed based on their availability. There were no specific selection criteria other than the level (i.e. executive) in the organisation, and this was considered a reliable source to validate the findings of this research.

- *Hypothesis 2*: The framework has been developed from extensive literature review and the survey was meant to validate the literature findings. Therefore, the findings of the research literature around FM KPIs have already been tested and the concern around validity of the KPIs was considered to be negligible. This research only sought to identify and filter early FM KPIs for the proposed PMF from those already defined for FM in general. In addition, other KPIs defined for early FM involvement by other researcher were incorporated in the proposed early FM PMF.

3.9.2. Reliability

Two methods were used to ensure the reliability of the research. Firstly, the participants for the study were required to be at a senior level in their chosen profession; therefore, three levels of management were targeted for the study sample.

1. The executive level – is mainly concerned with the planning and strategy to implement the PMS.

2. The senior management - is directly accountable for the implementation and monitoring of performance. EBE professionals are also found in the level

3. The middle management is directly accountable for the implementation and monitoring of performance. EBE professionals are also found in the level

It was anticipated that the quality (years of experience and knowledge) of the respondent would improve the reliability of the study.

As already discussed in Section 3.7, statistical methods were also used to test the reliability of the opinions expressed by the respondents.

CHAPTER 4. PRESENTATION OF RESULTS

4.1. Introduction

This chapter presents the key findings of the survey and interviews conducted regarding the proposed PMF. A total of 120 questionnaires were distributed among the selected sample, and a total of 32 questionnaires were returned. This number included nine incomplete responses as discussed later in this chapter. Although in Saunders *et al*. (2012:267-277) argument is made that incomplete responses may increase the level of bias, this did not impact the overall results as the random stratified sample was adopted with the intention to reduce the bias level of this research. Moreover, this research anticipated that there may be a lower response rate than predicted as discussed in Saunders *et al*. (2012:269-270), and as a result oral interviews were conducted with four representatives from the FM organisations as already discussed, in order to improve on the consistency of the survey results. Although the interviews were conducted within FM organisations, it should be noted that these organisations have PM and design departments, and as results it was expected that the interviewees would have broad knowledge on the research variables.

General overview of the response pattern:

- Seven respondents opted out
- Eleven emails bounced back
- Nine incomplete questionnaires were returned. Different respondents had different sections not being completed. Some of the data in these questionnaires were used.
- Twenty three questionnaires were fully completed.

In total, 34 KPIs were identified for the proposed PMF. It is important to note that the KPIs identified in this research represent the perceptions and views of the author and the industry participants who were consulted during the research.

This section is split into five sections as follows:

1) Respondent's profile: years of working experience, respondents per profession, and respondent's geographical location.
2) Interview responses pertaining to hypotheses 1 and 2.
3) Ranking of identified KPIs.
4) Summary of the oral interviews.
5) And lastly, the conclusions.

4.2. Results

As already discussed, the online survey results are presented in this section, which include respondent's profile (i.e. years of working experience, profession and, geographical area), interview responses related to hypotheses 1 and 2, and the ranking of KPIs.

4.2.1. Respondent's Profile

The respondents had over five years of work experience. As originally planned, the targeted respondents were three levels of management, which included executive, senior and middle management, and the results reflect this sample planning. Four respondents did not complete this section.

Table 4.1. Respondent's years of working experience

Years of work experience	Count	Percentage
Missing data	4	13%
1-5	0	0%
6-10	8	25%
11-15	6	19%
16-20	6	19%
above 20	8	25%
Total	**32**	**100%**

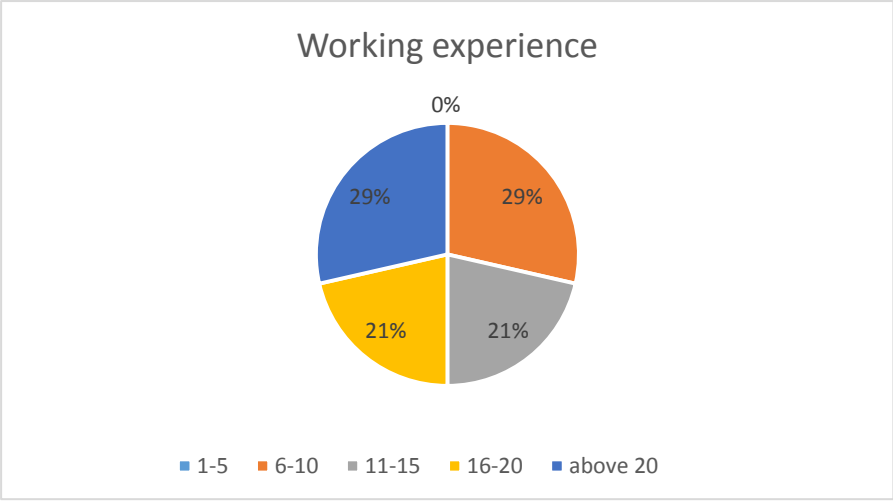

Figure 4.1. Graphical representation of the respondent's working experience

Distribution of responses according to profession is presented in Table 4.2 and Figure 4.2. As can be observed, most of the respondents were from Engineering, FM, PM and Architectural professions respectively. Out 32 received questionnaires, one respondent skipped this section.

Table 4.2. Responses according to respondent's profession and geographical location

Profession	Distributed	Count	Response
Facilities Management	30	10	33%
Project Management	30	6	20%
Engineering	30	11	37%
Architectural	30	4	13%
Total	**120**	**31**	**103%**

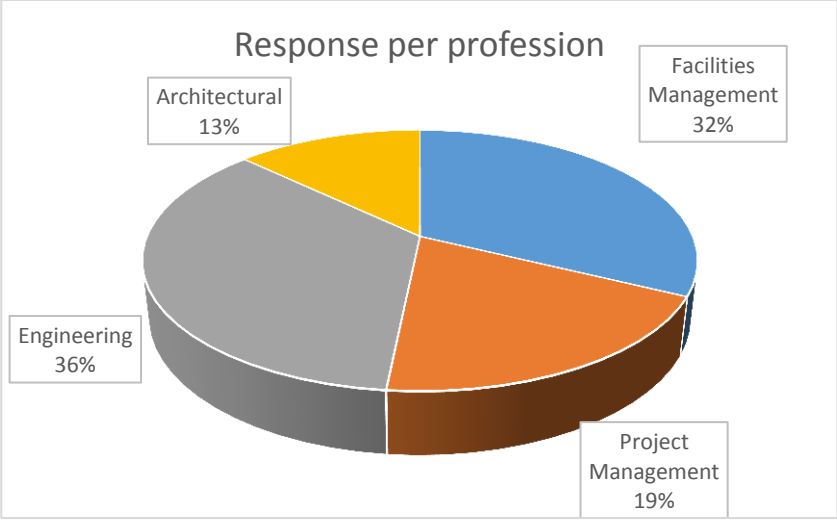

Figure 4.2. Graphical representation of the respondent's profession

The geographical area of respondents is presented in Table 4.3 and Figure 4.3 in order of the response rate. Most of the questionnaires received were form Gauteng.

Table 4.3. Geographical profile of respondents

Region	Count	Percentage
Gauteng	22	69%
Western Cape	4	13%
North West	2	6%
Kwazulu Natal	2	6%
Botswana	1	3%
Bogota	1	3%
Total	**32**	**100%**

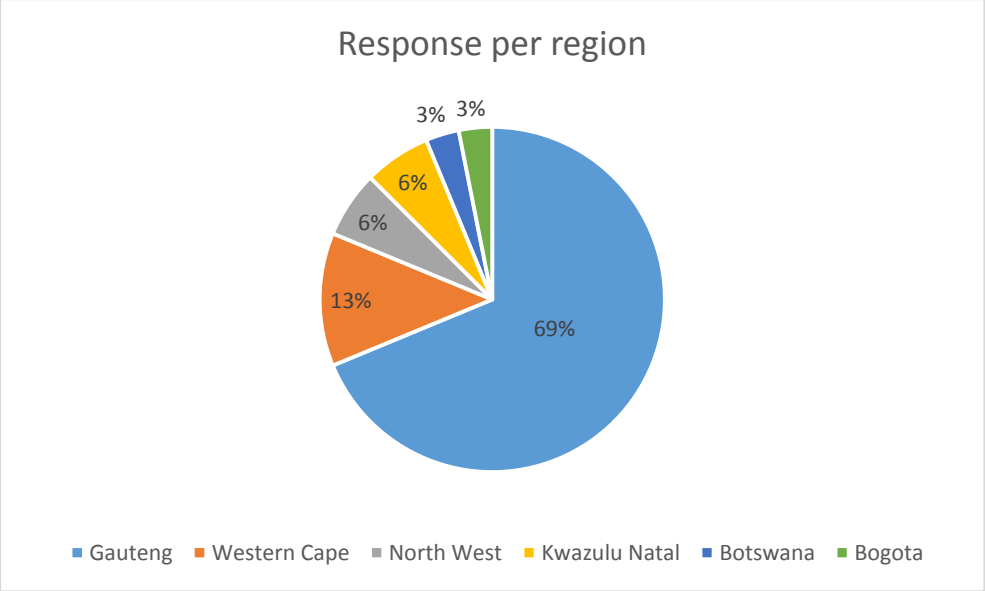

Figure 4.3. Graphical representation of the respondent's geographical area

4.2.2. Interview response on the proposed PMF

The results related to hypothesis 1 are presented in Table 4.4 and Figure 4.4. These questions were designed to assess the need for the proposed PMF. Based on the literatures review, it was discovered that there is a need for a comprehensive framework for early FM involvement and these results prove this hypothesis.

Table 4.4. Results for the interview questions related to hypothesis 1

Interview Question	Agree	Disagree	No opinion
PMF is needed for the management of early FM requirements	17		2
Most of the challenges encountered in FM stage maybe directly linked to design stage	13	6	1
Total	**30**	**6**	**3**

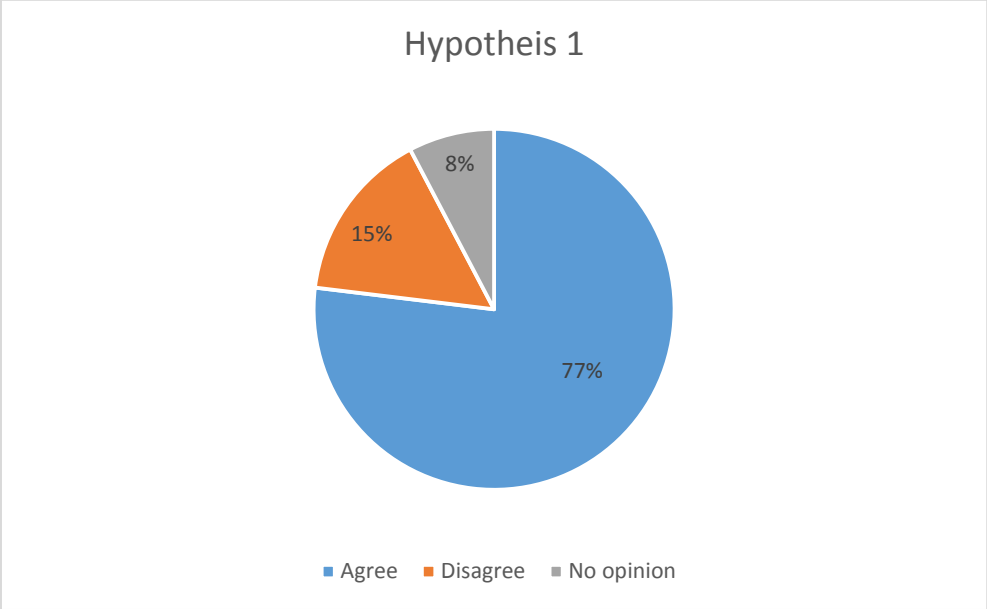

Figure 4.4. Graphical representation of the interview responses for hypothesis 1

The results pertaining to hypothesis 2 are presented in Table 4.5 and Figure 4.5. The interview questions were designed to assess the importance of knowledge management during the FM stage. The results show that knowledge management is important in defining the KPIs for the proposed PMF, however most respondents do not agree that FM industry is in a position to manipulate available FM data to use in early FM involvement. This is a clear indication of the silo approach between the PM and FM stages as argued by this research.

Table 4.5. Results of the interview questions related to hypothesis 2

Interview Question	Agree	Disagree	No opinion
Do you think lessons learned from the FM stage can be used to set up targets for performance indicators for FM requirements during the project management stage; What other methods can be used to define FM requirements during the project management stage, Please explain.	15		1
Do you think that most FM organisations are positioned to generate data and convert to information that can be readily used to define optimum facility performance requirements that can be used by project managers?	6	9	1
Total	**21**	**9**	**2**

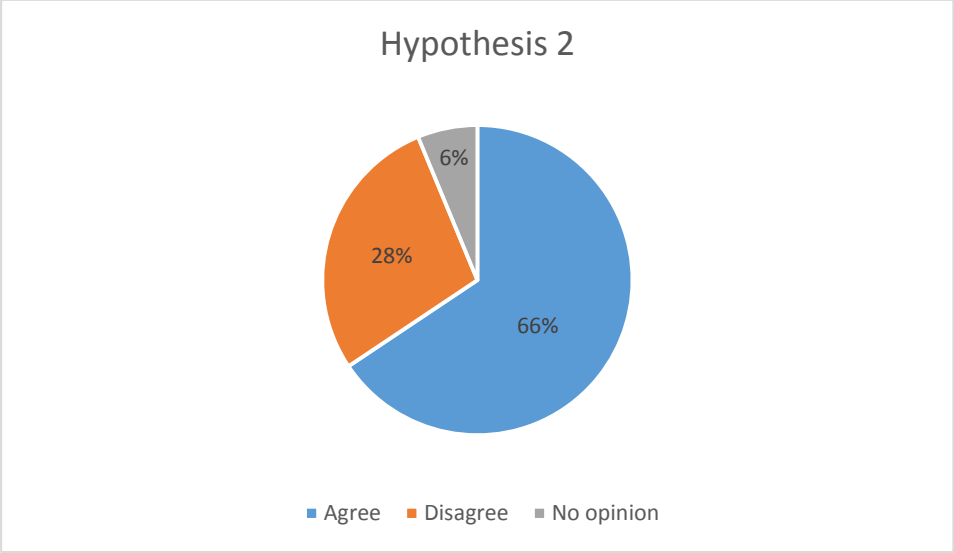

Figure 4.5. Graphical representation of the interview responses for hypothesis 2

In summary, this section presented the respondent's profile and interview responses, and the next section will present the results pertaining to the ranking of the KPIs for the proposed PMF.

4.2.3. Ranking of the proposed KPIs

The results of the proposed KPIs for the PMF are presented in Tables 4.6 to 4.10, as per the categorisations adopted. The categorisations include strategic, financial, quality, health and safety, environment and social impact, and lastly, Information management.

Table 4.6. Responses on Strategic KPIs

KPI - Importance of strategic decisions at project management stage on the effectiveness of facility.								
Answer Options	**Extremely Unimportant**	**Unimportant**	**Neither Unimportant Nor Important**	**Important**	**Extremely Important**	**N/A**	**Rating Average**	**Response Count**
Built Area (optimisation of maintenance and operational cost)	0	0	0	9	14	0	4,61	23
Occupancy (Impact on wear and tear)	0	1	1	14	7	0	4,17	23
Space planning	0	1	0	9	10	1	4,40	21
Energy Usage	0	1	0	6	14	0	4,57	21
Water Usage	0	1	0	10	10	0	4,38	21
Parking	0	1	3	10	7	0	4,10	21
Security	0	1	1	11	8	0	4,24	21
Facility design life	0	1	1	8	12	1	4,41	23
Site location	0	0	3	11	7	0	4,19	21
Selection of Equipment and Material	0	0	1	10	10	0	4,43	21
Availability of Equipment (Work hrs)	0	0	2	11	8	0	4,29	21
Efficiency of Equipment	0	0	2	10	9	0	4,33	21
Availability of parts	0	0	2	7	11	1	4,45	21

Table 4.7. Responses on Financial KPIs

KPI - Financial								
Answer Options	**Extremely Unimportant**	**Unimportant**	**Neither Unimportant Nor Important**	**Important**	**Extremely Important**	**N/A**	**Weighted Average Rating**	**Response Count**
Capital Cost	0	0	1	11	11	0	4,43	23
Operational Cost	0	0	0	6	16	0	4,73	22
Occupancy Cost	0	1	2	7	13	0	4,39	23
Maintenance Cost	0	0	0	7	16	0	4,70	23
Utility Cost	0	1	1	10	11	0	4,35	23
Disposal Cost	0	1	4	10	8	0	4,09	23
Residual Value	1	2	3	10	5	0	3,76	21

Table 4.8. Responses on Quality KPIs

KPI - Importance of the following Quality attributes to be managed at the project management stage								
Answer Options	**Extremely Unimportant**	**Unimportant**	**Neither Unimportant Nor Important**	**Important**	**Extremely Important**	**N/A**	**Weighted Average Rating**	**Response Count**
Accessibility	0	0	0	8	14	1	4,64	23
Convenience	0	0	1	15	6	1	4,23	23
Appearance	0	1	1	15	4	1	4,05	22
Quality of life (Lighting, HVAC, Noise, Air and Water quality)	0	0	0	4	18	1	4,82	23

Table 4.9. Responses on Health and Safety, Environmental and Social KPIs

KPI - Importance of Environment, Health and Safety, and Social impact								
Answer Options	**Extremely Unimportant**	**Unimportant**	**Neither Unimportant Nor Important**	**Important**	**Extremely Important**	**N/A**	**Weighted Average Rating**	**Response Count**
The project team must carry out operational risk assessment and mitigation at the development stage.	0	0	1	6	15	1	4,43	23
The project team should design for both construction and operational hazard	0	0	0	6	16	1	4,52	23
Environmental impact	0	0	0	7	14	0	4,67	21
Social impact	0	0	2	13	6	0	4,19	21

Table 4.10. Responses on Information KPIs

KPI - Importance of Information Management								
Answer Options	**Extremely Unimportant**	**Unimportant**	**Neither Unimportant Nor Important**	**Important**	**Extremely Important**	**N/A**	**Weighted Average Rating**	**Response Count**
Maintenance data	0	1	0	7	15	0	4,57	23
Product data	0	0	1	11	11	0	4,43	23
Equipment attributes (e.g. description, location)	0	0	0	12	9	0	4,43	21
Quality of data (usability)	0	0	2	8	11	0	4,43	21
Lessons learned from FM practice	0	0	2	5	15	1	4,39	23
Lessons learned from PM practice	0	0	2	7	13	1	4,30	23

Using an average score of 3 {(1+2+3+4+5)/5}, 34 KPIs were validated as a benchmark for the assessment of early FM involvement. The KPIs perceived as highly significant are presented in Table 4.11 in order of importance. These are all the KPIs which were categorised in different performance areas as presented from Tables 4.6 to 4.10.

Table 4.11. Perceptions on the proposed KPIs in order of significance

KPI	Weighted Average Rating	Rank.
Quality of life	4.82	1.
Operational Cost	4.73	2.
The project team should design for both construction and operational hazard	4.73	2.
Maintenance Cost	4.70	3.
Environmental impact	4.67	4.
Accessibility	4.64	5.
The project team must carry out operational risk assessment and mitigation at the development stage	4.64	5.
Built Area	4.61	6.
Lessons learned from FM practice	4.59	7.
Energy Usage	4.57	8.
Maintenance data	4.57	8.
Lessons learned from PM practice	4.50	9.
Availability of parts	4.45	10.
Selection of Equipment and Material	4.43	11.
Capital Cost	4.43	11.
Product data	4.43	11.
Equipment attributes (e.g. description, location)	4.43	11.
Quality of data (usability)	4.43	11.
Facility design life	4.41	12.
Space planning	4.40	13.
Occupancy cost	4.39	14.
Water usage	4.38	15.
Utility Cost	4.35	16.
Efficiency of equipment	4.33	17.
Availability of equipment	4.29	18.
Security	4.24	19.
Convenience	4.23	20.
Site location	4.19	21.
Social impact	4.19	21.
Occupancy	4.17	22.
Parking	4.10	23.
Disposal cost	4.09	24.
Appearance	4.05	25.
Residual cost	3.79	26.

4.2.4. Interview results with FM executives

The oral interview was conducted with four executive from selected FM organisations. The intention was to explore in details the challenges experienced by the FM organisations as a result of poor workmanship from the construction phase and how these challenges could be overcome. As a start the same questionnaire used during the survey was also used and discussions were allowed to expand during the engagement in order to obtain a deeper understanding of the underlying problems.

The summary of the results is as follows:

Question 1:

PMF is needed for the management of early FM requirements

Summary of the answers:

All of the interviewees agreed that the framework may provide a starting point, however some indicated that the main challenge in South Africa is lack of appropriate skills to deliver quality service. This suggests that even though the framework may sound appropriate, it may not necessarily eliminate the challenges faced in the FM industry as a result of lack of early FM involvement. This may be attributed to the cultural side of PMS, which most authors have already alluded that it is the most problematic. However, this research deals with the structural side of the PMS and the appropriateness of the proposed PMF.

Question 2:

Most of the challenges encountered in FM stage may be directly linked to design stage

Summary of the answers:

Some of the challenges may be attributed to poor management at the design stage resulting in rework during the FM stage. It is for this reason that warranties are included in the construction contracts to cover for poor designs and workmanship. However no warranties may cover for poor management of the project which makes the proposed PMF a powerful tool to assist in planning and monitoring which may in turn lead to improved management efforts.

The biggest challenge during the FM stage is the limited resources available to manage facilities allocated due to client's sensitivity to costs. Therefore, during the design stage, thorough consideration is needed to ensure that facilities are delivered with less maintenance requirements by selecting appropriate materials and equipment. This is also beneficial in terms of energy management which has become compulsory in any sustainable FM organisation.

Question 3:

Do you think lessons learned from the FM stage can be used to set up targets for performance indicators for FM requirements during the project management stage; What other methods can be used to define FM requirements during the project management stage, Please explain

Summary of the answers:

Information is part of the organisation's competitive advantage, hence organisations benchmark all the times. Most organisations use external consultants to generate this information, and it is mainly financial, time, and customer survey related. Therefore, the proposed PMF may be used to streamline the information requirements from these consultants and can provide a wide range of indicators to enable management to make informed decisions. Institutional memory loss is one of the biggest challenges that the FM industry is facing as result of the aging population of senior managers and technical staff such as artisans, and knowledge management as per the proposed PMF may facilitate information sharing to young and new entrants in the FM industry.

Question 4:

Do you think that most FM organisations are positioned to generate data and convert to information that can be readily used to define optimum facility performance requirements that can be used by project managers?

Summary of the answers

Most reputable FM organisations have the capacity to generate information, and SAFMA is in the forefront of professionalising the FM field. The extent to which the information may be customised as proposed in the PMF depends mainly on the client's willingness to perceive the value in acquiring and managing this information. At the end it boils done to available resources (i.e. money, the required system and human resources).

4.2.5. Conclusions

The results of the online survey were presented in a tabulated format as follows:

- The results of the respondent's profile were presented in Tables 4.1 to 4.3, and associated Figures 4.1 to 4.3.
- The results of the interview questions were presented in Tables 4.4 to 4.5, and associated Figures 4.4 to 4.5.
- The ranking of the proposed KPIs for the PMF were presented from Tables 4.6 to 4.10.
- The ranking of the proposed KPIs in order of importance were presented in Table 4.11.
- Interview discussions were collectively presented in a summarised format.

All the KPIs were ranked above the average of three, signifying agreement with the literature findings. Interview discussion also points to the advantage of having streamline information that can be used for early FM involvement.

CHAPTER 5. DISCUSSION OF THE RESULTS

This chapter discusses and explains the survey results with reference to the hypotheses made, and the outcome of the survey results.

5.1. Introduction

The structure of this chapter is divided into five sections to discuss the respondents' profiles, results pertaining to hypotheses 1 and 2, administration plan for the proposed PMF, and the conclusions with respect to the discussions of this chapter.

5.2. Demographic profile of respondents

As presented in Chapter 4, the respondents were compiled mainly from four provinces, which included Gauteng, Western Cape, North West and Kwazulu Natal. Analysis of the survey responses revealed the following:

Gauteng Province had the highest response rate of about 69% (22), 4 uncompleted (skipped), 2 partially completed surveys. Out of 22 returned responses, only 4 surveys could not contribute to this research. The uncompleted responses were from engineers with varying work experience. A number of factors could have contributed to this, including lack of adequate time to complete the survey. In fact, one of the engineers contact indicated lack of adequate time to complete the survey as the reason. The impact of this on the results was analysed taking into consideration the rest of the responses from other provinces.

Western Cape Province follows with a response rate of about 13% (4), 3 uncompleted surveys. Out of 4 returned responses only 1 survey was completed, contributing to the course of this research. There was a complete lack of response from the Western Cape in general. The responses received came from 2 x Architects, 1 x Construction Management and 1 x PM (for the purpose of this research construction and project management are regarded under a single profession, PM). The completed survey came from an architect (interior designer).

North West Province follows with a response rate of 6% (2). All the returned questionnaires were completed. Both respondents are FM practitioners.

Kwazulu Natal Province follows with a response rate of about 6% (2), 2 uncompleted surveys out 2 returned surveys, no contribution whatsoever towards this research.

The remaining two responses came outside of South Africa from Botswana and Bogota. The response from Botswana was fully completed and one from Bogota was partially completed.

The following conclusions were deduced from these observations:

- Gauteng had the highest response rate because it was easier to make physical and telephonic contact with the prospective respondents.

- Most of the organisations targeted for the research are based in Gauteng, with satellite offices in other provinces.

- Knowledge generation and management is the highest in Gauteng compared to other provinces. As a result most of the respondents may be more familiar with the concepts being researched, and thus, in a position to complete the survey. In 2011,

> Statistics South Africa ranked the level of education in Gauteng the highest at 18.1% followed by the Western Cape at 14.4% (Statistics South Africa, 2011).

Therefore, the results of this study will be more reflective of the EBE practitioners in Gauteng. However, the bias level as a result of the skewed response is not considered significant. Gauteng is the biggest economy in South Africa (Statistics South Africa, 2005). Most of the organisational policies and processes are developed at head offices (HO), which are in most cases based in Gauteng. Therefore, it can be argued that the activities of satellite offices are influenced by the knowledge generated in Gauteng. This is particularly true when looking at the HO of South Africa's FM organisations listed in Chapter 2, Section 2.2.1, Table 2.2.

Table 5.1 provides detailed analysis of partially completed and skipped questionnaires, with specific emphasis on sections where data is missing. The missing data was not considered in the statistical analysis of the results.

Table 5.1. Analysis of incomplete, partially complete and skipped survey

Survey Status	Region	Profession	Occupation	Years	Section Completed	Sections not completed
Partially completed	*Bogota*	Architect	CEO	24	Consent, respondent's profile and ranking of KPIs	Interview questions
Skipped						
Partially completed	Gauteng	Electrical Technologist	Consultant	6	Consent, respondent's profile	Ranking of KPIs and interview questions
Partially completed	Gauteng	FM	Self Employed	9	Consent, respondent's profile and ranking of KPIs	Interview questions
Partially completed	Gauteng	FM	Maintenance Manager	14	Consent, respondent's profile and ranking of KPIs	Interview questions
Partially completed	Gauteng				Consent	Respondent's profile, ranking of KPIs and interview questions
Partially completed	Gauteng	Electrical Engineer	Director	10	Consent, respondent's profile	Ranking of KPIs and interview questions
Partially completed	Gauteng	Mechanical Engineer	Consulting		Consent	Respondent's profile, ranking of KPIs and interview questions
Skipped						
Partially completed	Western Cape	Architect	Associate	10	Consent, respondent's profile	Ranking of KPIs and interview
Partially completed	Western Cape	Construction Management		9	Consent, respondent's profile	Ranking of KPIs and interview questions
Partially completed	Western Cape	Project Management			Consent	Respondent's profile, ranking of KPIs and interview questions
Skipped						
Incomplete	Kwazulu Natal	FM			Consent	Respondent's profile, ranking of KPIs and interview questions
Skipped	Kwazulu Natal				None	None

5.3. Discussion pertaining to Hypothesis 1

This hypothesis sought to establish the current situation and capability within the FM industry with regard to generation of FM knowledge and management thereof. Six out of sixteen respondents (38%) agreed that the FM industry is in a position to generate “intelligent” FM knowledge in order to set up the KPIs for early FM involvement, and nine (56%) disagreed, with the remaining one (0.1%) expressing no opinion. This is a worrying finding for the study, because it implies that FM organisation are not using any data at their disposal to influence facility designs. Therefore, the argument that there is fragmentation between both PM and FM stages is supported. However, the successful deployment of the proposed PMF depends upon the ability of the FM industry to generate and use FM knowledge to set up the KPIs identified for the PMF.

Interestingly, the overwhelming fifteen respondents (94%) agreed that the FM knowledge (i.e. lessons learned) can be used to set up the KPIs. Although the majority of respondents do not agree that the FM industry is in a position to generate FM knowledge that can be used to set up the proposed KPIs, there is general consensus that indeed lessons learned can be used to define these KPIs. Therefore, there is a basis for the proposed PMF.

As already discussed, one of the ways to generate the FM knowledge is by successfully implementing a PMS during the operational stage of FM. Although many South African organisations are using a PMS as shown in Deloitte & Touche Human Capital Corporation (2001), it may appear that it is not being successfully implemented or it may only be focussed in one particular area such as finances and excluding other areas.

5.4. Discussion pertaining to Hypothesis 2

The KPIs and the importance of the proposed KPIs as identified in the literatures reviewed were presented. All the KPIs were validated as proposed by this research for early FM involvement. The general agreement among the respondents is that the proposed KPIs are important (weighted average scoring between 4 and 5), indicating a positive response towards the proposed KPIs. Only one KPI, residual value, was ranked below four, albeit within the average scoring of three, indicating a positive response. The following could provide some explanation regarding the odd response with regard to the residual value:

- Residual value is regarded as the amount that the facility is worth after its useful life, or the amount that a willing buyer is prepared to put forward for the facility at the end of its life. For accounting and tax deduction purposes, this value is not regarded as important. However, for the purpose of disposal it may be necessary to compare the residual value, continued operational costs and disposal cost as to allow for informed decisions making, or,
- It may not be possible to determine the residual value with acceptable level of accuracy at the PM stage. However, for investment and FM strategic requirements it may be necessary to provide some indication of this value, hence the positive response from the survey.

The inter-rater reliability (IRR) using Fleiss’ kappa for the proposed KPIs was calculated as shown in Table 5.2. The value of the Fleiss’ kappa obtained was 0,12 indicating the slight level of agreement among raters as per the interpretation as presented in Chapter 3, Section 3.7, Table 3.1, however, this is a move away from random rating. This value must be interpreted in conjunction with the weighted average scoring of the KPIs. The weighted average ranking of the KPIs were between 4 and 5 (i.e. important and extremely important), as a result, the calculated IRR value is a reflection of agreement between important and extremely important, and for the purpose of this research, either value is acceptable. Hence

the level of reliability required between these values is negligible, since both important and extremely important ranking are regarded as positive feedback.

Table 5.2. Calculation of inter-rater agreement for KPIs ranking using Fleiss' kappa

KPI	Extremely unimportant	Unimportant	Neither unimportant nor important	Important	Extremely important	N/A	Pi		
1	0	0	0	9	14	0	0,61		
2	0	1	1	14	7	0	0,54		
3	0	1	0	9	10	1	0,39		
4	0	1	0	6	14	0	0,50		
5	0	1	0	10	10	0	0,43		
6	0	1	3	10	7	0	0,33		
7	0	1	1	11	8	0	0,40		
8	0	1	1	8	12	1	0,45		
9	0	0	3	11	7	0	0,38		
10	0	0	1	10	10	0	0,43		
11	0	0	2	11	8	0	0,40		
12	0	0	2	10	9	0	0,39		
13	0	0	2	7	11	1	0,37		
14	0	0	1	11	11	0	0,53		
15	0	0	0	6	16	0	0,65		
16	0	1	2	7	13	0	0,48		
17	0	0	0	7	16	0	0,68		
18	0	1	1	10	11	0	0,48		
19	0	1	4	10	8	0	0,38		
20	1	2	3	10	5	0	0,28		
21	0	0	0	8	14	1	0,57		
22	0	0	1	15	6	1	0,58		
23	0	1	1	15	4	1	0,53		
24	0	0	0	4	18	1	0,76		
25	0	0	1	6	15	1	0,58		
26	0	0	0	6	16	1	0,65		
27	0	0	0	7	14	0	0,53		
28	0	0	2	13	6	0	0,45		
29	0	1	0	7	15	0	0,60		
30	0	0	1	11	11	0	0,53		
31	0	0	0	12	9	0	0,49	**Sum of cell**	**750**
32	0	0	2	8	11	0	0,40	**Pbar**	**0,49**
33	0	0	2	5	15	1	0,56	**Pe**	**0,42**
34	0	0	2	7	13	1	0,48	**Pbar-Pebar**	**0,07**
Total	**1**	**14**	**39**	**311**	**374**	**11**	**16,8**	**1-Pebar**	**0,58**
pi	0,00	0,02	0,05	0,41	0,50	0,01	**0,42**	**Fleiss' kappa**	**0,12**

Similarly, looking at the pi values in Table 5.2 under important and extremely important columns, one notices that these values range between 0,41 and 0,50 respectively, the split is almost symmetrical indicating distributed responses, hence the scoring obtained as a reflection of this spread.

Notwithstanding the results of the KPIs, as already discussed, it should be noted that the successful implementation of the proposed PMF for early FM involvement relies on the knowledge generation and management throughout the lifecycle of the facility, which should be considered to span both PM and FM stages. The knowledge generated can be used to define goals and objectives, and thus appropriate performance indicators selected for the corresponding KPIs as identified herein.

The requirement for the proposed PMF was also established based on the results of the survey (interview questions 1). A total number of 17 out of 19 (89%) respondents agreed that there is a requirement for the proposed PMF. Two respondents expressed no opinion. About 13 out of 20 respondents (65%) agreed that some of the challenges encountered at the FM stage may be linked back to the PM stage (interview question 2).

The IRR regarding the interview questions was calculated as shown in Table 5.3. The missing data was omitted from this calculation as the impact was regarded low. This is due to the fact that the data that was missing was omitted randomly and not systematically, the latter could have negatively affected the results of this calculation. Therefore, the value of the Fleiss' kappa obtained for the interview questions was 0,53 indicating a positive agreement among raters, a move away from the random rating. Based on the interpretation as presented in Chapter 3, Section 3.7, Table 3.1, this value indicates a moderate agreement among the raters.

Table 5.3. Calculation of inter-rater agreement for interview questions using Fleiss' kappa

Interview Question	Agree	Disagree	None	Pi
1	16		2	1,02
2	11	5	3	0,58
3	16		2	1,02
4	11	5	3	0,58
Total	**54**	**10**	**10**	**3,19**
pi	0,73	0,14	0,14	**0,57**

Sum of cells	**74,00**
Pbar	**0,80**
Pebar	**0,57**
Pbar-Pebar	**0,23**
1-Pe	**0,43**
Fleiss' kappa	**0,53**

5.5. Administration plan for the proposed early FM involvement

This section discusses the administration plan for the proposed PMF within the project management processes. In developing the administration plan for early FM involvement, firstly the FM functions and early FM involvement KPIs are presented Figure 5.1:

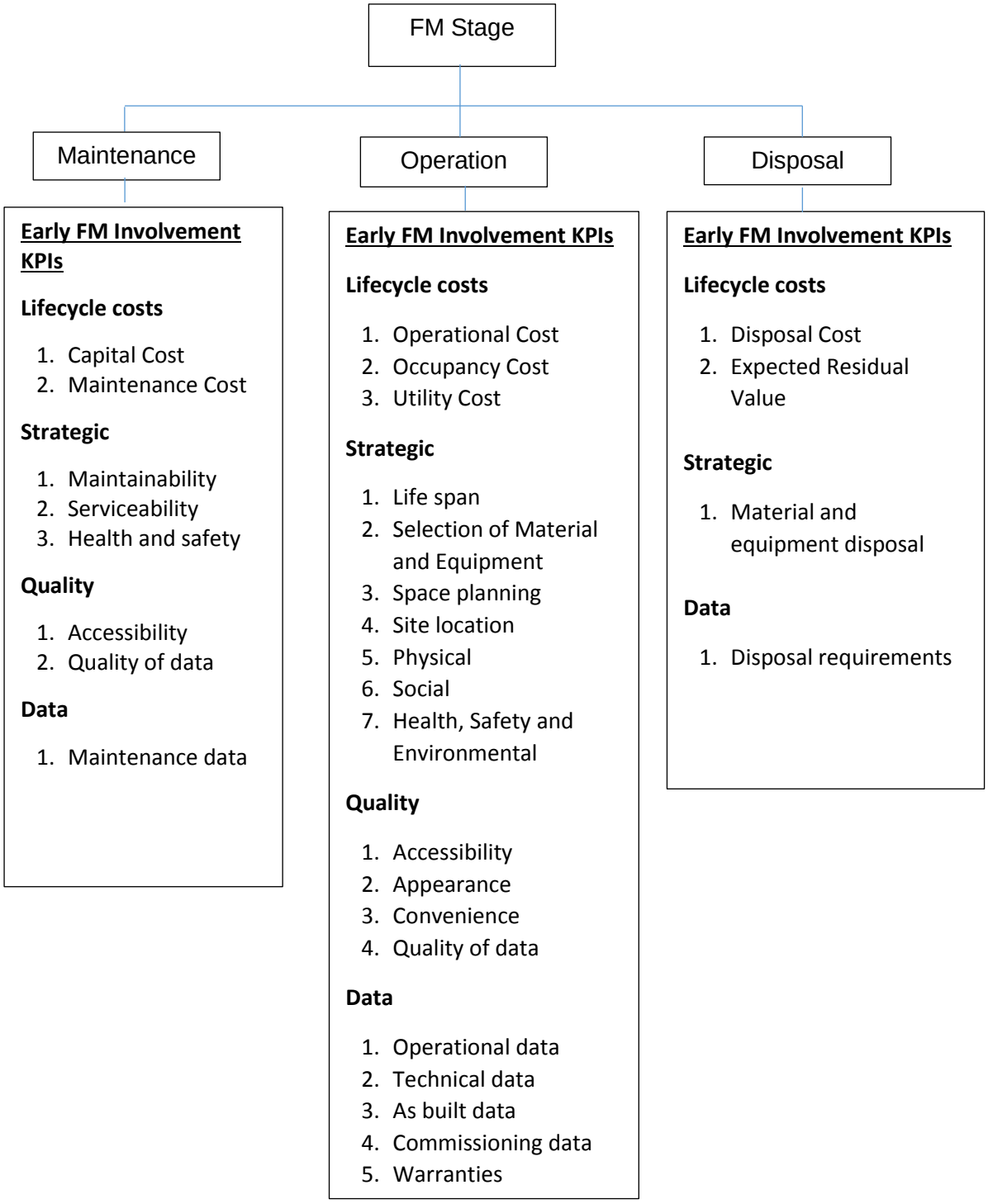

Figure 5.1. FM functions and proposed early FM KPIs

In reference to Figure 5.2, the administration plan is explained as follows:

Activities 1, 2 and 3 form the initial stages of the process to acquire a new facility. All the strategic decisions and FM knowledge are gathered and performance requirements defined (FM strategy). Activity 2 is the system that gathers and converts FM data into useful FM information. This may be achieved by successfully implementing a PMS and associated benchmarking exercises. As discovered in Chapter 2, section 2.2.2 of the literature review, the most preferred method of PMS in FM is BSC and KPIs. The information generated by the PMS can be benchmarked against available information in the FM industry in order to establish best practices. The information generated will be crucial in defining the requirements for early FM involvement and FM strategy.

Activity 4 comprises all the project management functions which include, planning design, procurement (including construction). The deliverables as required per the developed FM strategy will be scheduled and managed in this activity. In terms of the project management performance management triangle, the proposed KPIs can be grouped under cost (i.e., financial indicators), and quality (i.e., strategic, quality, SHE and social, and information management indicators). Time is excluded from the PMF for early FM involvement as it is considered an inherent aspect of PM, unlike other KPIs, time has one dimension associated with it, which is a set duration.

Activity 5 is the management of information generated during the PM stage. For all intent and practical purposes, activity 5 is a transition between the end of PM stage and the beginning of the FM stage, and in terms of the PMI project phases, it may be regarded as phase 5

Activity 6 is the FM stage or operational stage where FM knowledge is generated and managed.

Activity 7 is a platform where the structure and FM activities for the facility are developed and implemented. The platform may be Computer Aided Facilities Management (CAFM).

Figure 5.3 represents the early FM deliverables per project phase, however it is not within the scope of this research to validate the actual deliverables per phase.

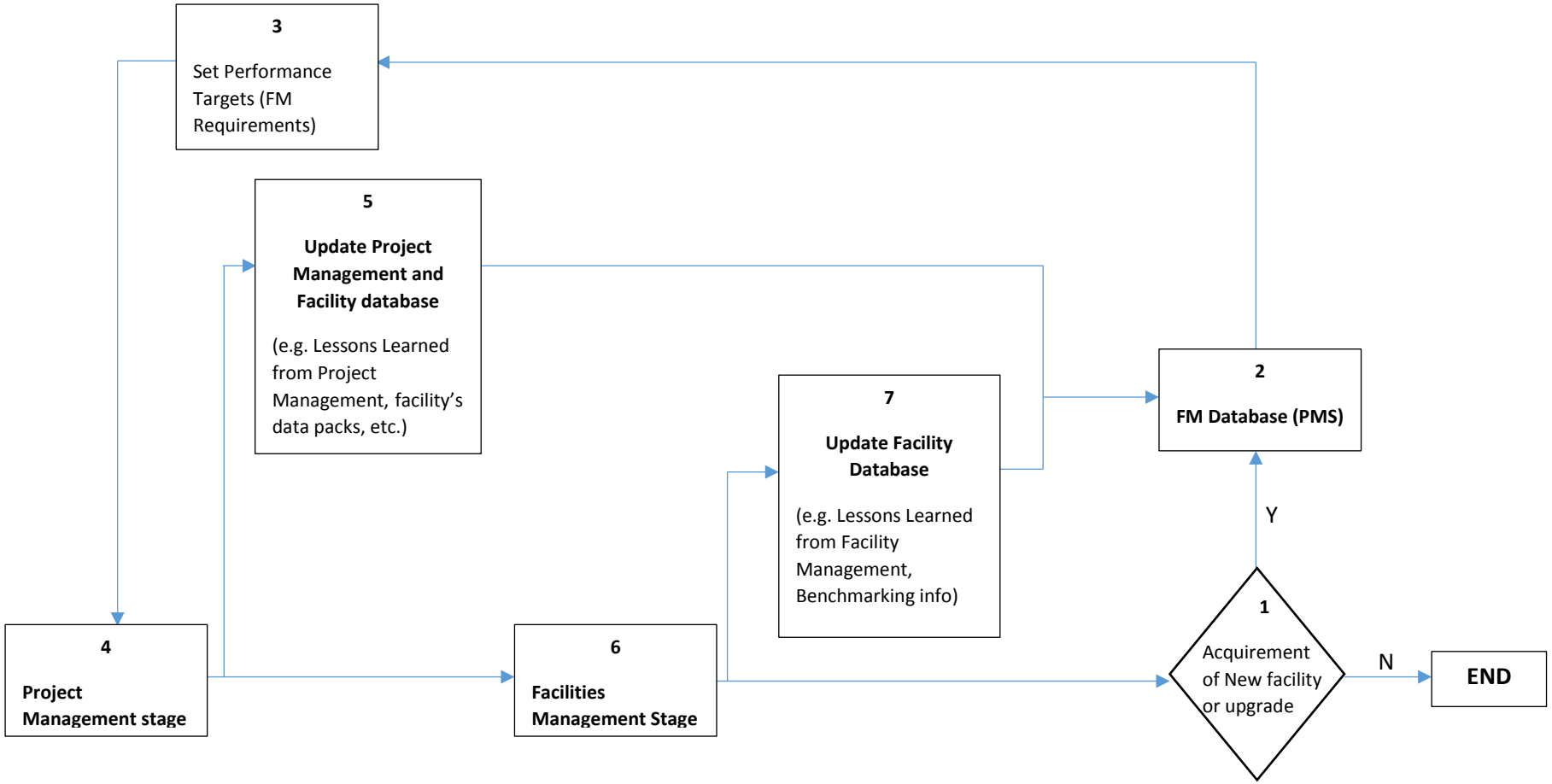

Figure 5.2. Proposed administration plan for early FM requirements (for further research)

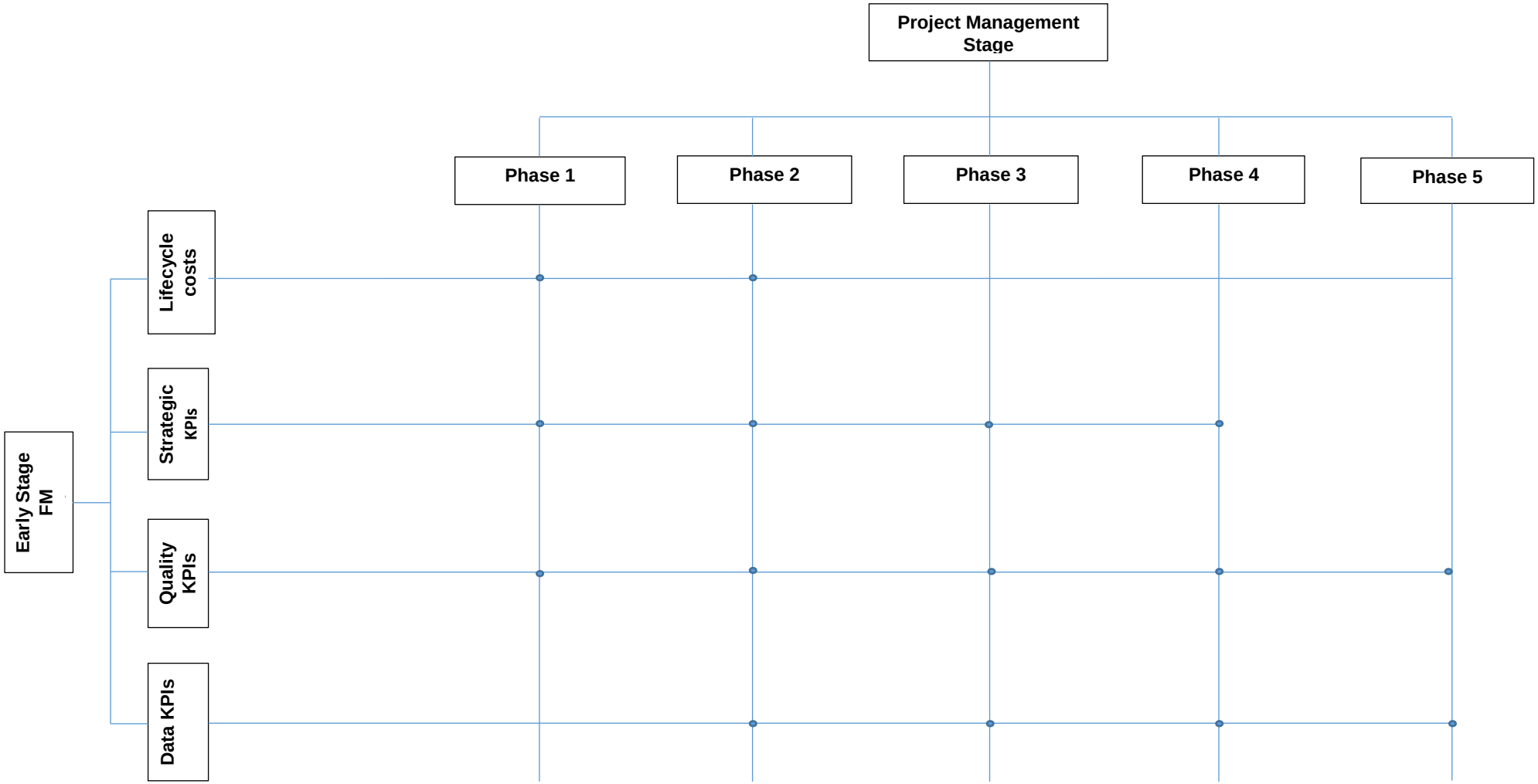

Figure 5.3. Early FM requirements per project phase (for further research)

5.6. Conclusion

The results of the study were discussed in details, allowing some deductions and interpretations to be made. The results for hypothesis 1 proved the importance of knowledge management during the FM stage as the basis for early FM involvement. Similarly, the results for hypothesis 2 proved the need for the proposed PMF and the associated KPIs. Although the proposed PMF may be seen to provide a comprehensive framework to engage early FM involvement, it should not be seen as the end by itself, but one of the tools to provide project stakeholders with a platform to address the issues of facility's lifecycle management. BIM philosophy has long recognised the need for whole lifecycle management, which cannot be underestimated given the drive for sustainable building throughout the world. There is lot of research on BIM with regard to lifecycle management of facilities and tools such as the proposed PMF can be used to define the data structure within the BIM models.

In conclusion, the research has identified and developed a comprehensive PMF to engage early FM involvement during the design stage within the South African context. All the hypotheses as identified from the literature review have been validated, however, the results are more reflective of the built environment professionals in Gauteng. This could be attributed to the level of interest and subject knowledge available in the province. Gauteng is the economic hub of South Africa and most of the organisation's head offices are based in this province. In 2011, the level of higher education was shown to be the highest in Gauteng at 18.1% and followed by the Western Cape Province at 14.4% (Statistics South Africa, 2011:23).

CHAPTER 6. CONCLUSIONS & RECOMMENDATIONS

6.1. Introduction

This chapter presents the conclusions, recommendations and suggestions for the study. The stakeholders for this research were identified and include the building owners, developers, project managers, construction managers, facility managers, engineers, building designers (architects) and researchers within the EBE.

6.2. Conclusions of the study

The study has identified the need for the proposed PMF and validated the KPIs for early FM involvement in the project management stage. The contribution of this research was to define the framework which integrates the unique requirements of FM in the early stages of design. The intention is to assist the project managers and facilities managers to manage and deliver requirements for FM at an early stage of facility development. Projects are by definition unique; however within project management activities there are activities that are repetitive which allow projects to be planned. And within this context, the proposed PMF can be planned within the tasks of project management thereby avoiding the possibility of having to deal with deviations due to the requirements of FM, which may end up bungling the project management performance triangle (i.e. cost, time and quality). The PMF itself must be seen as one of the many tools that project management may deploy in their functions in order to manage the expectations of FM as one of the project stakeholders.

6.3. Recommendations

The following recommendations are made

- This research has identified the need for a structured early FM involvement. Therefore, it is recommended that project management organisations develop their templates in such a manner that early FM requirements are addressed during the PM stage. Scorecards and tick sheets can be used for the assessment of goals attainment.

- It should be noted that each KPI as defined for the PMF may have a number of performance indicators that constitute the KPI itself. As discussed, the context and goals of different organisations can be represented by the performance indicators within the PMF. Therefore, the performance indicators within each KPI must be linked to the project and FM goals. As per the definition of performance management in the literature review, the intention is to monitor progress towards attainment of set goals.

- A culture of performance management within the built environment must be entrenched in order to ensure a scientific approach towards the definition of project success to all stakeholders. As part of expectation management, stakeholders can be presented with an objective data that can be used for informed decision making.

6.4. Suggestions for further research

Although this research has identified the structure for early FM involvement, further research is required on the following topics:

- Due to the limited time for this research, it is suggested that further research be conducted to include other respondents in different provinces. A case study is also identified, under different FM functions to test the implementation and practicalities of this PMF.

- Further research is suggested to determine any existence of causal relationships among various KPIs. There are indications that KPIs categorised under “strategic” may have some influence on other KPIs.

- The scheduling of KPIs in the PM stage is not determined in this research. Projects are managed in phases, and each phase has its own deliverable (PMI, 2008). Therefore, the deliverables for each KPI will also be delivered in phases.

- Engagement of early FM KPIs through BIM. Organisations that adopt BIM platform require a framework on how to incorporate the proposed PMF in their workflow. As discussed in the literatures review, Chapter 2, Section 2.2.6, there is a BIM framework that seeks to engage FM in the design stage (Ying, et al., 2013). However, this framework does not address all the goals and objectives as determined by this research.

- The structure of FM and PM knowledge management database (e.g. PMS, analytics, etc.) that should be used to gather FM and PM knowledge has not been defined by this research. Hanisch *et al.*, (2009) defines some elements required for knowledge management in the project environment.

References

Aaltonen, K., 2011. Project stakeholder analysis as an environmental intepretation process. *International Journal of Project Management,* 29(2), pp. 165-183.

Adhikari, D., 2010. Human Resource Development (HRD). *International Journal of Productivity and Performance Management,* 4(59), pp. 306-324.

Agresti, A. & Min, Y., n.d. *On Sample Size Guidelines for Teaching Inference about the Binomial Parameter in Introductory Statistics,* Gainsville, Florida 32611-8545: University of Florida.

Amaratunga, D., 2001. *Theory Building in Facilities Management Performance Measurement:"Application of Some Core Performance Measurement and Management Principles"..* UK, Unpublished PhD Thesis. University of Salford.

Amaratunga, D. & Baldry, D., 2002. *Performance Measurement in Facilities Management Organisation: Transition from Measurement to Management,* UK: University of Salford.

Amaratunga, D. & Baldry, D., 2003. A conceptual framework to measure facilities management performance. *Property Management,* 21(2), pp. 171-189.

Atkin, B. & Brooks, A., 2009. *Total Facilities Management.* 3 ed. United Kingdom: John Wiley and Sons.

Augenbroe, G. & Park, C., 2005. Quantification methods of technical building performance. *Building Research and Information,* 33(2), pp. 159-172.

Bitchi, U. S., Mendibil, K., Nudurupati, S. & Garengo, T. T. a. P., 2004. The interplay between performance measurement, organisational culture and management styles. *Measuring Business Excellence,* 8(3), pp. 28-41.

Bititci, U. S., Kepa Mendibil, S. N. P. G. & Turner, T., 2006. Dynamics of performance measurement and organisational culture. *International Journal of Operations Production Management,* 26(12), pp. 1325-1350.

Blasini, J. & Leist, S., 2013. Success factors in process performance management. *Busieness Process Management Journal,* 19(3), pp. 477-495.

Bosch, S. & Pearce, A., 2003. Sustainability in public facilities: Analysis of guidance documents. *Journal of performance of constructed facilities.*

Bryde, D. J., 2003. Modelling project management performance. *International Journal of Quality and Reliability Management,* 20(2), pp. 229-254.

Carton, F., Adam, F. & Sammon, D., 2008. Project Management: a case study of a successful ERP implementation. *Internationl Journal of Managing Projects in Business,* 1(1), pp. 106-124.

CBE, 2012. *CBE website.* [Online]
Available at: http://www.cbe.org.za/upload/CBE_AR_2012_WEB1F6C.pdf
[Accessed 15 December 2014].

Chareonsuk, C. & Chansa-ngavej, C., 2010. Intangible asset management framework: an empirical evidence. *Industrial Management and Data Systems,* 110(7), pp. 1094-1112.

Cooper, C. & Schindler, P., 2008. *Business research methods.* 10 ed. Boston: McGraw-Hill.

Davis, M., Coony, R., Gould, S. & Daly, A., 2005. *lbre.stanford.edu.* [Online]
Available at: lbre.stanford.edu/sites/all/lbre-shared/files/docs.../LCCA121405.pdf
[Accessed 03 March 2014].

De Waal, A., 2003. Behavioural factors important for the successful implementation and use of performance management systems. *Management Decision Design,* 41(8), pp. 688-697.

De Waal, A., 2004. Stimulating performance driven behaviour to obtain better results. *Journal of Productivity and Performance Management,* 53(4), pp. 301-316.

De Waal, A., 2007. Is performance management applicable in developing countries? The case of Tanzanian college. *International Journal of Emerging Markets,* 2(1), pp. 69-83.

De Waal, A. & Counet, H., 2009. Lessons learned from performance management systems implementations. *International Journal of Productivity and Performance Management,* 58(4), pp. 367-390.

De Waal, A. & Kourtit, K., 2013. Performance measurement and management in practice. *International Journal of Productivity and Performance Management,* 62(5), pp. 446-473.

Deloite & Touche Human Capital Corporation, 2001. *Human Capital Corporation Survey,* Johannesburg: Deloite & Touche.

Devenish, C. P., 2003. *Differentiartion of Old Mutual Properties Failities Management Division within the Market,* Durban: Graduate School of Business, Faculty of Management, University of Natal.

Drion, B., Melissen, F. & Wood, R., 2012. Facilities Management: lost, or regained?. *Facilities,* 30(5-6), pp. 254-261.

Edum-Fotwe, F. T., Egbu, C. & Gibb, A. G. F., 2003. Design Facilities Management Needs into Infrastructure Projects: Case from Major Hospital. *Journal of Performance of Constructed Facilites,* 17(1), pp. 43-50.

Elemica, 2012. *Integrated Facility Management in an Industrial Environment.* Frankfurt, ELEMICA.

Frost & Sullivan, 2012. *An Assessment of The South African Facilities Management Industry.* Johannesburg, SAFMA.

Ghyoot, V., 1994. *Property marketing III: Study guide 3,* Johanesburg: National Property Education Committee.

Gumbus, 2005. Introducing the balanced scorecard: creating metrics to measure performance. *Journal of Management Education,* 29(4), pp. 617-630.

Gwet, K. L., 2011. *Agreestat.* [Online]
Available at: http://www.agreestat.com/blog_irr/kappa_coefficient_for_multiple_raters.html
[Accessed 21 Janaury 2015].

Hallgren, M., Nilsson, A. & Blomquist, T., 2012. Relevance lost! A critical review of project management standardisation. *International Journal of Managing Projects in Business,* 5(3), pp. 457-485.

Hallgren, M., Nilsson, A., Blomquist, T. & Soderholm, A., 2012. Relevance lost! A critical review of project management standardisation. *International Journal of Managing Projects in Business,* 5(3), pp. 457-485.

Hanisch, B., Lindner, F., Mueller, A. & Wald, A., 2009. Knowledge management in project environments. *Journal of Knowledge Management,* 13(4), pp. 148-160.

Haponava, T. & Al-Jibouri, S., 2009. Identifying key performance indicators for use in control of pre-project stage process in construction. *International Journal of Productivity and Performance Management,* 58(2), pp. 160-173.

Hinks, J. & McNay, P., 1999. The creation of a management by variance tool for facilities management performance assessment. *Facilites,* 17(1/2), pp. 31-53.

Ho, D., Wong, E., Chan, N. & Chan, M., 2000. Significant metrics for facilities management benchmarking in the Asia Pacific region. *Facilities,* 18(13/14), pp. 545-555.

IFMA, 2008. *FM Knowledge Base.* [Online]
Available at: http://www.ifma.org/know-base/fm-knowledge-base/knowledge-base-details/11-core-competencies-of-facility-managers
[Accessed 09 May 2014].

IFMA, 2012. *Definitions of FM Terminology.* [Online]
Available at: http://www.ifma.org/know-base/fm-knowledge-base/knowledge-base-details/definitions-of-fm-terminology
[Accessed 18 April 2014].

Kaplan, R. & Norton, D., 1992. The Balanced Scorecard - measures that drive performance. *Harvard Business Review*, January, pp. 71-79.

Karuhanga, B. N. & Werner, A., 2013. Challenges impacting performance management implementation in public university. A case of Uganda. *African Journal of Economic and Management Studies,* 4(2), pp. 223-243.

Kent, R., 1993. *Marketing research in action.* London: Routledge.

Khaled, E.-A. & Richard, D., 2013. A Framework for Enginering Asset Management System. *Journal of Quality in Maintenence Engineering,* 19(4), pp. 398-412.

Khasebe, D., 2013. *Facilities Management Benchmarking as a tool to demonstrate Better FM, Better Business.* Johannesburg, SAFMA.

L.P., K., 2011. The impact of black economic empowerment (BEE) on South African Business Review. *South African Business Review,* 15(15), pp. 207-233.

Lam, E. W., Chan, A. P. & Chan, D. W., 2010. Benchmarking success of building maintenance projects. *Facilities,* 25(5/6), pp. 290-305.

Lavy, S., Garcia, J. A. & Dixit, M. K., 2010. Establishment of KPIs for facilities performance measurement: review of literature. *Facilities,* 28(9/10), pp. 440-464.

Lavy, S., Garcia, J. A. & Dixit, M. K., 2014. KPIs for facility's performance assessment, Part 1: identification and categorisation of core indicators. *Facilities,* 32(5/6), pp. 256-274.

Lavy, S., Garcia, J. A. & Dixit, M. K., 2014. KPIs for facility's performance assessment, Part 2: identification of variables and deriving expressions for core indicators. *Facilities,* 32(5/6), pp. 275-294.

Lepkova, N. & Zukaite-Jefimoviene, G., 2012. Study on Customer Satisfaction with Facilities Management Service in Lithuana. *Slovak Journal of Civil Engineering,* XX(4), pp. 1-16.

Lingard, H., Cooke, T., Blismas, N. & Wakefield, R., 2013. Prevention through design: Trade-offs in reducing occupational health and safety risk for the construction and operation of a facility. *Built Environment Project and Asset Management,* 3(1), pp. 7-23.

Liu, R. & Issa, R., 2013. *BIM For Facility Management: Design For Maintainability With BIM Tools.* Montreal, ISARC.

Liyanage, C. & Egbu, C., 2008. A performance management framework for healthcare facilities management. *Journal of Facilities Management,* 6(1), pp. 23-36.

Madritsch, T. & Matthias, E., 2011. Performanace Measurement in Facilities Management. The Environment Management Maturity Model (BEM3). *Research Journal of Economics, business and ICT,* Volume 2.

Marawa, S. M. & Zairi, M., 2009. In pursuit of performance oriented civil service reforms (CSRs): A Kenyan perspective.. *Measuring Business Exellence.,* 13(2).

Massheder, K. & Finch, E., 1998. Benchmarking metrics used in UK facilities. *Facilities,* 16(5/6), pp. 123-127.

Matthew, T. & Michael, P., 2009. National standards of customer satisfaction in facilities managment. *Facilities,* 27(13/14), pp. 497-514.

Meng, X., 2013. Involvement of Facilities management Specialiast in Building Design: UK Experience. *Journal of Performance of Constructed Facilities,* 27(5), pp. 500-507.

Meng, X. & Minogue, M., 2011. Performance measurement models in facility management: a comparative study. *Facilites,* 29(11/12), pp. 472-484.

Mohan, K., 2011. Editorial: integrated "infrastructure project management" with its built asset management. *Built Environment Project and Asset Management,* 1(1), pp. 5-13.

Morris, W. P., 2010. Research Note: Research and the future of project management. *International Journalof Managing Projects in Business,* 3(1), pp. 139-146.

Neely, A., Greogory, M. & Platts, K., 1995. Performance measurement system design: A literature review and research agenda. *International Journal of Operations and Production Management,* 15(4), pp. 80-116.

Neely, A., Mills, J., Platts, K. & Huw Richards, M. G., 2000. Performance measurement system design: developing and testing a process based approach. *International Journal of Operations and Production Management ,* 20(10), pp. 1119-1145.

Nel, P. et al., 2008. *Human Resource Management.* 7 ed. Cape Town: Oxford University Press Southern Africa.

Nneomachioma123, 2015. *Studymode.* [Online]
Available at: http://www.studymode.com/essays/The-Advantages-And-Disadvantages-Of-Que-66466282.html?
[Accessed 03 January 2015].

Ohemeng, F., 2010. The dangers of internationalisation and "one size fits all" in public sector management. Lessons from performance management policies in Ontarion and Ghana. *International Journal of Public Sector Management,* 23(5), pp. 456-478.

Ohemeng, K. L. F., 2009. Constraints in the Implementation of Performance Management Systems in Developing Countries: The Ghanaian Case. *International Journal of Cross Cultural Management,* 9(1), pp. 109-132.

Parker, D. et al., 2013. Critical evaluation of project-based performance management. Change intervention integration. *International Journal of Productivity and Performance Management,* 62(4), pp. 407-419.

Perkins, M., Grey, A. & Remmers, H., 2014. What do we really mean by Balanced Scorecard. *International Journal of Productivity and Performance Management,* 63(2), pp. 148-169.

PMI, 2008. *A Guide to Project management Body of Knowledge (PMBOK Guide),* Newton Square, PA: Project Management Institute Inc.

PricewaterhouseCoopers, 2013. *www.pwc.co.za/construction.* [Online]
Available at: http://www.pwc.co.za/en_ZA/za/asset/pdf/sa-construction-december-2013.pdf
[Accessed 21 June 2014].

Radnor, Z. & McGuire, M., 2004. Performance management in the public sector: fact or fiction. *International Journal of Productivity and Performance Management,* 53(3), pp. 245-260.

R, C., 2009. New Public Management Reforms in South African Public Service. 28 April, pp. 1999-2008.

Robert, A., Orwig & Brennan, L. L., 2000. An integrated view of project and quality management for project based organisations. *International Journal of Quality and Reliability Management,* 17(4/5), pp. 351-363.

SAFMA, 2010. *SAFMA Website.* [Online]
Available at: http://www.safma.co.za/portals/0/What_is_FM_presentation.pdf
[Accessed 10 July 2013].

SAFMA, n.d. *SAFMA website.* [Online]
Available at: http://www.safma.co.za/Membership/RegisteredProfessionals/tabid/120/Default.aspx
[Accessed 20 11 2014].

Saunders, M., Lewis, P. & Thornhill, A., 2009. *Research methods for business students.* 5th ed. England: Pearson Education.

Saunders, M., Lewis, P. & Thornhill, A., 2012. Selecting Samples. In: *Research Methods For Business Students.* Harlow, England: Pearson, pp. 258-295.

Schraven, D., Hartmann, A. & Dewulf, G., 2011. Effectiveness of infrastructure asset management: challenges for public agencies. *Built Environment Project and Asset Management,* 1(1), pp. 61-74.

Shohet, I. M., 2006. Key Perfromance Indicators for Strategic Health Care Facilities Maintenace. *Journal of Construction Engineering and Management,* 132(4), pp. 345-352.

Singh, N., 2013. *Staff and Service Provider Measurement.* Johannesburg, SAFMA.

Statistics South Africa, 2005. *Statistical release P0020. Economic activity survey,* Pretoria: Statistics South Africa.

Statistics South Africa, 2011. *Census 2011: Provinces at a glance,* Pretoria: Stats SA.

Sturgis, P., Roberts, C. & Smith, P., 2014. Middle Alternatives Revisited. How the neither/nor Response Acts as a Way of Saying "I Dont' Know"?. *Social Methods and Research,* 43(1), pp. 15-38.

Underwood, J. & Isikdag, U., 2011. Emerging technologies for BIM 2.0. *Construction Innovation,* 11(3), pp. 252-258.

Whyte, J., 2012. *Building Information Modelling in 2012: Research Challenges, Contributions, Opportunities,* UK: Design Innovation Research Centre working paper 5, [1], University of Reading, UK.

Whyte, J., 2012. *Building Information Modelling in 2012: Research Challenges, Contributions, Opportunities,* UK: DIRC Working Paper 5 (www.reading.ac.uk/designinnovation/) version 1.01.

Wikipedia, 2014. *Built Environment-Wikipedia.* [Online]
Available at: http://en.wikipedia.org/wiki/Built_environment
[Accessed 18 April 2014].

Wikipedia, 2014. *Wikipedia, the free encyclopedia.* [Online]
Available at: http://en.wikipedia.org/wiki/A_Guide_to_Project_Management_Body_of_Knowledge
[Accessed 16 July 2014].

Wikipedia, 2014. *Wikipedia, the free encyclopedia.* [Online]
Available at: http://en.wikipedia.org/wiki/PRINCE2
[Accessed 30 June 2014].

Ying, W. et al., 2013. *Downloads.* [Online]
Available at: http://downloads.hindawi.com/journals/ace/2013/189105.pdf
[Accessed 12 March 2014].

Appendix A. Survey data for respondents profile

Table A1. Respondent's Profile

	Respondent's Profile						
Respondent	**Position**	**Profession**	**Years of working experience**	**Department**	**City/Town**	**Province**	***Comments***
1.	Construction Project Manager	Construction Management	15	Project Management	Woodmead	Gauteng	Complete Response[3]
2.	Director	Asset Management	18	Asset Management	Johannesburg	Gauteng	Complete Response[3]
3.	CEO	Architect	24	Cundinamarca	Bogota	Bogota D.C.	Partially Complete Response[2]
4.	General Manager: Facilities	Facilities Management	14	Facilities Management	Johannesburg	Gauteng	Complete Response[3]
5.	General Manager	Engineer	22	Operations	Pretoria	Gauteng	Complete Response[3]
6.	Electrical Consultant	Electrical Technologist	6	Professional Service	Centurion	Gauteng	Incomplete Response[1]
7.	Self-employed/ MD	FM/ PM	9	N/A	Johannesburg	Gauteng	Partially Complete Response[2]
8.	Facilities manager	Civil Engineer	8	Facilities management	Rustenburg	North-West	Complete Response[3]
9.	Facilities and Maintenance Manager	Operations	25	Properties	Rustenburg	North West	Complete Response[3]
10.		FM			Durban	Kwazulu-Natal	Incomplete Response[1]
11.	Maintenance Manager	Facilities Manager	14	Facilities Management	Johannesburg	Gauteng	Partially Complete Response[2]
12.					Pietermaritzburg	Kwazulu-Natal	Skipped all
13.	Senior Manager :Real Estate Services	FM	24		Johannesburg	Gauteng	Complete Response[3]

CONT'	Position	Profession	Years of working experience	Department	City/Town	Province	*Comments*
14.		FM			Pretoria	Gauteng	Incomplete Response[1]
15.	Associate	Consulting Engineer (Electrical)	14	Buildings	Sandton	Gauteng	Complete Response[3]
16.	Associate	Architect	10	Archi	Cape Town	Western Cape	Incomplete Response[1]
17.	Director	Electrical Engineer	10		Johannesburg	Gauteng	Incomplete Response[1]
18.		Mechanical Engineer		Consulting	Centurion	Gauteng	Incomplete Response[1]
19.	Senior Electrical Engineer	Consulting Engineer	19	N/A	Pretoria	Gauteng	Complete Response[3]
20.	Project Manager	Project Manager	22	Projects	Johannesburg	Gauteng	Complete Response[3]
21.	Green Star Accredited Professional	Construction Management	9	Green Building	Cape Town	Western Cape	Incomplete Response[1]
22.	Head: Project Management	Property Development	22	Development Management	Johannesburg	Gauteng	Complete Response[3]
23.	Senior Mechanical Engineer	Consulting Engineer	42	Consulting	Centurion	Gauteng	Complete Response[3]
24.	Head: Business Transformation	Senior Management - Facilities Management	19	Business Transformation	Johannesburg	Gauteng	Complete Response[3]
25	Mechanical engineer	Mechanical Engineer	16		Gaborone	Botswana	Complete Response[3]
26.		Project Management			Cape Town	Western Cape	Incomplete Response[1]
27.	SHE Manager	Construction	30	Buildings		Gauteng	Complete Response[3]
28.	Technical Manger	Interior Designer (Architect)	17	Tech	Cape Town	Western Cape	Complete Response[3]
29.	MD	Facilities Management	20	Facilities Management	Johannesburg	Gauteng	Complete Response[3]
30.	HOD Electrical	Electrical Engineer	10	Design Service	Centurion	Gauteng	Complete Response[3]
31	Lecture	Architect			Johannesburg	Gauteng	Complete Response[3]
32	Electrical Consultant	Electrical Engineer	9	Professional Service	Pretoria	Gauteng	Complete Response[3]

Notes.

1. *Incomplete response* means that either the respondent only consented to take the survey or consented to take the survey and completed respondent's details sections but never completed the rest of the survey.
2. *Partially completed response* means that respondents completed all the section of the survey except the interview section of the survey.
3. *Complete response* means all the sections of the questionnaires were completed in all respects

Appendix B. Interview questions and answers

Table B1. Interview response from EBE professionals on the proposed PMF

Respondents	Is it necessary to develop an FM performance management framework to manage FM requirements at an early stage of facility development (Project management stage), to guide project teams, as proposed by this research? Please explain.	Do you think that most of the challenges encountered during the FM stage maybe directly related to the hidden flaws at the project management stage (development stage)? Please explain.	Do you think lessons learned from the FM stage can be used to set up targets for performance indicators for FM requirements during the project management stage; What other methods can be used to define FM requirements during the project management stage, Please explain.	Do you think that most FM organisations are positioned to generate data and convert to information that can be readily used to define optimum facility performance requirements that can be used by project managers?	Please provide any other additional comments.
1.	**Yes.** Final delivery of project must be linked with its maintenance plans	**No**. It is responsibility of all stakeholders to coordinate their requirements accordingly	Yes. Known gaps are mostly associated with projects vs. maintainability after completion.	No. To a great extent only prominent FM organisations have this kind information	It's important to assume intelligent systems that are able to coordinate where the project is coming or going to and define its expected lifespan after completion. Dynamic stakeholders would keep probing the technological markets and ensure up-to-date systems are continuously adopted
2.	**Yes** - management and operational experience must guide development decisions and project feasibility	Not always	Yes - operational input into development must provide framework for operational performance post development completion	Data gathering is good, data analytics way behind	
3.	Skipped	Skipped	Skipped	Skipped	Skipped

Respondents	Is it necessary to develop an FM performance management framework to manage FM requirements at an early stage of facility development (Project management stage), to guide project teams, as proposed by this research? Please explain.	Do you think that most of the challenges encountered during the FM stage maybe directly related to the hidden flaws at the project management stage (development stage)? Please explain.	Do you think lessons learned from the FM stage can be used to set up targets for performance indicators for FM requirements during the project management stage; What other methods can be used to define FM requirements during the project management stage, Please explain.	Do you think that most FM organisations are positioned to generate data and convert to information that can be readily used to define optimum facility performance requirements that can be used by project managers?	Please provide any other additional comments.
4.	**Yes** - The FM requirements can provide a guide for the PM's to ensure that the design allows for ease of preventative maintenance	Maintenance and replacement of components are not normally taken into account when projects are designed. Projects are much cost driven and thus as an example, hideaway AC units are installed to ensure shortest pipe runs. Additional cable trays follow shortest route and that tends to be in the middle directly under the hide-away unit and making it impossible to replace the filters on the unit.	Yes the stages must support each other. FM stage must look at long term processes and the PM stage must not just look at the initial cost but total life cycle cost of the facility.	I think FM organisations can generate the information but the mind set of Project managers and the construction industry is in a space where they are ready to incorporate long term FM planning in the initial design.	
5.	**Yes** it is important. If the FM requirements are not taken into consideration during the Project Phase, the maintenance team will struggle to maintain the equipment during the operation stage.	**True**, the project teams at times think short term and not consider the long life expected after the implementation stage. Some of the equipment cannot be maintained after being put in operation because the project team didn't even make available any space for the maintenance team to have access. Chillers installed in the roof of a tower building cannot be taken down or replaced because the project team never catered for such after they have left. Spares are also usually an issue because no study was done to check if the equipment is supported after purchase and installation	Yes. The equipment maintenance history can also be used as well as maintenance schedules for the equipment being installed	Yes that is true. The FM organisations are exposed to the actual obstacles that are encountered with after the project team has left. They spend more time with the equipment long after the project is completed	It has always been an oversight not to include the FM team in the project stage of any building work. The is value in including these FM teams so that they can guide the project team with the end in mind since they will eventually run with the equipment afterwards

Respondents	Is it necessary to develop an FM performance management framework to manage FM requirements at an early stage of facility development (Project management stage), to guide project teams, as proposed by this research? Please explain.	Do you think that most of the challenges encountered during the FM stage maybe directly related to the hidden flaws at the project management stage (development stage)? Please explain.	Do you think lessons learned from the FM stage can be used to set up targets for performance indicators for FM requirements during the project management stage; What other methods can be used to define FM requirements during the project management stage, Please explain.	Do you think that most FM organisations are positioned to generate data and convert to information that can be readily used to define optimum facility performance requirements that can be used by project managers?	Please provide any other additional comments.
6.	Skipped	Skipped	Skipped	Skipped	Skipped
7.	Skipped	Skipped	Skipped	Skipped	Skipped
8.	**Yes** it is. Many of the challenges experienced in my work could have been avoided during the PM and design phase of the construction of the facility. Some of these challenges are very costly to rectify.	**Many of them are**. The designers of a facility should learn how to ask the right questions of a client during the early stages of the design phase.	I do believe that Facilities managers should be consulted quite intensively on the performance of buildings in order to learn lessons which can be applied in the PM phase of future facilities. There should be a feedback loop that begins to crystallise into targets for key performance indicators.	I do not have sufficient exposure to answer.	A good project team should involve a facilities manager to avoid potential pitfalls and obstacles to the effective operation of the facility.
9.	**Yes** it is, because it will reduce re-work and shorten the post development snags-list.	**Yes** indeed. During construction there has to be frequent progress inspection to check/verify that building specifications (which have been vetted by FM) are strictly adhered to,	The lessons learnt during project management stage are must be recorded and communicated with FM (e.g. document them as snag lists), stating the remedial actions taken/not taken irt the lessons learnt.	In pursuit to achieve high profit margins plus record project completion times, FM is deliberately excluded during the development-site-inspections because they are viewed as a nuisance, and/or pedantic, and/or causing deviating from the signed-off job scope.	FM must be involved as early as during the signing-of the architectural drawings/designs/specifications/schedule-of-finishes/etc.
10.	Skipped	Skipped	Skipped	Skipped	Skipped
11.	Skipped	Skipped	Skipped	Skipped	Skipped
12.	Skipped	Skipped	Skipped	Skipped	Skipped

Respondents	Is it necessary to develop an FM performance management framework to manage FM requirements at an early stage of facility development (Project management stage), to guide project teams, as proposed by this research? Please explain.	Do you think that most of the challenges encountered during the FM stage maybe directly related to the hidden flaws at the project management stage (development stage)? Please explain.	Do you think lessons learned from the FM stage can be used to set up targets for performance indicators for FM requirements during the project management stage; What other methods can be used to define FM requirements during the project management stage, Please explain.	Do you think that most FM organisations are positioned to generate data and convert to information that can be readily used to define optimum facility performance requirements that can be used by project managers?	Please provide any other additional comments.
13.	**Yes**. Often the client and the professional team have no knowledge of FM or efficiently operating a building and design for ego or appearance and not optimum use.	**Yes**. As said design for appearance or other factors and not for functionality or use.	FMs must get involved upfront in establishing the initial brief for the project. Long before the site, sizes etc. are determined.	Not really. It is most often a business that requires a building and not an FM organisation. The FM organisation may only come into the picture later to operate the building.	I was answering from the perspective of an In House Facilities Manager of a large corporate.
14.	Skipped	Skipped	Skipped	Skipped	Skipped
15.	**Yes**, for the FM team	It can be, but not necessarily.	Yes	not sure	none
16.	Skipped	Skipped	Skipped	Skipped	Skipped
17.	Skipped	Skipped	Skipped	Skipped	Skipped
18.	Skipped	Skipped	Skipped	Skipped	Skipped
19.	**Yes**, but it has to be done in conjunction with the FM that will actually be responsible for operating and maintaining the facility. In my view, using an external FM Consultant is not optimal as the day to day operation and maintenance will not be clear to him. Designing for FM will reduce OPEX.	**No**. I think that some challenges may be attributed to this, but in my experience most challenges are due to flawed FM practices.	By its very nature, FM needs to MANAGE facilities while PM needs to BUILD it. If FM dictates how buildings should be build, then all buildings will look and function exactly the same. In my view maintainability insofar plant and equipment is concerned should be reviewed by FM during the PM process, but it should never become a case of the tail wagging the dog.	No. Most FM companies in South Africa are focussing more on trying to overcome their internal incompetence and less on data acquisition.	FM in South Africa is a relatively new field. This was traditionally done in-house and a formal structure was never really in place. Due to that fact, most FM companies now agrees to ridiculous SLA's out of pure ignorance, and then struggles to keep up with it. In my view, a formal education framework needs to be set up for the FM fraternity before we can hope to have FM part of a PM process.

Respondents	Is it necessary to develop an FM performance management framework to manage FM requirements at an early stage of facility development (Project management stage), to guide project teams, as proposed by this research? Please explain.	Do you think that most of the challenges encountered during the FM stage maybe directly related to the hidden flaws at the project management stage (development stage)? Please explain.	Do you think lessons learned from the FM stage can be used to set up targets for performance indicators for FM requirements during the project management stage; What other methods can be used to define FM requirements during the project management stage, Please explain.	Do you think that most FM organisations are positioned to generate data and convert to information that can be readily used to define optimum facility performance requirements that can be used by project managers?	Please provide any other additional comments.
20.	**Yes** - need to bring FM expertise into design.	Lack of FM expertise in Design stage	Need Competent FM people first.	No. They should be but are not that interested.	
21.	Skipped	Skipped	Skipped	Skipped	Skipped
22.	**Not sure** on what is meant by the FM performance management framework and who this would be imposed on the PM structure of a project	**Yes** - designers (PM) and operators (FM) often approach issues from very different points of view	**Yes** but these need to be managed as there needs to be an understanding that just because something is done in a certain way historically that this then defines the way forever more going forward	No - I don't believe that they understand the concepts required to effectively take from spreadsheet to plan on paper at the design phase	There needs to be a balance found between excluding the important role played by the appropriate FM role players at design time against having FM dictate the overall design and operation model at the risk of committing excessive capital to this, making the project no longer viable.
23.	**Yes**, it is important to ensure that the project at the end of construction complies with all the FM requirements	**Definitely**, if insufficient attention is given to access and maintainability of equipment the building will not perform as required in terms of the expected life cycle.	**Yes**, the FM previous experience can be used to set up performance indicators, as well as previous experience of the Design Team.	I think there are FM organisations that have this experience, but I do not think the majority have that insight and experience.	Integration of disciplines is always difficult and there are the FM requirements as well as Green Building considerations to keep track of. The design process is becoming more and more complex and could add to the cost of buildings, but should pay back in the long term.

Respondents	Is it necessary to develop an FM performance management framework to manage FM requirements at an early stage of facility development (Project management stage), to guide project teams, as proposed by this research? Please explain.	Do you think that most of the challenges encountered during the FM stage maybe directly related to the hidden flaws at the project management stage (development stage)? Please explain.	Do you think lessons learned from the FM stage can be used to set up targets for performance indicators for FM requirements during the project management stage; What other methods can be used to define FM requirements during the project management stage, Please explain.	Do you think that most FM organisations are positioned to generate data and convert to information that can be readily used to define optimum facility performance requirements that can be used by project managers?	Please provide any other additional comments.
24.	**Yes**, As what is installed and quality of installation will impact through the life of the Assets	**No**, depends on quality of the installation and availability of information. Also disconnect between installation design and actual life cycle of building	**Yes**, planned performance of building and actual performance of building is considered. Accountability of PM provider for actual performance essential. FM provider to be involved in PM stage	No, at this stage FM market in SA very immature compared to European and American markets. Metrics not defined or standardised in industry. 70 % still in-sourced with limited availability of data	
25.	*What is a "FM performance management framework"? You don't sufficiently explain what it is you are proposing, other than using lots of jargon.*	***Not sure** what you mean - name some typical FM challenges?*	***Possibly**, but not sure the value of such KPIs.*	*No*	*Not a very well designed survey - I couldn't really understand what you were looking for. Try looking at the "soft landings" publications in the UK.*
26.	Skipped	Skipped	Skipped	Skipped	Skipped
27.	**Yes** this way FM's will be able to operate pro-active and work with PM's to develop.	**Most definitely**,	One hand is helping the other that is what we all need.	They are equipped but not utilizing it.	none
28.	**Would be ideal**, but not sure how practical.	**Yes**.	**Not sure**.	Not all.	Skipped
29.	**Yes**, but there is no standard or guideline. FMs are not design engineers so the level of design and FM input needs to be determined up front before the project is implemented.	**Not necessarily**. Most of the challenges relate to quality of service delivered by the FM team and the maintenance budget.	FM's need to be involved in the initial design concept. The designers need to design the building to these concepts. The concept needs to be specify with regard to systems, energy targets, security, and life cycle expectations amongst others.	No. There is no standard, so each organisation will come up with different results. FM also doesn't get paid professional fees so there is no FM budget initially to do draw up proper specs.	Good luck.
30.	**Yes**, to be used as a standard for project delivery	**Yes**, due to poor quality control	**Yes**, other methods maybe benchmarking	No	This a good initiative

Respondents	Is it necessary to develop an FM performance management framework to manage FM requirements at an early stage of facility development (Project management stage), to guide project teams, as proposed by this research? Please explain.	Do you think that most of the challenges encountered during the FM stage maybe directly related to the hidden flaws at the project management stage (development stage)? Please explain.	Do you think lessons learned from the FM stage can be used to set up targets for performance indicators for FM requirements during the project management stage; What other methods can be used to define FM requirements during the project management stage, Please explain.	Do you think that most FM organisations are positioned to generate data and convert to information that can be readily used to define optimum facility performance requirements that can be used by project managers?	Please provide any other additional comments.
31.	**Yes**	**Yes**			None
32.	As a value management exercise this framework is crucial.	Not necessarily			This a good exercise as it seeks to standardize scope management

Appendix C. Templates used for Data Collection

C1. Survey invitation message

To: [Email]
From: "sindile1@outlook.com via surveymonkey.com" <member@surveymonkey.com>
Subject: Early FM requirements

Body: Dear Sir / Madam

I am an MSc candidate at the University of Witwatersrand, from the School of Construction Economics and Management. I am carrying out a research that seeks to define the operational requirements for facilities that should be managed and delivered upon at an early development stage of the facility. The research was borne out of the observation of the continued fragmentation between the two lifecycle stages of facilities which includes the Project management (PM) and Facility Management (FM) stages. A lot of research has been done about the importance of early FM involvement, however lacks the element of defining the early FM requirements.

In order to achieve the desired integration, the proposal is to develop tools in the form of a performance management framework (PMF) that seeks to define the structure of FM requirements at the PM stage by identifying key performance indicators (KPIs) within which the project manager should deliver the FM requirements upon. The KPIs were identified through extensive literature review, and thus the purpose of this survey is to validate the proposed PMF for early FM requirements.

The thesis for the study is that once the FM requirements are defined upfront, they can be managed at the PM stage to the benefit of the FM during the operational stage and thus reducing the need for rework and costly maintenance due to design and development “faults” at the PM stage.

If you have any pertinent questions and require further information, please contact me via 079 529 9121 or 9707539t@students.wits.ac.za, or my supervisor (Oluwayomi Babatunde) at 011 717 7658 or oluwami.babatunde@wits.ac.za.

Here is a link to the survey:
https://www.surveymonkey.com/s.aspx

This link is uniquely tied to this survey and your email address. Please do not forward this message.

Thanks for your participation!

Please note: If you do not wish to receive further emails from us, please click the link below, and you will be automatically removed from our mailing list.
https://www.surveymonkey.com/optout.aspx

C2. Interview Questions

1. Is it necessary to develop an FM performance management framework to manage FM requirements at an early stage of facility development (Project management stage), to guide project teams, as proposed by this research? Please explain.

2. Do you think that most of the challenges encountered during the FM stage maybe directly related to the hidden flaws at the project management stage (development stage)? Please explain.

3. Do you think lessons learned from the FM stage can be used to set up targets for performance indicators for FM requirements during the project management stage; What other methods can be used to define FM requirements during the project management stage, Please explain.

4. Do you think that most FM organisations are positioned to generate data and convert to information that can be readily used to define optimum facility performance requirements that can be used by project managers?

5. Please provide any other additional comments.

C3. Ranking of the KPIs

Table C1. Questionnaire template - Respondent's profile

Respondent's Profile		
Answer Options	**Response Percent**	**Response Count**
Position		
Profession		
Years of working experience		
Department		
City/Town		
Province		

Table C2. KPIs template - Strategic

KPIs - Physical and Functional (Importance of strategic decisions at project management stage on the effectiveness of facility).						
Answer Options	**Extremely Unimportant**	**Unimportant**	**Neither Unimportant Nor Important**	**Important**	**Extremely Important**	**N/A**
Built Area (optimisation of maintenance and operational cost)						
Occupancy (Impact on wear and tear)						
Space planning						
Energy Usage						
Water Usage						
Parking						
Security						
Facility design life						
Site location						
Selection of Equipment and Material						
Availability of Equipment (Work hrs)						
Efficiency of Equipment						
Availability of parts						

Table C3. KPIs template - Financial

KPIs - Financial (Managed from the early stages of project management)						
Answer Options	**Extremely Unimportant**	**Unimportant**	**Neither Unimportant Nor Important**	**Important**	**Extremely Important**	**N/A**
Capital Cost						
Operational Cost						
Occupancy Cost						
Maintenance Cost						
Utility Cost						
Disposal Cost						
Residual Value						

Table C4. KPIs template - Quality

KPIs - Functional (Importance of the following Quality attributes to be managed at the project management stage)						
Answer Options	**Extremely Unimportant**	**Unimportant**	**Neither Unimportant Nor Important**	**Important**	**Extremely Important**	**N/A**
Accessibility						
Convenience						
Appearance						
Quality of life (Lighting, HVAC, Noise, Air and Water quality)						

Table C5. KPIs template – HSE and Social impact

KPIs - Functional (Importance of Environment, Health and Safety, and Social impact to be managed at the project management stage)						
Answer Options	**Extremely Unimportant**	**Unimportant**	**Neither Unimportant Nor Important**	**Important**	**Extremely Important**	**N/A**
The project team must carry out operational risk assessment and mitigation at the development stage.						
The project team should design for both construction and operational hazard						
Environmental impact						
Social impact						

Table C6. Information management template

KPIs - Functional (Importance of Information Management at the project management stage)						
Answer Options	**Extremely Unimportant**	**Unimportant**	**Neither Unimportant Nor Important**	**Important**	**Extremely Important**	**N/A**
Maintenance data						
Product data						
Equipment attributes (e.g. description, location)						
Quality of data (usability)						
Lessons learned from FM practice						
Lessons learned from PM practice						