

IMPROVING THE INTEGRATION OF BUILDING DESIGN AND FACILITIES MANAGEMENT

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List of Abbreviations

AC	Air Conditioning
AIA	American Institute of Architects
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
BIFM	British Institute of Facilities Management
BIM	Building Information Modelling
BMS	Building Management System
BOO	Build, Own and Operate
BOOT	Build, Own, Operate and Transfer
BOT	Build, Operate and Transfer or Build, Own and Transfer
BRT/BLT	Build, Rent/Lease and Transfer
BRE	Building Research Establishment
BREEAM	BRE Environmental Assessment Method
BTO	Build, Transfer and Operate
CCTV	Closed Circuit Television
CPMS	Customer Performance Measurement System
CPRM	Client Requirements Processing Model
CR	Client Requirements
CSI	Construction Specifications Institute
dB	Decibel
DBFO	Design, Build, Finance and Operate
DQI	Design Quality Indicator
FM	Facilities Management
Gulf	Saudi Arabia, United Arab Emirates, Qatar, Kuwait, Bahrain and Oman
HVAC	Heating, Ventilation and Air Conditioning
IEEE	Institute of Electrical and Electronics Engineers

IFC	Issued For Construction
IFMA	International Facilities Management Association
IPD	Integrated Project Delivery
IT	Information Technology
KPI	Key Performance Indicators
KSA	Kingdom of Saudi Arabia
LED	Light-emitting Diodes
LEED	Leadership in Energy and Environmental Design
MEFMA	Middle East Facilities Management Association
MENA	Middle East and North Africa
MEP	Mechanical, Electrical and Plumbing
NFPA	National Fire Protection Association
O&M	Operation and Maintenance
PAS	Publicly Available Specification
PBD	Performance-based Design
PFI	Private Finance Initiative
PM	Project Management
POE	Post Occupancy Evaluation
PROBE	Post-occupancy Review of Building Engineering
QFD	Quality Function Development
QSAS	Qatar Sustainability Assessment System
RAE	Royal Academy of Engineers
RERA	Real Estate Regulatory Agency (Dubai, UAE)
RIBA	Royal Institute of British Architects
RICS	Royal Institution of Chartered Surveyors
RM	Requirements Management
UAE	United Arab Emirates
USGBC	United States Green Building Council

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Abstract

This thesis investigates the relationship between facilities management (FM) and design on construction projects in the Middle East region. Input provided by facilities management, the party responsible for developing and maintaining a facility support services system, is found to be vital for enhancing the design's supportive function and preventing operation problems from occurring during the occupancy phase.

An extensive literature review is undertaken to study both FM and design practices, their responsibilities during a facility's life cycle and the types of services each discipline provides. The nature of facilities management input into design is also explored. The review of literature reveals a limited integration among the facilities management and design professions, a problem mainly caused by the nature of project delivery processes that prevent external input into the design. Accordingly, the research aims of investigating integration in practice and determining the actions to be taken to improve the situation are developed.

The survey method is chosen for carrying out the research, involving FM and design practitioners. Semi-structured interviews are utilised for collecting qualitative rich information on professional views and experiences.

Research findings disclose the nature of the relationship between facilities managers and designers as well as the status of their current collaboration on construction projects in the Middle East. FM-related concerns occurring during the occupancy phase are identified to show the prominence of their consideration during the design stage. This research also presents the various benefits of achieving successful integration and identifies the different means which could be implemented to improve the process of integration and avoid negative consequences currently affecting facilities and their occupants.

Chapter 1 | **INTRODUCTION**

Rapid advancement in technology and the increased competition in modern economies, have forced organisations to create efficient supporting services systems to achieve business objectives. One of the factors that challenge the implementation of such efficient systems, provided by facilities management, is the design of facilities.

In the absence of additional management efforts, complex buildings can get dysfunctional early on. FM gathers knowledge from both the design and building management to guarantee that long term design activities and short term management strategies should not ignore one another (Leaman, 1992). This shows the connection between design and management of buildings which should be always present to maintain an efficient long term building functionality and successful business operation.

Bröchner (2003) points out the reality that innovation in jointly developing goods and associated services in manufacturing is starting to surface, while the connection between facility design and management is still weak underlying an absence in integration.

Rarely do designers get back to measure building performance of facilities that they were responsible for designing, an indication of lack of communication between designers and facilities managers (Arditi and Nawakorawit, 1999). Such communication is still considered an exception rather than a rule in project design and construction, despite the rise in using post-occupancy evaluations and the importance of their results about building performance.

Erdener (2003) explains that research has shown major gap between client/user needs and the facility's ability to accomplish those needs, a limitation attributed to inadequate/insufficient communication between all parties involved in designing, building and operating facilities. Minimizing errors that lead to unsatisfactory

results in designing facilities is achieved through providing designers with true-life information that is in the possession of facilities managers.

According to Jensen (2009), achieving an FM involvement during design stage would lead to facilities that:

- a. Meet organisational business needs more appropriately
- b. Attract customers more
- c. Are simpler to commission and maintain
- d. Are easier to manage and control
- e. Are operated more cost effectively
- f. Respond better to occupant needs

The involvement of facilities management in the design phase of facilities, providing designers with this true-life information has diverse positive effects on facilities, core business operations, facilities management operations and users, as shown above.

After all, design has an effect on sales, efficiency, staff, profit, capital investment and maintenance costs (Ransley and Ingram, 2001). These factors are the concern of facilities management as much as they relate to the organisation's core business success. Therefore, managing FM requirements during design is necessary for an organisation to achieve its goals after occupying a newly built facility.

1.1 Research Problem

Olatunji and Sher (2009) reveal two correlated phases of construction development and management of facilities which are: Construction processes and management, and facilities management. On one hand, construction processes

and management incorporate project initiation and conceptualization, design drafting and development, specification preparation, contract documentation and contracting reaching the construction phase. On the other hand, there is facilities management that takes care of post-construction activities and support services throughout the facility life. The authors state that the challenge for construction processes is to deliver a functioning facility within the initially set budget and on time, whereas the challenges for facilities management are to fulfil client and user needs and requirements without affecting the project's economic and structural benefits.

The increase in sophistication of buildings has led to the investment of up to half the building cost (both capital and operating) in services and facilities, as stated by Jaunzens et al. (2001). The authors therefore state that it is surprising, and rather unacceptable that the FM role continues to be rarely acknowledged as being key in guaranteeing that the requirements for facilities and services are considered during design phase.

In addition, Martin and Guerin (2006) argue that designers are required to be knowledgeable about the relationship between people and their built environment because standard design processes nowadays are insufficient in resolving multifaceted problems involving people in various environments.

Despite the fact that the participation of facilities management personnel within a client organisation was handled by Jaunzens et al. (2001), concerns about the overall integration of FM knowledge and requirements in design were still being revealed in studies that followed.

Hien et al. (2003) declare that most cases of current practices in conventional building delivery processes have shown limited integration among the various concerned parties, and the process is highly fragmented from design to

construction phase. The approach, according to Hien et al., is usually a one direction process which focuses most on the design procedures without any further input from outside professionals.

In line with the above, facilities management and design are seen as two different processes whereby the former starts on with the commencement of the construction process and the latter engages in post construction practices, according to Ercoskun and Kanoglu (2003). Martin and Guerin (2006) also mention that FM personnel are not seen interfering in the production of design solutions and are relying on designers to take action in benefiting from research practices in design. This matter had led Jensen (2009) to propose mechanisms for the transfer of FM knowledge to design in order to achieve integration.

Fianchini (2007, p. 139) added on to Hien et al. (2003) and Martin and Guerin (2006) the fact that “the real needs of the different user groups are not adequately satisfied, because they are not identified accurately”. Fianchini (2007) continued to affirm that this is resulting in built facilities that are not fit for purpose, and the reasons behind such consequences is, on one hand, due to limited follow-up and evaluation of project outcomes and on the other hand, the absence of a culture of user-participated decision making in construction processes. The inaccurate identification of various user group needs leading to inadequate satisfaction is therefore not only due to the absence of participation during the design phase of a facility, but also extends to occupancy phase whereby facility performance evaluation is being limited.

Moreover, Jensen (2009) considers that one of the drawbacks in the building industry is the inadequate knowledge attained from facilities’ operational and maintenance experiences. The author considers that the field of facilities management research is still new and only a small number of studies are carried out to address the topic of FM integration in design.

1.2 Establishing the Research Questions

From what has preceded, it is deduced that while facilities management and design need to be integrated to enhance the supportive function of the design and avoid facing FM related concerns during occupancy phase, the two disciplines are still seen as different processes and the integration remains limited.

Existing literature reveals various factors related to design and FM which affect the integration process as well as an absence of project outcome evaluation and feedback loop from occupancy to design phase. Limited integration also leads to several consequences affecting the built facility, users and facilities management operations. FM knowledge is hindered from reaching designers at a time when it is essential to transfer this knowledge from FM to design in order to achieve integration.

The above is also coupled with an insufficient knowledge acquired from facility use and operation experiences and a limited amount of research carried out to study the subject of integration.

Despite the few studies available which address integration, the limited integration of FM and design was handled by several authors (Jaunzens et al., 2001; Bröchner, 2003; Erdener, 2003; Martin and Guerin, 2006; Jensen, 2009). In addition, means to approach this limitation and overcome barriers was also presented by Jaunzens et al. (2001) and Jensen (2009). However, these studies were carried out on FM and design practices in the United Kingdom, United States of America and Nordic countries.

None of the research available targets limited integration of FM and design within the Middle East region. One study was carried out in the Kingdom of Saudi Arabia by Al-Hammad, Assaf and Al-Shihah (1997) to investigate building design defects,

part of which affect the adequacy and practicality of building maintenance. Nevertheless, this study did not involve the party concerned with maintenance of facilities, facilities management that is, but rather involved designers, building contractors and clients. The need for FM and design integration was not mentioned, and no limited integration was highlighted or examined.

Stensgaard (2006) considers that the FM practice in the Middle East has been different from that in European countries, with a lack of concentration on efficient and integrated facilities management. Moreover, the rapid growth of the construction industry in the Middle East region is demanding a greater understanding of the FM practice and money-saving measures within the FM service. Eagle (2011) also reveals that ensuring FM incorporation in design of new facilities is still underway in the Middle East, and no measures are yet developed and available to address this subject. This shows that the Middle Eastern FM industry in general is in many ways different from other regions where research has been taking place, and there is a need for more understanding of the FM practice as well as initiatives to incorporate facilities management requirements in design.

In view of the above, this research proceeds through asking the following questions:

“How is the integration of facilities management and design experienced within the construction industry in the Middle East?”

and

“What could the scope for improvement be?”

To answer these questions, the research aim and objectives were hence formulated.

1.3 Research Aims and Objectives

Literature review demonstrated that facilities management and design need to be integrated in order for designers to consider FM aspects while designing, and enhance the supportive function of their designs. While integration should take place to avoid operation problems and FM related concerns during occupancy phase, literature has revealed that facilities management and design integration is limited on construction projects. Whereas little amount of research was carried out to study this integration, none was carried out on FM and design practices in the Middle East; despite the need for further understanding in this region that is witnessing a rapid growth in construction activity.

Therefore,

The aim of this research is to investigate the integration of building design and facilities management in the Middle East region, and identify potential approaches to enhance the chances of incorporating FM considerations in design.

The above mentioned aim results in the following objectives:

- 1. Perform an extensive literature review on FM and design disciplines, the nature of their integration and the factors affecting this integration*
- 2. Analyse the relationship between facilities managers and designers in the Middle Eastern practice. This includes the general relationship and interaction, as well as the FM participation in design*

3. *Explore the involvement of facilities managers and designers in evaluating occupied facilities, highlighting the roles of both parties in assessing the design outcome*
4. *Examine the facilities management related concerns arising during occupancy phase, and the status of their current consideration in design solutions*
5. *Investigate the factors affecting FM and design integration and the resulting consequences*
6. *Determine the purposes of improvement and the resulting possible measures to be taken.*

1.4 Uniqueness and Relevance of the Research

This research aims to provide an insight into the facilities management and design integration on construction projects in the Middle East, in light of the absence of previous research on the topic in the aforementioned region.

The researcher intends to tackle the relationship between facilities management and design professionals as currently occurring in practice and provide recommendations on actions that could be taken to enhance the FM and design interaction and improve the integration process.

This research is also set to provide clients, facilities managers and designers with knowledge to better understand the situation occurring in practice, in relation to FM and design integration. This understanding can be used to benchmark organisations' processes in relation to what is described through this research,

and introduce modifications to benefit facilities, core business operations, occupants and the FM service provided.

1.5 Research Limitations

As the situation is with any other research, this study has some limitations.

One limitation is that research participants taking part in this research either worked for design firms which practice design in various market sectors or FM firms that offer a wide range of FM services for various types of facilities. While this contributes to the generalisability of the research, the information included in this research might not necessarily be applicable in its entirety to each and every facility type; taking into consideration that each facility has its own requirements and every project is unique.

Inquiring about the particulars of different design markets, i.e. the various facility types (hotels, hospitals, offices, residential, airports, etc...) did not prove to have effective results. Participants were asked about the differences between FM-related issues among various types of facilities and the answer was rather general; mainly that every facility has its own requirements but there is a lot in common.

This research suggests that hotels, hospitals, shopping malls and other facilities involving transient users would be the most facility types to benefit from FM and design integration. This fact could be related to the type of end-users involved, whether hotel occupiers, hospital patients and the like whom their satisfaction continuously affects long term operation and the overall organisational profit.

Another limitation is due to time constraints. Approaches related to FM participation and role during design stage suggested by this research were not tested on projects under construction, to analyse the effectiveness of their

implementation and the resulting outcome. This process requires the involvement of the researcher in an ongoing construction project and follow-up on events from inception to completion and through to occupancy phase; a duration that is longer than the normal time given to complete a Ph.D. degree. A study concerning such an involvement was beyond the researcher's ability to carry out, but should be implemented whenever possible.

1.6 Thesis Organisation

Comprising eight chapters (Figure 1), this thesis proceeds to Chapter 2 to present the literature review carried out. Facilities management and design disciplines are introduced through providing history and definition, roles and responsibilities and the details related to services provided by each discipline. Managing client requirements which include those of facilities management are presented, uncovering the content of the design-related FM issues. This chapter then provides an explanation of the process of FM and design integration, factors affecting it, consequences resulting from limited integration, and the purposes for implementing improvements. Finally, previous research done in relation to FM and design integration is presented.

Chapter 3 introduces research methodologies and data collection methods. The different approaches to research, research design and assumptions, various methodologies and data collection techniques used for both quantitative and qualitative research are all reviewed. This chapter also discusses the research context, population and the sample frame.

Chapter 4 describes the data collection exercise carried out by the researcher and the analysis of the collected data. Pilot work done, development of the standardised interview, selection process of the members of the sample, and the data analysis process are all discussed.

The research findings obtained are included in Chapter 5 of this thesis. Findings handle the topics of FM and design relationship, evaluation of constructed facilities in use, the current integration of FM knowledge in design, promoting the inclusion of FM in design and achieving integration outside the boundaries of a facility under construction.

Discussing the research findings against the knowledge presented by the literature is performed in Chapter 6. Research findings are compared and contrasted with the literature knowledge and additional (new) information provided by this research is also identified.

Chapter 7 includes a review of the various approaches to achieving validity and reliability of the conducted research. Various strategies for achieving trustworthiness of qualitative research are explored. The strategies relevant to this research are discussed describing the actions taken by the researcher to ensure that the results of this research are credible, transferable, dependable and confirmable.

The thesis concludes with Chapter 8 which highlights the main findings of this research as well as the contribution to knowledge, and suggests actions that could be implemented for future research.

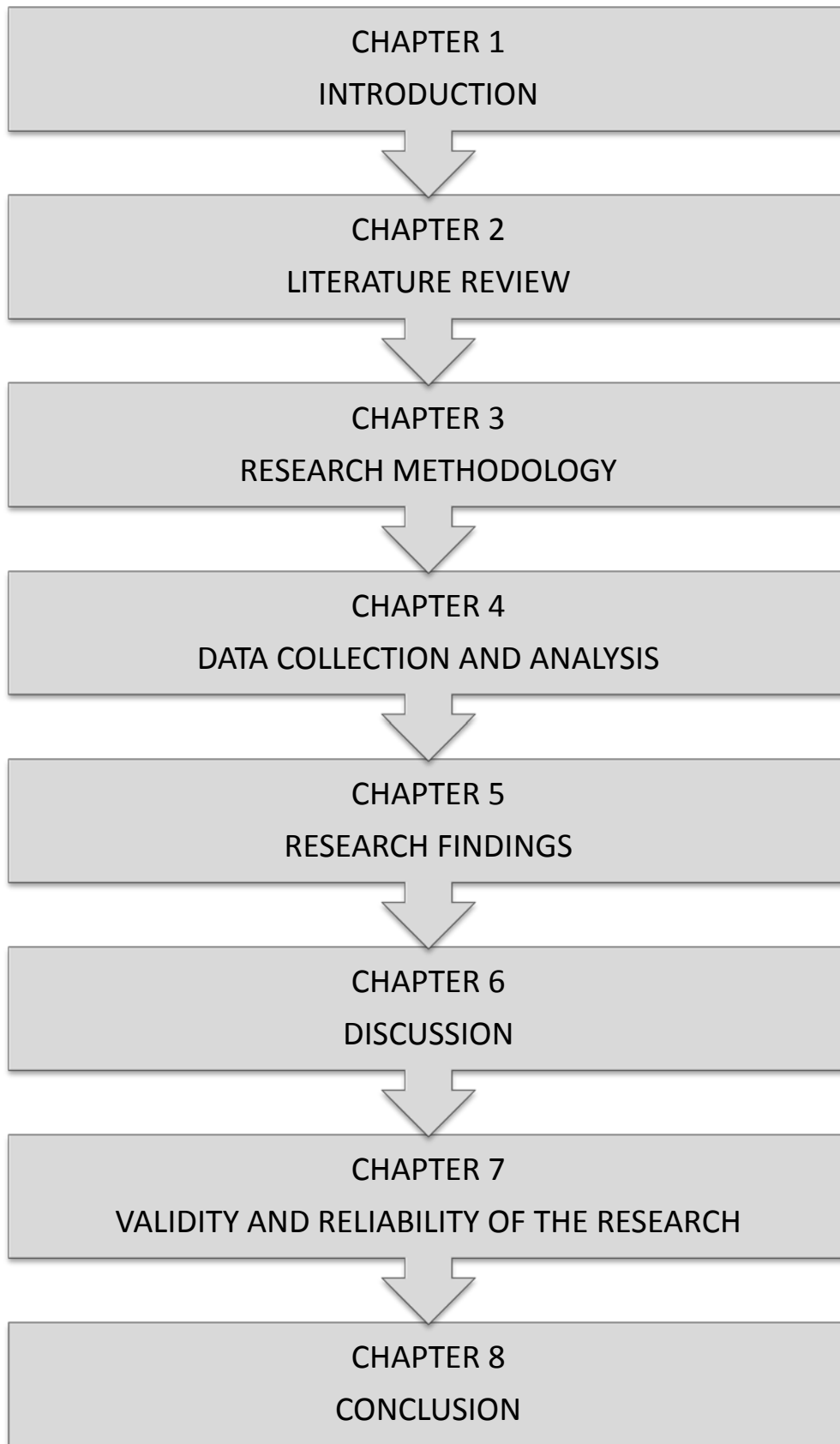


Figure 1 Thesis Organisation

1.7 Ethical Considerations

The researcher declares that no psychological, financial or social harm is caused to any of the participating individuals or the organisations employing them. The researcher throughout the course of this research has ensured that anonymity of participants is preserved, participants are not exposed to any mental stress, no research is carried out without participants' knowledge and none of the participants is embarrassed or offended in any way.

This research does not approach any vulnerable individuals or communities, but is only related to commercial sensitivity and confidentiality. All information gathered for this research is kept confidential, and no participant names or the names of organisations they work for are mentioned anywhere in this thesis. Research participants are assured that the information they provide shall remain confidential, not to expose any data related to clients, projects or organisational operations.

CHAPTER 2 | **LITERATURE REVIEW**

Due to having a more knowledgeable and networked contemporary society, designers are being required to deal with building occupiers of different cultures and various professional backgrounds. As a result, the traditional design knowledge is no longer enough in solving complex client demands (Manzini, 2009). Therefore, the continued utilisation of design knowledge based on traditional processes will result in unsatisfied client demands as the complexity increases. This increase in complexity also affects facilities management (FM) operations which are directly linked to the facility type and purpose of use.

“...but it is only the analysis of best practices in facilities management that can provide an innovative input to the supportive function of building design” (Bröchner, 2003, p. 23). The above statement illustrates the idea behind the need to enhance the supportive role of a building’s design through integrating FM requirements when designing. Qualitative non-financial factors on top of the conventional cost, profit, and output concerns (Pitt & Tucker, 2008) will have to be considered.

In order to discuss facilities management and design integration, the two facility-related disciplines and their role should be introduced first, followed by a discussion on the nature of integration and content of FM input into design. In other words, this literature review starts with discussing facilities management, its components and relation to an organisation’s core business. Facility design is handled next, elaborating on the various design stages and revealing the correlation between facility users’ needs and design processes. Facilities management requirements, their identification and communication to designers are then presented to conclude the description of the research topic.

Based on the literature review, a research problem is identified leading to the identification of a gap in the knowledge presented. Contributions to the knowledge

reflecting previously carried out work to address the research problem are revealed.

2.1 Facilities Management

Once an organization occupies any facility for the purpose of implementing its core business services and processes, facilities management is then required to support the core business and ensure continuity.

Combining both resources and activities, effective facilities management is fundamental to the success of any organisation. FM contributes to the delivery of corporate strategic and operational needs, as well as provides an efficient and safe environment through carrying out the day-to-day operations. The role of FM is strategically important as it translates the requirements of senior decision makers into a day-to-day situation affecting people at work or where they live (BIFM, 2012).

2.1.1 History and Definition

Facilities management as defined by the Centre for Facilities Management (Quoted in Alexander 1996, p. 1) is “the process by which an organization delivers and sustains support services in a quality environment to meet strategic needs.” Alexander continues to mention that FM is important to all types of organizations all over the world, taking into account the varying cultures and management styles from one context to another.

Facilities management is an ancient practice dating back to the Romans, who considered FM to be essential. The word facility is derived from the Latin word *facio* (I do) and the adjective *facilis* (easy to do), through a medieval French intermediary (Bröchner, 2010).

Bröchner (2010) continues to state that the period marking the Late Republic and the Early Empire, dating back to the first century BC and followed by two centuries, provides rich sources of texts written by Roman authors, as well as other papyrus letters and archaeological remains which could illustrate what would be called facilities management. Although there was an absence of a unified profession of facilities managers in Rome, three sites could be identified which involved the roles of facility services coordination. These sites were agricultural estates, housing estates and baths. Public baths required special managing skills and there were FM managers available to run these baths. In the Roman society, baths were also regarded as the most complicated facilities to manage.

Fagan (1999) also discusses bath management contracts, in societies that existed in what is now the country of Portugal, requiring the FM manager to wash, dry and grease the bronze implements used while carrying out the FM service.

Although FM existed in ancient times as presented earlier, the term “facilities management” originated around the year 1970 (Price, 2003a; Price 2003b). According to Becker (1990), the increasing global competition and IT development, the higher costs of office space, the numerous defects in quality and the increasing expectations from staff, are all reasons that contributed to the development of a new discipline, facilities management that is.

According to Teicholz (2001, p. 21), facilities management is considered to be “multidisciplinary or trans-disciplinary” dealing with knowledge from engineering, architecture, design, accounting, finance, management, and behavioural science.

As a result, it is deduced that FM is not only correlated with the operations and maintenance works in a building. “It is clear that facilities management is not simply the operation and maintenance of buildings, the provision of cleaning services or the recording and rearranging of furniture in offices”; but instead, FM

handles strategic planning that provides efficient and effective services starting from top management in any organization to deliver enhancements to the relevant economy and better corporate competing capabilities (Alexander 1996, p. 7).

Both Alexander (1999) and Tay and Ooi (2001) consider that the FM sector typically deals with business support services such as the management of space and the workplace. FM offers a wide range of services; but these services are linked due to their purpose of meeting organizational needs (Sillanpää and Junnonen, 2012).

2.1.2 Role and Responsibilities

Comprising a broad range of facility services, FM is considered to be a factor seriously contributing to the success or failure of an organization in running its business effectively and achieving its goals (Chotipanich, 2004). Teicholz (2001) states the 41 responsibilities set by the International Facilities Management Association (IFMA) which are grouped into eight categories covering real estate, planning, budgeting, space management, interior planning, interior installation, architecture/engineering services, and building maintenance and operations.

Chotipanich (2004) also lists the various types of support services in order to reflect the wide range of FM services grouped under the following different categories: Real Estate & Property Management, Facility Project Management, Maintenance & Repairs, Building Services & Operations, Office Services, Planning & Programming, Space Planning & Management, Operations Administration/Management, and Employee Support and Services.

The model generated by the Facilities Management Institute (FMI) showing FM as “People, Process, and Place”, reflects the contribution of FM in relating employees to working procedures and workplaces through an efficient and integrated system.

Therefore, FM practically links the work type and nature to the work location and consequently handles issues such as human resources, process engineering, ergonomics, architecture, and interior design (Teicholz 2001). Jensen (2011) also adds that facilities management in relation to corporate business provides support value. Corporate business creates value to external customers while FM creates value to customers who are internal to the organisation, in the course of providing support to the core business.

FM supports organisations' businesses through managing both the physical resources and the workplace in two aspects, operational and strategic (Chotipanich, 2004). The former, which is the more visible aspect, deals with matters which run on a daily basis to ensure an optimal workplace that is safe and efficient. The latter covers more issues related to planning, decision making, and facility development strategies.

Jensen (2011) also discusses the two types of facilities management: strategic and non-strategic FM. The author considers that strategic FM aims to provide an FM service which fits the corporate needs, a matter which is only achievable when corporate strategic planning is linked to FM. According to Jensen (2011), strategic FM is mainly involved with:

- a. Long-term development of infrastructure
- b. Capability development of facilities and relevant services
- c. Defining FM policies and FM organisational goals

Non-strategic FM on the other hand, mainly deals with executing the contract provisions through delivering the service to clients, guided by the various strategies, policies and goals.

Combining both the strategic and operational (non-strategic) aspects, the various outputs of proper facilities management should then include (BIFM, 2012):

- a. Effectively managing organisational assets
- b. Enhancing facilities managers' skills and providing them with specific career opportunities
- c. Enabling innovative working processes in an era driven by technology
- d. Enhancing the image and identity of organisations
- e. Helping the integration procedures linked to change, merging or acquisition
- f. Providing business continuity and protecting the workforce

Based on Schindler (1998, quoted in Chotipanich 2004), FM practices are influenced by business objectives and nature in addition to the prevailing culture. Chotipanich (2004) also discusses internal and external factors that directly influence the type of services provided by facilities management. Internal factors deal with the characteristics of a facility and the type of business, while external factors include socio-economical matters, culture and context, legal issues, and the environment. These internal and external factors influence all decisions taken by an organization concerning FM services and its appropriate practices.

Due to the above internal and external factors, facilities management should therefore acquire knowledge on how to measure its performance within a specific business sector in order to link business strategy to operational management (Price, 2001).

2.1.3 Components

Sullivan, Georgoulis and Lines (2010) mention that, according to the International Facility Management Association (IFMA), and through utilising the principles of multiple disciplines to manage people, processes and technology, facilities management coordinates the operation of facilities and corresponding assets.

The FM service concept, as seen by Edvardsson and Ohlsson (1996), is made up of customer outcome, customer process, and the service prerequisites. Customer outcome and process relate to the client, while the prerequisites for services are formed from the FM point of view. FM managers' responsibility is to manage the space, enhancing the performance of the organisation occupying it (Edum-Fotwe et al., 2003).

Edvardsson and Ohlsson (1996) identify three FM service prerequisite elements:

a. Concepts

Concepts describe client needs and the methods of carrying out the FM service. FM service contracts signed between client and FM are important for defining customer requirements as well as the FM tasks.

b. System

The service system comprises all the resources needed for carrying out the FM service. These include users and customers, the FM service provider personnel, the technical and physical resources in addition to organizing and control.

c. Process

The service process constitutes the chain of parallel and/or sequential actions, part of which take place inside the client's organisation.

FM services are mainly divided into hard services (building fabric) and soft services (including catering, cleaning, security, mailroom, health and safety, etc...) BIFM (2012).

Kulatunga, Liyanage and Amaratunga (2010) describe hard FM as the maintenance and management of facilities, whilst soft FM as the management of

support services. Hard FM involves the built environment which includes property and physical assets, electricity, telecommunication systems, indoor air, structure and fabric and water supply. Soft FM handles cleaning, catering, security, waste management, and laundry.

Jensen (2008) refers to hard services as being building-related, and soft services as being service-related. These technical (building-related) and service functions constitute the operational functions; however, FM also originates from other functions related to clients and corporate real estate, i.e. strategic role of FM dealt with earlier.

Pitt and Tucker (2008) present the three FM components being physical, functional and financial. The financial component comes as a consequence of the other two. Physical properties include structural integrity, lighting, heating, energy efficiency, maintainability and durability. While functional aspects incorporate space, layout, ergonomics, image, ambience, communication, health, safety, flexibility and all concerns relevant to the link between the building and its occupants.

For the purpose of introducing facilities management services, some of the activities which facilities professionals are in charge of, are presented in what follows:

- a. Maintenance and Resource Management

Maintenance management, as stated by Hernandez, Seepersad and Mistree (2002), requires using resources efficiently, effectively and economically to restore equipment or keep it in its serviceable state.

Maintenance management embraces both corrective and preventive maintenance. While corrective maintenance is required after a failure occurs, preventive maintenance according to Monga and Zuo (1998), comprises tasks necessary for improving the system before it fails. Preventive maintenance of a mechanical system for example, requires tasks such as cleaning, lubricating and adjusting to ensure that the system is restored as new after preventive maintenance is carried out (Monga and Zuo, 1998).

According to Chandrashekar and Gopalakrishnan (2008), implementing an efficient maintenance strategy is required to manage resources effectively and decrease the costs of repairs and replacements, in addition to reducing overall risk and equipment failure. Such maintenance strategies aim to develop a preventive maintenance program, promote in-house inspection procedures and priority scheduling for rectification, on top of creating a corporate maintenance management knowledge base.

b. Environmental Management and Energy Issues

Nousiainen and Junnila (2008) state the main user objectives in relation to the environment which include minimizing electricity consumption, waste recycling/reusing, minimizing waste generation, decreasing climate change emissions, considering environmental requirements in purchasing, reducing water consumption, particle matters, acidification, and ozone depletion substances. In addition, waste treatment, improving operation efficiency, the use of raw materials, and personnel training are also of great importance.

According to the authors, one of the most important services is the environmental information reporting which includes data on emissions,

energy consumption, waste amounts, and relevant expenses. On the other hand, energy efficiency is still considered a low priority objective which will apparently rise with the increase in energy prices.

c. Building Flexibility

Another FM role deals with the flexibility of buildings and the multiple uses of space for a range of functions. McGregor (2000) talks about efficiently utilizing a space layout, correlated with building flexibility and the capability to handle workgroup relocations, various functions, and varying work practices.

Saari et al. (2007) emphasize the growing needs for building flexibility due to the fact that the ownership of property has become separated from its use; adding to that the changing nature of work which imposes modifications to existing premises.

Szarejko and Trocka-Leszczynska (2007) declare that owners of modern office buildings, for example, are facing serious trouble in performing changes while taking into consideration the needs of potential users. Consequently, modernizing an office building requires knowledge about the expectations of various tenants taking into account the building flexibility which enables the space to accommodate for different needs.

d. Ergonomics

Facilities management should also look after ergonomics (workstation design and furnishings, lighting and noise considerations, etc...) to provide flexible working environments which enhance productivity, meet safety

requirements, balance costs, and meet the needs of workers (Ergonomics and Facilities Management, 2008).

Facilities managers should coordinate with designers and tenants to include ergonomics (workstation design and furnishings, lighting and noise considerations for example) in the design of buildings in an effort to provide flexible working environments which enhance productivity, meet safety requirements, balance costs, and meet the needs of workers (Ergonomics and Facilities Management, 2008).

e. Planning and Organisations' Future Concerns

Having a strategic role in supporting organisations, facilities managers are also responsible for planning taking into consideration the organisation's future needs and requirements.

When executing a master plan for example, "The question is which facilities should be opened in order to guarantee that overall benefit return over time is on the highest possible trajectory" (Hochbaum, 2009, p. 649). Hochbaum argues that once any facility is constructed, fixed costs are incurred which cannot be terminated by simply closing the facility.

According to Chotipanich (2004), internal factors related to the facility characteristics affect FM services. These characteristics are defined by the design of a facility as Section 2.2 will reveal.

2.1.4 Present and Future Development

Including new developments and constant innovation is important to FM organisation as this would result in greater customer satisfaction, additional value to the core business and business continuity (Sillanpää and Junnonen, 2012).

As a profession, facilities management is continuously gaining importance within the industry due to the increase in competition within the international market. According to Cotts (1999) and Badger and Garvin (2007), businesses have realised that their facilities require considerable investments of resources, which in turn has created an essential role for FM in the success of organisations.

Since the early beginnings of the profession reaching our present day, FM has passed through various development stages. According to Pathirage et al. (2008), there are four generations of FM development, each of which considered FM as:

1. An overhead which should be implemented at minimum cost rather than best quality.
2. A continuous and integrated process with respect to an organisation's core business.
3. A resource management process taking care of FM functions and related supply chain management.
4. A strategic management process ensuring that organisational structure, work process and the physical environment are alignment based on the organisation's strategy.

The above mentioned generations of development show that the focus in FM has gradually moved from cost reduction to a strategic core business support (Jensen et al., 2012).

Since the 1970s, the methods of controlling facilities have changed significantly. Back then, organisations had dedicated teams of engineers responsible for

carrying out the maintenance on an organisation's premises in addition to other business supporting services (Bernard Williams Associates, 1996).

Moving towards the mid-1980s, the concept of outsourcing emerged within large public and private companies, in an endeavour to reduce maintenance costs, enhance labour skills and adapt to the advancement in technology. Even though outsourcing had started to become more and more common, services such as cleaning and security were the ones being outsourced while the technical/engineering services were still carried in-house. The development of the facilities management as a profession was greatly assisted by the widespread practice of outsourcing during the 1990s, when all FM services along with the non-technical services were being outsourced. FM began to perform a more integrated role covering the whole but fragmented organisational structure (Loosemore and Hsin, 2001).

The use of social media as a major factor in collaboration could, by the year 2020, increase integrated communication within organisations and enhance connections between different departments, thus realising FM's true value (FM LINK, 2013).

This rise in importance within the industry is also coupled with concerns. Based on an extensive literature review carried out by Georgoulis (2008), it was proven that only a small amount of data currently exists on the FM profession.

Other concerns related to the FM industry are also discussed by Sullivan, Georgoulis and Lines (2010), mainly dealing with facilities managers of the older age group who will be retiring soon, coupled with the low number of new entrants into the profession. The authors also mention concerns related to university education, whereby available FM programs that offer suitable education for new FM managers are still very few.

2.2 Building Design

Having introduced facilities management, the design role and position within the overall facility development phase will be handled next, in order for FM input into design to be later visualised and discussed.

Merritt and Ricketts (2001) define facility design as a process which provides all required information necessary for construction, according to the owner's requirements, satisfying health, safety and welfare obligations. Wong et al. (2009) state that when provided with the client requirements and preferences, designers are responsible for producing drawings and specifications. These documents are later utilised in constructing the facility to be occupied by the client.

“Being a designer means being an optimist” (Manzini, 2009, p. 4). Designers must make proposals; based on opportunities they meet, and through combining subjectivity and creativity, they are able to deal with the most difficult problems and consequently generate solutions.

In this section, the topic of building design shall be discussed reflecting on the history of the profession, various design objectives, design disciplines, and the different design stages. Client and users involvement in the design process, their requirements and consequent satisfaction, together with designers' performance and the quality of design outcomes shall also be examined.

2.2.1 History

From a facilities point of view, the Roman age differed from our present-day conditions in that Romans lacked the differentiation between home and office. Work and leisure were realised in different ways, mainly due to the ancient technology which only changed when energy became available during the 1870s. From that point onwards, electricity was used for lighting, heating, ventilation and

cooling, as opposed to the unsustainable approach of Romans who relied on timber for fuel (Bröchner, 2010).

Dating back as early as the first century BC, studies on architecture and its fundamentals have been carried out to define the objectives of design and the factors affecting the overall development of facilities.

Vitruvius, a roman architect and engineer active in the first century BC stated that architecture depends on the elements of order, arrangement, eurythmy, symmetry, propriety and economics.

Vitruvius in his works on the fundamental principles of architecture (Vitruvius, 1934) defined Order as giving a measure to members of work which are considered separately, and symmetry to the proportions of the whole. The construction of the whole work starts with considering the individual modules within those members.

Arrangement is expressed through groundplan, elevation and perspective and involves putting things in proper places and performing adjustments according to the character of the work to achieve an elegance effect. When the height, breadth and length of the work are designed in a way to correspond symmetrically to each other, the beauty and fitness achieved in the adjustments of the members is called Eurythmy.

To achieve Symmetry, or the appropriate arrangement between the work members, one part is selected as a standard to attain a certain relation between the various parts and the whole. Vitruvius compared perfect buildings to the symmetrical harmony found in the human body between forearm, foot, palm, finger and other small parts of the body.

Propriety involves the perfection of style through the use of approved principles, and according to prescription, usage or nature. The construction of temples is carried out according to the gods they are built for and follow a certain prescription. Magnificent interiors should be provided with the appropriate and elegant entrance-courts, thus justifying the usage. The use of eastern light for bedrooms and libraries and a western light in winter for baths and winter apartments reflects propriety arising from nature.

Vitruvius also studied Economy which represents the correct management of site and materials as well as construction cost considerations. The selection of materials should be decided by the architect based on their availability so as not to incur additional expenses of making them available. Economy also calls for different forms of construction and products used depending on each and every class of householders.

Several works followed Vitruvius's explanations, including the works carried out by Alberti (1452) and Palladio (1570).

Alberti (1452) considered that the art of buildings comprises six elements which are Region, Seat or Platform, Compartment, Walling, Covering and the Apertures. The Region meant the open space where the building is to be built, according to a Seat or Platform determined within a part of this region. Walls circumscribe the platform where people actually walk on, to provide the use and service within the building.

Compartitions are therefore the subdivisions dividing the platform into sub-platforms. Walling provides the structure on which the roof or covering is built to protect from rain and extends over all parts that cover the heads of occupiers within the building. Apertures are considered to be all outlets for occupants to

enter and leave the building and provide the passage of all necessary things that the occupants require.

Alberti (1452) considered that the covering and walling of buildings should provide convenience and be wholesome. They should also be solid, durable and provide stability, gracefulness and beauty.

Palladio (1570) in turn studied the designs of different types of buildings according to usage. On one hand, the houses in cities or townhouses are the place where the administration of the community and running personal affairs is carried out. Townhouses should be useful and comforting, soothing and provide tranquillity for the study of literature and quiet contemplation.

On the other hand, buildings in the country are where the family resides and private business takes place. Choosing the site where the building should be constructed is of considerable importance. The architect should study the estate and decide on a convenient and healthy location for the site to be constructed. The site should be preferably in the middle to make use of the land around it. The site should also be convenient and attractive when built on a river or next to another source of running water. The running water provides transportation of goods, a lovely sight and can be used for irrigation. The site should also be planned in such a way to provide shelter from rain and sun and storage areas for wood and other objects.

The successive researchers studying the design and architecture of buildings clearly relied on defining buildings based on context and use. Facilities were defined according to the type of usage, such as the distinction between town and country houses, in addition to facilities built for other reasons such as temples for the gods.

Studies also focused on the aspect of aesthetics which is stressed in the works of all three researchers mentioned earlier, whereby buildings have to be perfect and attractive, entrances magnificent and walls providing gracefulness and beauty. Designs were required to provide convenience for occupiers and ease their work and transportation, in addition to maximising the use of land around the built facility. The issue of protection and stability was tackled by researchers as well which shows that buildings needed to provide security and protection to people occupying them.

Design economics appeared as one of the fundamentals of architecture, involving the creation of different construction budgets depending on the various classes of people forming the entire society. Cost optimisation should also be thought of when selecting material for construction and using what is available in the vicinity of the construction site.

As presented in this sub-section, numerous factors affect the design of buildings in terms of image and functionality. Factors including aesthetics, convenience, access, usability, safety and economics were all elements influencing the design of buildings discussed by many researchers as the centuries emerged.

All these factors represent objectives that the design needs to achieve in order to produce a facility that meets the requirements of image, usage and convenience of occupants.

2.2.2 Objectives

Design objectives are significantly important; must be understood, assessed, and properly applied to be met in order to reach a successful outcome.

Moving on to more recent studies, and according to Ferguson (1989), Yamakawa (1997), Thomson et al. (2003) and Voordit & Wegen (2005); quoted in Wong et al.

(2009), design objectives which should be met when designing include Aesthetics, Functionality, Buildability and Economics.

In addition, Ransley and Ingram (2001) discussed effective design which can affect various soft aspects of facilities including image, style, comfort, marketing and ambience. Image and style symbolise identity and quality which are mainly a subjective perception of the client.

Design can also affect hard aspects such as operational efficiency, cost, safety, cleanability and maintenance, ergonomics, noise and space distribution. Such harder aspects are considered more tangible than soft ones, and could be identified clearly through a product concept set by the client and translated into a design brief. Ransley and Ingram (2001) consider that balancing form and function is vital to achieve what they call a good design.

According to Merritt and Ricketts (2001), architects throughout the design process should abide by various principles resulting in a design that

- a. Serves the purposes set by the client.
- b. Is constructable through available techniques, labour, equipment and a suitable timeframe.
- c. Provides a building that is able to withstand normal usage for a lifetime specified by the client.
- d. Portrays a visually pleasing facility from both the inside and outside.
- e. Eliminates all safety and health hazards faced during normal use and provides a safe evacuation/refuge for occupants during emergencies.

- f. Results in a building which provides shelter and control of the interior environment (air, temperature, humidity, light, and acoustics) as specified by the client.
- g. Has a minimum impact on the environment.
- h. Minimises energy consumption during operation whilst allowing the facility to serve its purposes.
- i. Limits the costs of construction, operation, maintenance, repair, and anticipated future alterations to what is initially set by the client.

Views have not differed in concept between the ancient and more recent explanations on the guidelines of the design outcome. Based on what has preceded, an expanded list of design objectives would therefore include (Project Guidance, 2009):

- a. Accessibility: Addresses aspects such as flexibility and the needs of disabled people.
- b. Aesthetics: Deals with the physical appearance, spaces, and the building image.
- c. Cost-Effectiveness: Pertains to cost estimation/cost management practices and budget control, building element selection based on life-cycle costs, and evaluation of design alternatives.

- d. **Functionality/Operability:** Relate to fulfilling spatial needs and requirements, ensuring system integration and meeting performance objectives, guaranteeing durability, and promoting efficient maintenance.
- e. **Historic Preservation:** Addresses preservation, rehabilitation, restoration, and reconstruction approaches when changing historic building elements.
- f. **Productivity:** Cares for the physical and psychological comfort and is concerned about elements such as comfortable air distribution and lighting, changing workspaces, reliable systems, and technology.
- g. **Security/Safety:** Pertains to protecting occupants and assets from all kinds of hazards such as fire protection, providing security, resisting natural hazards, and ensuring occupant health and safety.
- h. **Sustainability:** Deals with all aspects of environmental performance. Examples include optimizing energy use, protecting and conserving water, using environmentally preferable products, enhancing indoor environmental quality, and optimizing operational and maintenance practices.

The AIA (2007a) provides a somewhat different approach to the elements influencing facility design. Every project to be designed is affected by different sets of requirements, limitations, challenges and opportunities. These factors in turn influence the cultural, environmental, technological and aesthetic elements of the project. The AIA (2007a) groups the various factors affecting any design into 10 different categories.

1. **Client:** While some clients have clear ideas about requirements and budget, others rely on architects to help them define the various project objectives.

The client-designer relationship is vital for the implementation of design decisions.

2. Program: The project program includes all client requirements, and could either be general or specific when describing or suggesting design solutions.
3. Community Concerns: Facilities should be designed in a way to satisfy communities, neighbours and public officials.
4. Codes and Regulations: Safety requirements, minimal land-use, light-and-air zoning and building codes and regulations are all considered regulatory constraints which affect the design.
5. Context and Climate: The surrounding context of natural and built elements directs the design towards choosing certain materials, colours and textures. In addition, the region's climate characterised by temperature, humidity, wind, precipitation and solar radiation also influence design decisions.
6. Site: Factors affecting the design also include the size of the construction site, geotechnical characteristics, ecology and accessibility to the project.
7. Building Technology: Requirements for the various building systems differ greatly between the different types of facilities. When designing for an apartment house compared to an office building, design criteria for mechanical, lighting and ceiling systems require different floor-to-floor heights, for example.

8. Sustainability: Designs should be able to produce buildings with the lowest impact on the environment, and simultaneously ensure health, productivity, community and quality of life.
9. Cost: Limited budgets provide constraints on building size as well as the selection of material.
10. Schedule: The design approach towards implementing a design plan or various design alternatives is affected by the time constraint set by the project schedule.

Whether it is the exterior or interior physical appearance, the functionality of the various systems within a facility, building cost and technology, or the environment, design objectives are found to be related to the previously presented facilities management components which define the role of FM during occupancy phase. Operability and access issues, aesthetics and ergonomics, productivity, safety/security as well as sustainability and energy issues are all matters that the design aims to achieve, and which become the concern of facilities management after the facility is constructed and handed over to the client.

2.2.3 Disciplines

In order for the design objectives to become implemented and transformed into a tangible design, these objectives are represented by various design disciplines which constitute the overall design outcome.

Design disciplines differ by the nature of standards, skills, and operation within the facility, and include the following (Project Guidance, 2009):

- Structural Engineering
- Architecture

- Interior Design
- Landscape Architecture
- Plumbing Engineering
- HVAC and Refrigerating Engineering
- Information Technologies Engineering
- Low voltage/Low current System Design

Austin et al. (1999) provide a general structure for the detailed design of facilities which is normally divided into several sub-processes. Sub-processes involve the design for all systems which fall under the responsibility of each of the five major design disciplines, namely architectural, civil, structural, mechanical and electrical (Figure 2).

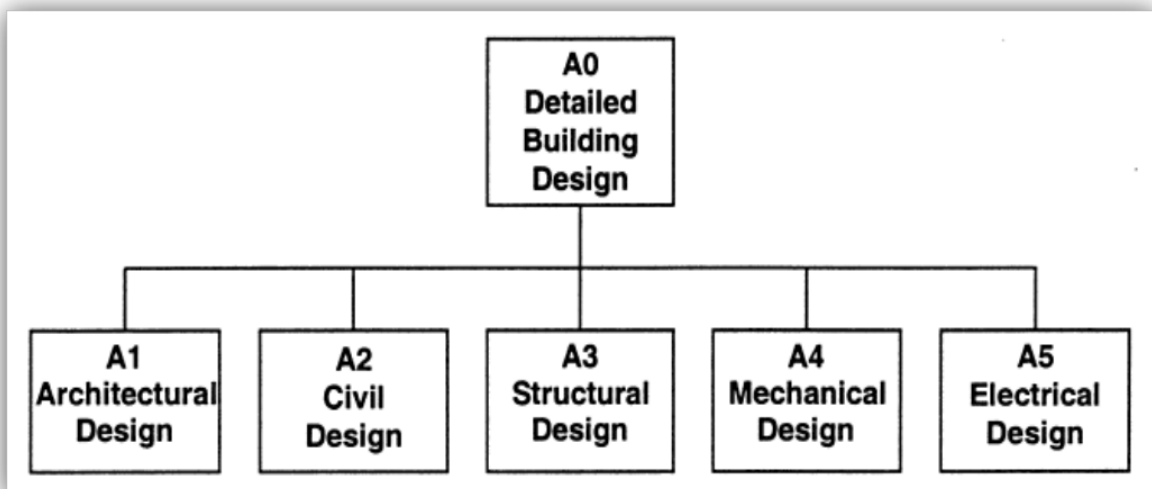


Figure 2 Detailed building design process divided by discipline Austin et al. (1999)

The different design disciplines are then translated into design drawings and specifications which represent the entire designed facility. The Construction Specifications Institute (CSI) lists 16 different divisions which are generally accepted as industry standards and represent the major classes of work (Merritt and Ricketts, 2001).

The CSI divisions are the following:

1. General Requirements
2. Site Work
3. Concrete
4. Masonry
5. Metals
6. Woods and Plastics
7. Thermal and Moisture Protection
8. Doors and Windows
9. Finishes
10. Specialties
11. Equipment
12. Furnishings
13. Special Construction
14. Conveying Systems
15. Mechanical
16. Electrical

Those divisions are further divided into smaller units of work called sections (Merritt and Ricketts, 2001).

2.2.4 Markets

The different requirements set by each discipline rely on the type of facility being designed, and as Reina and Tulacz (2010) present, the various markets related to the design practice are mainly the following:

- a. Building
- b. Manufacturing
- c. Power

- d. Water
- e. Industrial/Petroleum
- f. Transportation
- g. Hazardous Waste
- h. Sewer/Waste

Designing for the various disciplines throughout the design phase is carried out in different stages characterised by the requirements set within each stage and the level of details which increases as the design progresses.

2.2.5 Stages

Merritt and Ricketts (2001) consider that the ultimate design objective is to supply all information required for construction through the development of drawings, specifications and a construction contract to be established between contractor and client.

The architect's duty is not only focused on the preparation of design drawings and communicating with the client, according to RIBA (2000), the architect is also responsible for:

- a. Consulting the client on all major design issues
- b. Investigating the practicability of the requirements
- c. Advising on the initially set brief
- d. Advising on the client brief preparation through client requirements

Design therefore involves designer-client communication and requirements identification and analysis, leading to the production of drawings, specifications and other required contract documentation suitable for construction.

Archer (1968) describes the design process in four different phases, which are inter-related:

Phase 1: Problem analysis.

Phase 2: Solution synthesis.

Phase 3: Evaluation.

Phase 4: Communication.

According to Shen et al. (2012), *communication* between all design participants extends throughout the entire design process. In a typical architectural design situation, the design participants are mainly architects, clients and consultants from various disciplines. The client-design communication is important and thorough during the preparation of the brief and the design solution.

Design is therefore divided into different phases, entailing various responsibilities that designers have to attend to in order to produce a design outcome. Several different representations of the design phase are found in the literature. This research shall distinguish between the AIA and RIBA phases of design.

The American Institute of Architects, AIA (2007b), breaks down the design stage prior to bidding into the following different phases:

1. Schematic Design Phase

This stage marks the production of a schematic design comprising site and floor plans, sections, an elevation, and other computer images and renderings. Drawings usually include overall dimensions as well as a construction cost estimate.

2. Design Development Phase

Further development is carried out on the schematic design to produce floor plans, sections, and elevations showing full dimensions. Drawings usually include door and window details in addition to material specifications.

3. Construction Document Phase

A full set of drawings including all relevant information is produced, providing contractors with all the requirements for pricing and building the project.

The Royal Institute of British Architects, RIBA (2008), provides a slightly different representation of the design phases, but can still be linked to the phases provided by the AIA. The design phases according to RIBA are the following:

1. Preparation

A. Appraisal

The client's requirements and objectives are identified along with possible constraints of the facility being developed.

B. Design Brief

Requirements are stated into the brief, procurement methods and the various consultants involved in the project are identified.

2. Design

C. Concept

Concept design is prepared according to the design brief including proposals on various systems, in addition to preliminary specifications and cost plan.

D. Design Development

Concept design is further developed reflecting structural and building services system. Updated specifications and cost plan are produced.

E. Technical Design

Technical design is carried out to coordinate all project components and elements.

3. Pre-Construction

F. Production Information

Preparation of detailed product description is performed in preparation for tendering

G. Tender Documentation

Tender documents are prepared in detail to obtain tenderers for the project

H. Tender Action

Potential contractors are identified and assessed. The resulting proposals are evaluated and a recommendation is provided to the client.

The RIBA and AIA representations both call for the preparation of an initial design reflecting the client's requirements and budget constraints, which is later developed into a more detailed design and specifications set. However, the RIBA representation clarifies the designer role during briefing, where client requirements are identified and recorded.

A third view on the various phases of the design stage is also found in the literature, which combines between the preparation stages described by RIBA and the design phases provided by AIA.

Merritt and Ricketts (2001), in their *Building Design and Construction Handbook*, provide a definition of the various design phases. The authors discuss a designer role during feasibility and project programming prior to actual commencement of the design exercise. They also distinguish between schematic (AIA) and concept (RIBA) design phases which practically deliver the same output as explained by both aforementioned institutions.

Merritt and Ricketts' (2001) design phases progress as follows:

1. Feasibility Studies

Studies are carried out to advise the client on project scope and services. These studies include feasibility, environmental impact, master planning, site selection, site analysis and code and zoning review

2. Environmental Impact Studies

These studies are carried out to attend to zoning, soils, and the potential of hazardous materials.

3. Programming

A program is developed jointly between the client and the designer to define various client requirements related to space, interrelationships of project components, usage, special systems, flexibility, constraints, future expansion, phasing, site requirements, budgetary and scheduling limitations, and any other data that may be required.

4. Conceptual Design

The architect at this stage studies the client requirements to develop design alternatives which act as a guide for the rest of the development process.

5. Schematic Design

The entire project design team, including the architect and all other consultants, prepares a schematic design based on the conceptual design produced. The schematic design includes drawings and descriptions of the project to define the scope and various inter-relationships between the different project components. This exercise is followed by a cost estimate to check that the overall construction cost does not exceed the budget set by the client.

6. Design Development

The schematic design is further detailed to define the size and character of the project. Architectural, civil, structural, mechanical and electrical, materials, specialty systems, interior development, and other project component drawings are produced.

7. Construction Documents

The architectural, engineering and other specialty consultants produce the construction drawings and technical specifications at this stage. General and special conditions of contract are also prepared and followed by a second detailed cost estimate prior to bidding stage.

Value engineering exercises should also be carried out during schematic and design development phases (Facilities Manual, 2007). Merritt and Ricketts (2001) mention that value engineering applies the scientific method to study the values of systems, with a major objective of reducing the initial as well as life-cycle costs.

When the project cost is studied, value engineering review should then be undergone in case the total cost is greater than the initially set budget. Changes resulting from such a design review will have to be fed back into the schematic as well as the developed designs and documents should be altered to get the client's approval before moving on to the next phase (Facilities Manual, 2007).

While the design evolves according to the stages previously mentioned, the level of detail is also seen to increase when moving from one stage to the other. As the design becomes more advanced, the changes introduced at later stages will require the modification of decisions taken in all previous stages.

2.2.6 The Design Front End

Although the design stage consists of several phases, understanding the design front-end has proven to be important for project success. Project design front-end is considered critical, whereby applying improvements at this end will result in benefits which will most probably surpass improvements performed later on in the design process as discussed by Cooper and Kleinschmidt (1997) and CRISP (2001) both quoted in Tzortzopoulos et al. (2006).

Phases of the construction design front-end are:

- a. Phase 0 (demonstrating the need for the project), outlining a business case.
- b. Phase 1 (conception of need), including the brief.
- c. Phase 2 (outline feasibility), applying feasibility studies on various design options.
- d. Phase 3 (substantive feasibility study), defining the project and producing the conceptual project brief.

The clients' involvement at the front-end is vital in defining business and user needs and requirements, obtaining stakeholders' ideas for assessment and further development.

2.2.7 Design Quality and the Designer's Performance

Ferguson (1986) mentions the widely known fact that poor design strongly impacts efficiency during construction. A number of studies have also shown the great percentage of defects in built facilities which arise due to decisions taken during design stages (Cornick 1991).

Even though this fact had been established for quite a long time, researches over the years have focused more on the performance of contractors during the construction phase rather than paying attention to the performance of architects in the industry (Oyedele and Tham, 2007).

Architects' performance is of great importance because decisions made at the beginning of the design process will definitely affect the project success. Failures occurring on the architect's side during concept design will result in stress factors which cause serious problems at later project stages (Hartkopf et al., 1986). Formoso et al. (1998) also argue that the performance of building design processes largely affects the success of the construction process and the quality of the finished facility.

Performance of architects must be considered in an efficient project implementation strategy, in order to develop a high quality design that leads to a product which meets the client's needs and requirements (Latham, 1994). As mentioned by Colander (2003), design quality problems appear due to differing perceptions between the client and the design team.

Architect performance criteria in building projects as ranked by clients based on the importance index, are as follows (Oyedele and Tham, 2007):

1. Effective Pre-design Project Meetings
2. Forethought and Consideration of User's Requirements
3. Coordination among Phases of Design
4. Identifying and Prioritizing the Project Objectives
5. Standardization of Elements

According to Formoso et al. (1998), the increase in complexity of modern buildings within a highly competitive market, has augmented the pressure for enhancing performance of the design process with respect to time and quality.

2.3 Client Requirements

According to Oyedele and Tham (2007), attending to user requirements is the second most important architect performance criteria after effective pre-design meetings. This shows the importance of considering requirements by designers as the design commences.

Russell and Arlani (1981) discuss 13 different primary purposes for investors to start a construction project; Hedge against inflation, quality of cash flow, rapid recovery of equity, leverage potential, income tax shelter, capital appreciation potential, high rate of return, portfolio diversification, liquidity, pride of ownership, demonstrable need, presence and economic need.

These motives result in different implications for building designers. The various implications, according to Russell and Arlani (1981), are as follows:

- a. Producing designs which remain competitive with future projects. They should consider the quality of space layout and finishes, building

subsystems such as energy consumption, maintenance cost and adaptability.

- b. Minimising both capital and future costs, and the expense side of annual cash flows.
- c. Producing designs which enhance the resale value of the built facility
- d. Delivering flexible designs that enable the facility to adapt to the changes in use and the developments in technology
- e. Minimising project risks through reducing construction durations and selecting systems having minimum capital and future cost uncertainty.
- f. Providing a design which preserves marketability.
- g. Considering the quality of architecture, finishes and the various building systems.

Kamara, Anumba and Evbuomwan (2000a) also mention that a client's business needs and areas of concern include:

- a. Facility utilization information such as activities carried out and equipment used.
- b. User information such as type and size.
- c. Facility functions such as tasks performed and their corresponding basis.
- d. Facility attributes such as image and purpose of existence.

In light of all the previously mentioned client requirements, Stappers et al. (2009) argue that design firms worldwide are researching methods to cope with the new client demands on the design process. The authors assert that designing for other

people's experiences is a difficult task which involves solving out complex and multifaceted problems. New approaches are being developed such as vision-based design and iterative user-centred experience prototyping, in order to manage these complex problems. Co-design also deals with the long-term user participation, which starts from early project definition, through concept realization, detailing and marketing.

The above mentioned approaches, as discussed by Stappers et. al (2009), are set out with the following aims:

- a. Sustaining fundamental innovation by designing from a contextual vision, instead of following a pre-fixed product plan.
- b. Increasing the importance of design-relevant knowledge found in users.
- c. Enhancing the communication between all stakeholders, users and the expert body needed in the design of people's experiences.

Such aims encourage participants to express themselves as well as motivate them through proving that their input is being used by designers and that they are being part in owning and creating the design process (Rijn and Stappers, 2008).

2.3.1 Requirements Management

Phase 1 of the construction design front end, mentioned in Section 2.2.6, deals with the conception of need and the preparation of the design brief. Therefore, the client needs and requirements have to be stated and recorded during this phase.

For this purpose, requirement management (RM) is tackled during pre-design services as stated by Duerk (1993; Quoted in Ozkaya and Akin, 2006). RM includes practices such as gathering, analysing, selecting, documenting, verifying and managing (Halbleib, 2004).

RM methods provide ways to file requirements and verify their progress throughout the project design. Out of three levels of RM adoption, level 1 is the most used; an unplanned RM process through which it is hard to estimate and control costs, and lacks customer satisfaction (Sawyer et al., 1999).

Darlington and Culley (2004) point out the two main roles of design requirements which are:

- a. Setting the agreement on what is required from the product being designed
- b. Acting as the basis for the designers' use in proceeding to solution processing

Factors influencing the design requirement process include (Darlington and Culley, 2004):

- a. Client Types

Clients approach designers with various levels of clarity about the design they require to be executed. There are clients who haven't got any clue about detailed requirements, a matter which forces the design firm to exert significant effort in transforming needs into design requirements. Other clients provide semi-developed statements of need. Such statements might include physical aspects of a solution or references to solution domains which are useful in preparation of an initial brief. Yet another type of clients provides fully specified requirements expressed in contractual terms. Only clarifications about the design requirement constituents are needed before commencing with the actual design work.

b. Stakeholder Relationships

A complete design requirement document incorporates an agreement between the client and the designer on what is wanted in a product. Stakeholders, a term used for any individual or business group who is interested in the new product, will influence the design requirement preparation and the agreement set between the client and his designer.

Stakeholders include the following:

- i. External: Customers, users, suppliers, distributors, subcontractors.
- ii. Internal: Marketing, engineering, manufacturing, sales, services, purchasing, finance.

Observing the above mentioned stakeholders, it is noticed that facilities management therefore influences the design requirements preparation, whether FM is regarded as “engineering” or “services”, based on what was discussed in Section 2.1.3 regarding the nature of hard and soft FM services.

2.3.2 Design Brief

Drawing out and defining client requirements is known as briefing or in other words, facility programming (Perkinson, Sanvido and Grobler, 1994).

A construction brief forms the basis for design and is considered as a document showing the background and requirements for a building project. Therefore, it is through this document, that requirements are actually transferred to designers in order for them to translate the same into drawings and specifications. The requirements of the client and the various stakeholders should be included in the brief so that they are conveyed to designers.

Briefing extends into the concept development phase of design promoting expectations that determine the project trend later on (Ryd, 2004).

According to Ryd (2004), the brief documents are mainly used as:

- a. Strategic planning basis for the design process and the completion of the project.
- b. Basis for decision making in the detailed development phases.
- c. Basis for investment computations.
- d. Basis for procuring contractors.
- e. Basis for reviewing the proposed design solutions.

In addition to the various types of clients and the relationships between different project stakeholders affecting design requirement preparation, problems faced during the briefing process are discussed by Kamara, Anumba and Evbuomwan (2000a) and include:

- a. Poor involvement of all project related parties
- b. Inconsiderable time allocation for briefing
- c. Insufficient deliberation of client perspectives
- d. Dissatisfactory communication between personnel involved in preparing the brief
- e. Incomplete handling of changes to requirements

The above are all examples leading to the improper consideration of requirements when preparing the design brief. As a result, these requirements will not be fully reflected on design drawings and will not become part of the constructed facility.

FM managers' authority within an organisation may be limited in many cases. These managers might just be provided with decisions made without their

involvement due to their separation from major decision makers within the organisation. However, the knowledge and experience in the possession of FM managers could represent information that is essential for facility-related decision making (Blyth and Worthington, 2010).

It is worth noting that the early involvement of facilities management in the design process is also troubled by difficulties of managing requirements of the various professionals whom are involved in the design process (Pitt et al., 2005). Ryd (2004) proposes that comparisons between the intentions of briefs and the post-occupancy evaluations could be a subject of further research. Moreover, Tzortzopoulos et al. (2006) emphasise the communication gaps between users, clients, owners, and designers and that the reason behind this gap in communication is due to the absence of a common language leading to the designers being criticised for not being able to interpret business needs of clients.

Barrett and Stanley (1999) assert that improper brief preparation can lead to different implications, some of which are short term and others in the long run. Short term implications are mainly changes required at late stages as well as dissatisfied clients due to problems in interpreting their needs. While long term implications are mainly the inefficiency and ineffectiveness of building operation and the negative effects on business success.

In view of the above, the literature reveals that there are various problems affecting the definition and recording of requirements, including those of facilities management. Client types, the relationship and communication among various stakeholders as well as the degree of involvement of the related parties are all factors affecting the identification of client requirements and consequently the facility being designed.

2.3.3 Processing Client Requirements

A client is the person or firm responsible for commissioning and paying for the design and construction (BPF, 1983). Clients can also be users of facilities and they may be separate entities. The client integrates interests of buyers of construction services, prospective users/tenants, and other interests groups.

Knowing that clients are the ones who commence and pay for construction projects, there has been a growing recognition about clients being the core of construction processes. This matter resulted in initiatives to guarantee that client requirements (CR) are fully satisfied, as discussed by Bennett et al. (1988) and Latham (1994). Such initiatives generally aim at improving construction process efficiency through the introduction of new strategies such as integrating design and construction activities.

Kamara, Anumba and Evbuomwan (2000a) state that it is usually necessary to translate CR into design terms, as construction clients are likely to express their needs in non-design terms. As a result, CR processing presents information in ways to improve understanding of what the client exactly requests. It involves identifying, analysing, and translating explicit and implicit CR into design solutions.

Client Requirements need to be translated into design/construction terms to ensure that they are:

- a. Well defined and free from ambiguities to be fully understood by client body (Gause and Weinberg, 1989).
- b. Represented in a solution-neutral format that enables the different disciplines working on the project to clearly interpret the translated terms (Perkinson, Sanvido and Grobler, 1994).

- c. Configured in ways to ease correlation of design decisions with original client intentions (Perkinson, Sanvido and Grobler, 1994).

Translating client requirements to technical terms could be achieved through using the Quality Function Development (QFD) at early stages of the building design process as proposed by Low and Yeap (2001).

Design Quality Indicator (DQI) is another tool which can be used for enhancing design quality through feedback obtained from the various project stakeholders (Wong et al., 2009).

Client Requirements Processing Model (CPRM) is a third tool used to properly process client requirements, whereby it incorporates a framework that (Kamara, Anumba and Evbuomwan, 2000a):

- a. Promotes effective CR processing.
- b. Guarantees a continuous focus on client requirements.
- c. Settles competitive concerns within the client organisation.

The three main stages of the CRPM are to define client requirements, analyse client requirements, and translate client requirements. The “Define requirements” stage deals with client interest groups’ requirement identification. The “Analyse client requirements” task relates to CR structuring as per interest groups preferences. The “Translate client requirements” comprises creation of design features, setting targets, conversion of CR into design terms with priorities.

Benefits of using CPRM include (Kamara, Anumba and Evbuomwan, 2000b):

- a. Aiding clients in conveying their vision as well as ensuring continuous management of requirements.

- b. Supporting communication among client and interest groups/stakeholders.
- c. Spreading a common understanding of client requirements among the design team.
- d. Promoting design creativity through clearly stating client requirements.
- e. Considering facility life-cycle issues in order to avoid future problems/uncertainties.

Outcomes of CPRM are deemed limited whenever clients decide not to integrate the input from interest groups, due to the fact that the model effectiveness relies greatly on the client body. Therefore, appropriately investing in CPRM may create higher initial costs but will render benefits for the client later on that prevail over such aforementioned costs (Kamara, Anumba and Evbuomwan, 2000a).

2.3.4 Achieving Client Satisfaction

According to Maister (1993), better understanding of the client's needs results in a competitive advantage of the design firm. This is due to the fact that when client needs are properly interpreted, client objectives are met and satisfaction is therefore achieved.

Clients' expectations are numerous, and include facts as well as emotional feelings to gain full satisfaction. It is worth noting that elements of client satisfaction to be considered in building design extend beyond the traditional finishing on time, and achieving a reasonable quality within a previously set budget (Egemen and Mohamed, 2006).

The use of performance criteria such as customer satisfaction in construction is still at an early evolutionary stage (Torbica ZM and Stroh RC, 2001; Quoted in Egemen and Mohamed, 2006). Nevertheless, Baxter et al. (2008) affirm that by carefully considering client requirements and ensuring that they are met, customer satisfaction can be enhanced and consequently the design development time can

be reduced simultaneously with achieving the required product quality. Satisfied clients are considered to be an important source of new work, whether through further commissions or through recommendations to others (Kaderlan, 1991; Quoted Oyedele and Tham, 2007).

2.4 Design-related FM Knowledge: FM Requirements

The previous section revealed the importance of addressing client and user requirements at the design front end, and the factors influencing the identification and incorporation of those requirements into the design brief.

While facilities management is regarded as one of the major stakeholders involved during occupancy phase, Nutt (1999) regards knowledge on facilities design and use as one of the three main sources of FM knowledge, besides the knowledge of property and construction and the FM-related knowledge. Olatunji and Sher (2009) also argue that the success of facilities management processes is directly related to the improvement in construction processes.

However, FM's involvement during early design stages is often held back due to the problems of coordinating requirements of various professionals within the design process, especially that FM is not concerned with a simple function but involves multiple functions that require a complex design solution (Pitt et al., 2005).

This section shall handle the FM knowledge related to facilities design, and the ways of identifying such knowledge, while the issue of FM's involvement in design and the coordination of FM requirements will be presented later in this chapter.

2.4.1 Measuring Facility Performance and Customer Satisfaction

According to Amaratunga et al. (2000), the role of facilities management is not limited to reducing operating costs, but instead, FM should plan on enhancing the building efficiency and fit in the control service needed for the success of the business operation.

Lavy, Garcia and Dixit (2010) consider that measuring FM effectiveness is achieved through reaching an understating of the current facility conditions prior to modifying FM services in order to achieve the expected performance. Moreover, Then (1999) highlights the topic of *measuring facilities performance* as being an emerging theme within strategic FM along with *connecting FM and corporate strategies* and *proactively managing facilities*.

Hence, project outcomes need to be evaluated from an FM point of view to tackle building efficiency and business success. Evaluation procedures will serve to identify the FM concerns and requirements, part of which is related to facility design.

2.4.1.1 Facility Evaluation Tools

Lavy, Garcia and Dixit (2010) discuss major facility performance measurement practices including benchmarking, post occupancy evaluation, and measurement through metrics or key performance indicators (KPIs).

McDougall et al. (2002) mention in their review a number of post-occupancy tools performed within the organisation, including:

- a. Building quality assessment (BQA)
- b. Serviceability tools and methods (STM)
- c. Post-occupancy review of building engineering (PROBE) occupant questionnaire

d. Building research establishment environmental assessment method (BREEAM)

As the descriptions of the different tests imply, BQA and STA are mainly used for assessing occupant requirements and rating the building's quality. The PROBE questionnaire represents a tool used to gather feedback from building occupants and the BREEAM method is a tool used for environmental assessment of constructed facilities.

Post Occupancy Evaluation

One of the most popular tools used to measure building performance and user satisfaction is Post Occupancy Evaluation (POE). The Royal Institute of British Architects defines Post-Occupancy Evaluation as “a systematic study of buildings in use to provide architects with information about the performance of their designs and building owners and users with guidelines to achieve the best out of what they already have” (RIBA, 1991, p. 191).

A second definition presented by the Federal Facilities Council at the National Academy of Sciences states the following: ‘Post-occupancy evaluation (POE) is a process of systematically evaluating the performance of buildings after they have been built and occupied for some time (Preiser, 2002a). POE differs from other evaluations of building performance in that it focuses on the requirements of building occupants, including health, safety, security functionality and efficiency, psychological comfort, aesthetic quality, and satisfaction’.

A third more recent definition provided by Hadjri and Crozier (2009) describe POE as a “systematic process guided by research covering human needs, building performance and facility management”.

Post-occupancy evaluation or sometimes called post-occupancy assessment is a common expression for a set of various activities performed in order to acquire required knowledge about buildings performance as soon as they are completed and ready for operation (Hewitt et al., 2005). The above mentioned activities also address building users and question their satisfaction with the surrounding environment that is newly constructed; a matter which also concurs with all three aforementioned definitions in that POEs do not only focus on the technical aspects or building performance, but also focus on the needs of owners, occupants, users and facilities management.

Eley (2001) states that FM specialists knowledgeable about POEs and their outcomes in various types of buildings would have a vital role in the briefing stage of building construction. They are also able to link between the various concerned parties such as clients, users, and designers. As long as FM specialists are proactive in dealing with building evaluation and performance measurement, in addition to making use of the output information to plan for the future, user satisfaction and better product quality are always achieved.

Cohen et al. (2001) present questions normally asked while conducting a POE such as “physical conditions within the environment (lighting, noise, air: movement, quality and temperature), personal control over the physical conditions, management response to complaints, health and overall comfort productivity, background and the overall quality of the building.

Many other representations reflect on the tasks carried out by POE. Those mentioned by Hewitt et al. (2005) include environmental design audits, building-in-use evaluations, facility assessment and building performance evaluations.

Benchmarking

As Camp (1989) explains, benchmarking developed from the practice of total quality management for the purpose of assisting managers to apply contextual factors to their performance measurement exercises.

Benchmarking is to identify a point of reference called a benchmark, which acts as the standard used for judging performance. This benchmark could be a internal factor related to the organisation itself, but also an external reference related to the competition or best practices.

Leake and Stanley (1994) present a series of ten stages followed when benchmarking facilities (Table 1). Broyd and Rennison (2000) confirm that there is a range of benchmarking practices taking place in facilities management.

The main two purposes of benchmarking are to aid organisations in having focus on external references, in addition to helping them identify the industry's best practices when performance is continuously compared to others (Ho et al., 2000). Douglas (1996) considers benchmarking to be fundamental in building performance measurement, due to the fact it could involve both cost-related and non-cost-related benchmarks. The former are quantitative measures providing short-term views, whereas the latter are of a qualitative nature and offer a long-term view.

Key Performance Indicators (KPIs)

Fitz-Gibbon (1990) defines a performance indicator as a measure of performance. KPIs are broad indicators of performance concentrating on significant elements of end results (Chan and Chan, 2004). Meng and Minogue (2011) consider that KPIs have become progressively more established, within various industries, as a performance measurement system. Main indicators for the construction industry were conventionally time, cost and quality.

Stage	Steps
Planning	1. Identify facility performance dimensions to be benchmarked
	2. Identify best practices to compare with
	3. Collect performance data
Analysis	4. Compare with best practice and identify performance gaps
	5. Determine how to improve performance
Integration	6. Communicate findings and gain acceptance of need for improvement
	7. Establish performance goals/targets
	8. Develop action plans and implementation strategies
Action	9. Implement specific actions and monitor progress
	10. Re-calibrate benchmarks and update with ongoing changes

Table 1 The Benchmarking Process (Leake and Stanley, 1994)

According to Loosemore and Hsin (2001), using KPIs in facilities management has many advantages. KPIs can direct the managerial effort towards more important areas of performance, and can be embedded in the FM services contract to clearly present the required outcomes and their relevant monitoring and control. The majority of KPIs generated in FM are ones related to the cost of maintenance and operation, revenue, space management, and environmental and safety issues.

KPIs should be determined in a way to represent the facility performance in a wide-ranging way (Lavy, Garcia and Dixit, 2010). KPIs should be monitored over a certain time period, and then compared to a baseline in order to identify changes, whether improvements or deterioration (Cable and Davis, 2004). Amaratunga et al. (2000) and Brackertz (2006) confirm that current performance measurement should focus on the business and its goals as well as job satisfaction, rather than only dealing with financial issues as the case has been in the past.

Apart from concentrating on the business and employees, Lebas (1995) argue that measurement should also depend on the users of facilities ranging between managers, supervisors and customers. Different users require different measures depending on the purpose set by each user type.

KPIs, according to Yuan et al. (2009), spread over five different topics namely, physical characteristics of the project, financing and marketing, innovation and learning, stakeholders, and processes. Amaratunga and Baldry (2003) instead consider KPIs to belong to four basic categories: customer relations, FM internal processes, learning and growth, and financial implications. Another four different categories are defined by Augenbroe and Park (2005), being energy, lighting, thermal comfort, and maintenance.

Hinks and McNay (2005) created a list of 172 KPIs under eight different categories: business benefits, equipment, space, environment, change, maintenance/services, consultancy, and general.

Observing the different views on the selection of performance indicators, all agree on the fact that the physical condition of facilities has to be considered, in addition to FM processes or sometimes called maintenance which also need to be measured and evaluated.

2.4.1.2 Performance Measurement

According to Douglas (1996), the goals for carrying out performance measurement include identifying the degree to which a facility is serving occupants and recognising the most important factors negatively influencing its performance.

Maclennan (1991) considers four tasks regarding performance evaluation, namely: measurement of criteria, comparison of the measurement, evaluation of the measurement, and feedback. Measurement techniques are first applied to criteria

and to individual cases to increase objectivity. These measurements aid the comparison between different situations. Comparison in turn improves communication and aids decision making. Evaluation promotes opportunities to innovate and develop new courses of action to arrive to better future solutions. To finish off with, feedback increases the success for decision makers by providing ways to adjust previous decisions.

Measuring facilities performance mainly comprises three different elements, being the physical, functional and financial components (Bernard Williams Associates, 1996). Valins and Salter (1996) argue that up to 90% of the influence on an organisation's core objectives actually comes from the functional performance of the occupied facility.

According to Loosemore and Hsin (2001), the relevant physical aspects include building fabric and the various physical characteristics of facilities such as structural integrity, lighting, heating, energy efficiency, durability and maintainability. The functional component consists of issues related to the building and its occupiers including space layout and flexibility, ergonomics, ambience and health and safety. Measuring financial performance embraces calculating expenditures, depreciation, and the efficiency of use.

Current advances in POE shed the light on building performance evaluation (BPE) and universal design evaluation (UDE), whereby non-technical factors influencing the design of facilities are beginning to surface (Preiser, 2002b). However, Meng and Minogue (2011) consider that performance measurement is still new to FM, with some research done on the application of individual models in certain areas.

2.4.1.3 Client and User Satisfaction Assessment

Alongside the facility performance measurement, an anthropological aspect is considered by Friedman et al. (1978, p. 20) through the definition: "An appraisal of

the degree to which a designed setting satisfies and supports explicit and implicitly human needs and values of those for whom a building is designed". Customer satisfaction should therefore be assessed and evaluated to measure the degree by which both the facility and the service provided meet the requirements of clients and users.

Tucker and Pitt (2009) present a model for utilising customer performance measurement to enhance FM service provisions. The customer performance measurement system (CPMS) involves both qualitative and quantitative methods and consists of four stages that begin with benchmarking customer satisfaction at the national level. The second stage calls for a similar approach but applied internally to clients of the FM organisation itself. The national standards obtained and internal results are compared in stage 3 to identify the gaps and areas where improvements in the service can be made. The strategic decisions are taken in stage 4 to introduce new processes and further enhance the quality of service.

O'Neill and Duvall (2004) discuss KPIs which, throughout the post occupancy evaluation process, are set based on the strategy followed by the senior management. These KPIs are wide-ranging measurement areas correlated with the goals set by the organisation, one example is *Support for Innovation*.

Through reviewing the business literature and discussing matters with upper management, KPIs are created. Strategic in nature, KPIs reveal the aim of the organisation to enhance performance quality such as key behaviours which will, consequently, support the business goal of innovation and achieve customer satisfaction (O'Neill and Duvall, 2004).

2.4.1.4 Benefits of Conducting Evaluation Exercises

The reasons behind carrying out facilities performance measurement, according to Cable and Davis (2004), are mainly that performance measurement addresses

performance issues in relation to the organisation's mission. In addition, this type of measurement touches on various issues related to the facility itself, its current conditions, any requirements for additional buildings to realise organisational goals, various concerns that need to be addressed and the results of investment-related issues.

Benefits for carrying out a POE as discussed by Whyte and Gann (2001) incorporate promoting a more effective application of design skills, improving user requirements, enhancing management procedures, and presenting valuable knowledge for design and regulatory processes.

As explained by the Federal Facilities Council, effective occupancy evaluation has several benefits including (Preiser, 2002a):

- a. Improvements to programming and design criteria to be incorporated into standards and guidance literature
- b. Enhancing building performance measurements through realizing occupant viewpoints and physical environmental factors
- c. Testing the effectiveness of new concepts in occupied buildings
- d. Making use of the acquired information for decision-making purposes especially in the pre-design phase to avoid repeating past mistakes
- e. Facilitating communication among designers, clients, facilities managers, and end users

Hewitt et al. (2005) also elaborated on the possible purposes and benefits for POEs which include:

- a. Design and planning support
- b. Feedback to the building industry
- c. New concepts testing

- d. Explaining reasons for major expenditures
- e. Educating decision makers (owners and designers) not to repeat past mistakes
- f. Improving building performance over time; e.g. remedying problems and/or adapting the facility to changing organizational needs
- g. Accountability of design professionals and owners for building performance
- h. Providing better communication among designers, clients, facilities managers and end-users

Observing the various benefits mentioned, it is noted that performing occupancy evaluation contributes to improving facility designs and facility performance, supporting enhanced decision making and promoting better communication among clients, designers, users and facilities managers. Improvements are realised through informing the design about past mistakes and problems faced during occupancy phase.

This was initially discussed by Ellis (1987), when stating that future planning is achieved through either collecting information to feed into the design of new buildings apart from those being evaluated, or accumulating information for undetermined future designs. In both cases, following a systematic evaluation will provide basic material for future design teams.

2.4.1.5 The Role of FM in Performing Facility Evaluation

Facilities managers are concerned with planning for a new facility, its performance, and user satisfaction. From a facilities management perspective, POE demonstrates the commitment to integrate end user needs and concerns into the design process (Coleman, 2002; Quoted in O'Neill and Duvall, 2004).

Knowing beyond why users dislike certain issues such as layouts which are unsuitable for the style of work for instance, would generate a valuable piece of

information which can be transferred to other situations where similar problems may arise (Ellis, 1987).

Maclennan (1991) asserts that plans set by facilities managers include evaluating complex criteria related to buildings and their use. This means that POE, as a performance evaluation method, can aid facilities managers in taking the correct decisions through offering them the chance to increase their professional status with the availability of sufficient measurements for evaluating their own success. It also enables facilities managers to objectively compare buildings in a property range and select or construct a facility while knowing its end results.

In a research project they carried out, Loosemore and Hsin (2001) portrayed facilities management as a fragmented profession having a simple and uninspired facilities performance measurement approach. The reason contributing to this approach is the poor understanding of the relationship between facilities and organizations occupying them. The authors consider that there is a big challenge to create a common methodology that helps to understand this relationship. If this understanding is not established, FM managers will remain having a controlling role rather than a managerial function within organisations.

An important fact mentioned by McDougall et al. (2002) is the advantage of facilities management within an organisation, as internally positioned, which makes the access to a deeper knowledge base possible. Such knowledge includes access to sensitive data and information about organisations which cannot be retrieved through facility visits carried out by external evaluators. Nevertheless, POEs are often considered a low priority concern for facilities professionals.

2.4.1.6 POEs Considered a Low FM Priority

Eley (2001) clears out some of the reasons that explain why post-occupancy evaluations are still a facilities management low priority. Those reasons include the following:

a. Lack of Finance

Financing building performance measurement is usually not possible unless the resulting cost savings for the organisation are clear enough in advance. It is a lot important to get finance managers to understand the importance of carrying out POEs.

b. 'Fire fighting' habits

Facilities managers' trend of acting reactively, through finding solutions to instant problems, makes it difficult to identify future problems which might have no possible solution, while at the same time resolving current problems.

c. Few authoritative measurement methods

Measurement criteria well known to employers may have few good measurement tools for assessment, one example is productivity. Due to its implicit monetary value, a factor such as productivity would not be financially supported and highly prioritised the same as cost reduction issues correlated with power or services system changes.

d. Outsourcing

Facilities managers working for an FM firm would only be spending few years at the same facility and will not consequently be able to know the building well and thoroughly understand user needs. Those managers will then move within the FM firm to another location leaving the learning behind for the next person who gets in charge. Therefore, it is difficult for FM

personnel to react to new challenges and issues which differ from standard situations; a matter which prohibits process improvement and finding new ways of responding when problems arise.

e. Outside the briefing process

Facilities management professionals are either usually absent at the briefing stage or called in at late stages when many irreversible decisions have been made.

The aforementioned reasons show that carrying out POEs by FM managers during occupancy phase are affected by factors related to the client, the FM's act towards occupancy problems as well as the non-involvement of FM during design briefing which limits the use of POE-gathered information.

2.4.1.7 Linking Post-Occupancy to Design

POEs are strategically used to build up information on lessons learned from the past and use this information in future projects especially for organisations involved in long-term, multi-phased projects (O'Neill and Duvall, 2004).

In an endeavour to relate POEs to workplace design, Preiser (2002a) states that carrying out POEs interestingly addresses topics in relation to the facilities design phase. Those include:

- a. The positive influence of workplace designs on outcomes sought by organizations
- b. The contribution of workplace designs on cost reduction and increased revenue
- c. The effect of workplace designs on enhancing human resource development

When it comes to the contribution of design in reducing costs, The Royal Academy of Engineers (RAE) provides the typical commercial office building whole life cost ratio in relation with total business costs. Table 2 shows that the cost of maintaining and operating a building is five times the construction cost. Economically speaking, improvements occurring at the construction stage through earlier design modifications might positively affect the overall operation of the building as well as the organisation occupying it (McDougall et al., 2002). Moreover, improvements aimed at reducing business operating costs will even have a much greater effect on whole life costs.

According to Hughes et al. (2004), the abovementioned ratio seems to be widely accepted and used without questioning the accuracy and underlying calculations.

Cost Type	Ratio
Construction Costs	1
Maintenance and building operating costs	5
Business operating costs	200

Table 2 Whole life costs vs. Total business costs (McDougall et al., 2002)

However, the supporting data leading to this ratio is no longer available. The authors state that the ratio may differ depending on the lifetime of the facility, or in other words the number of years through which the facility will remain in operation. The ratio also depends on other significant factors such as the region where the project is built, staff costs and location (Axcell, Procter and Fennell, 2001).

The original definitions related to the 1:5:200 ratio assume that the building is an office type facility and the lifetime is 25 years. This ratio cannot be simply applied to buildings without taking into consideration the type of building and the number of years of operation, as this number affects both maintenance and business costs. Confirming this, Seeley (1996) asserts that projects are never identical and

by using data from one project and applying it to another could be dangerous. Therefore, using a fixed ratio of construction/maintenance/business costs for all projects is challenging. Moreover, Wong (2000) presents another issue that could affect the aforesaid ratio; when higher quality of construction is implemented while avoiding a higher cost but resulting in reduced maintenance costs.

Hughes et al. (2004) consider that the ratio of 1:5:200 is exaggerated. Instead, the majority of the literature on real estate shows that the property cost (total of construction and maintenance costs) comprises between 10% and 30% of the business cost. No ratio could be fixed or unique because again, each facility is influenced by location, height, energy consumption and numerous other factors which result in a unique ratio for every individual building.

Different types of inconveniences encountered at the occupancy stage are due to reasons of not properly considering user requirements and needs in the design phase; a matter which saves money and time if treated more seriously. Problems reported by evaluators of a shopping mall, for example, collected through a cost-effective usability evaluation method to explore usability problems include the following (Afacan and Erbug, 2009):

- a. Insufficient elevators
- b. The curved stair, which causes accidental or unintended actions
- c. No usage of daylight to guide and direct users
- d. Limited visibility of the shop windows
- e. Lack of restrooms for disabled people on each floor
- f. Lack of smooth level changes outside
- g. No well-defined fire-exit in the food court/cinema floor
- h. Unusable hand dryers/towel dispensers in the restrooms
- i. Insufficient public phones
- j. Inappropriate material selection for restrooms doors

The above list shows that all the reported problems could have been avoided and eliminated from the finished facility, had they been considered during design stage and incorporated within the design output to be constructed. The list also shows that many changes are impossible to carry out after the facility has been constructed, such as increasing the number of elevators or creating restrooms for disabled people on each floor.

2.4.2 Identifying FM Requirements

As discussed in the previous section, carrying out facility evaluation during occupancy phase (to measure facility performance and user satisfaction and to identify various design mistakes and problems faced) also covers facilities management.

Jaunzens et al. (2001) carried out a series of workshops with FM managers in the UK to identify the problems that those FM managers have to attend to due to the inadequate consideration of issues related to operation during design stage. The common problems they found were:

- a. Problems with mechanical services
- b. Problems with electrical services and equipment
- c. Problems with fixtures and fittings
- d. Problems with the building fabric
- e. Problems with public health services
- f. Problems with deliveries and waste management
- g. Problems with landscaping
- h. Problems with layout
- i. Problems with the procurement process
- j. Problems with fire safety systems

Another study carried out by Bainbridge and Finch (2009) asking facilities managers about the most important challenges faced within the organisation,

35.5% of responses pointed out meeting customer/tenant expectations as a major challenge that needs to be addressed.

In addition, incorporating operation, sustainability, and user need considerations in design is considered the most important according to Jensen (2009).

Facilities managers, upon carrying out evaluation procedures, point out problems from within their scope of work that are related and/or caused by design decisions. The design-related FM concerns identified in the literature could be grouped under the following sub-headings:

1. Client and User Satisfaction
2. Operation and Maintenance
3. Space Layout and Flexibility
4. Sustainability
5. Energy Efficiency
6. Ergonomics

A brief description on each of these FM-related issues is presented next, showing their relationship to facilities management as portrayed in the literature.

2.4.2.1 Client and User Satisfaction

As Sillanpää and Junnonen (2012) state, the issue of providing unique services customized to suit the needs of customers is getting more common in FM. This means that customers are increasingly expecting an FM service that addresses their requirements, a matter which increases the pressure on FM to deliver a better quality service.

Customers nowadays are more aware of what they need and are consequently demanding higher service quality. An indicator strongly correlated with measuring

the efficiency and quality of FM service delivered is customer satisfaction. Therefore, the objective of having satisfied clients is one of the major goals that FM companies should achieve in order to remain competitive (Bastos and Gallego, 2008). Hui and Zheng (2010) add that FM companies should understand what drivers result in customer satisfaction, given the fact that service quality is regarded an important reason for establishing customer satisfaction.

The concentration on customers has resulted in considering customer satisfaction as central to the marketing concept (Patterson, Johnson, & Spreng, 1997). In a report issued by BIFM in 2004, encouraging customer satisfaction was considered one of the five crucial issues in FM and was expected to remain as such up till the year 2014. Tucker and Pitt (2009) also argue that based on the results of this report, performance measurement in relation to customer satisfaction should have already become an essential aspect of strategic FM.

Greenwell, Fink and Pastore (2002) argue that the strategic planning of physical facilities influences client satisfaction, which is regarded as an important constituent of the marketing concept. The authors found in a study that both the physical facilities as well as the perception of service personnel affect satisfaction. Physical environment attributes such as ambient conditions, layout of space and signage affect customer behaviour and attitudes. Therefore, the quality of the physical facility should be addressed along with other quality factors in order to enhance customer satisfaction.

In addition, Bernhardt, Donthu, and Kennett (2000) mention that customer satisfaction is related to an organisation's sales and profits in the long term. Even though other variables such as the cost of improvement in the service provided are correlated with profitability, strategies targeting an improvement in customer satisfaction are also expected to have a return in the long run.

Olatunji and Sher (2009) argue that end users' requirements are rarely considered when clients address design teams; a drawback resulting from the fact that facilities managers are not involved as soon as the design exercise commences. Jensen (2009) in turn asserts that user need considerations comprise user involvement and follow-up on the building brief during design.

Yng Ling et al. (2008) conducted a study to investigate facilities management requirements, in relation to client and user satisfaction, that should be included in warehouse designs. In order to reach such aim, several objectives had to be considered as follows:

- a. Identifying FM-related warehouse tenant requirements
- b. Exploring the relationship between facility performance and tenant satisfaction
- c. Advising on specific FM tenant needs which should be considered at early design stages

Based on the abovementioned objectives and reasons to consider FM related issues in the design of warehouses, Yng Ling et al. (2008) managed to identify warehouse tenant requirements, which in turn are essential for the success of the whole procedure:

- a. Power (electricity) supply: Allowing for a space to accommodate a generator set for backup power supply and providing the required access for maintenance and diesel filling
- b. Cleanliness of workspace: Accounting for rubbish disposal areas
- c. Air-conditioning of office environment: Avoiding post-occupancy installation on external walls to avoid ugly and stained facades in the long run

- d. Air well in loading/unloading bay: Designing for an air well at the loading/unloading bay for the natural clearance of toxic fumes from vehicles instead of using mechanical systems for air extraction thus saving energy

On top of identifying tenant needs, Yng Ling et al. (2008) stated that the study was of great importance to warehouse owners as well, for reasons of enhancing product/service quality in ways to attract possible tenants and increase the occupancy rate. The authors emphasised the fact that tenant satisfaction is not only obtained through the application of FM post-occupancy best practice processes, but instead, FM practice enhancements should also be considered during the design phase.

2.4.2.2 Operation and Maintenance

According to Lai, Yik and Jones (2006), operation and maintenance services include a broad range of activities involving various building components such as roofing, facades, and internal finishing; in addition to specialist engineering services such as HVAC, electrical, plumbing, drainage, fire and conveying systems. The main tasks falling under operation and maintenance according to Lai, Yik and Jones (2006) are:

- a. Operational control and monitoring of plant and equipment
- b. Routine inspection
- c. Normal repair works
- d. Equipment servicing
- e. Emergency fault recovery and replacement
- f. System modification and modernisation

The resources required for performing the above mentioned tasks include skilled labour, equipment, consumables and different types of tools.

Facility performance depends on the correct execution of operation and maintenance works which usually include systems such as air-conditioning, fire, plumbing, drainage and electrical installations (Lai and Yik, 2007). Accomplishing the best facility performance requires optimum maintenance which, as defined by Kelly (2006, p. 26), “is to achieve the established plant operating pattern, availability and product quality within the accepted plant condition (for longevity) and safety standards, and at minimum resource cost.”

Achieving minimum operating cost, as stated by Gopalakrishnan et al. (2004), is viewed as an important factor for the organization to gain industrial competitiveness. Layout development and material handling systems for example, often viewed as cost centres, are instead necessary elements that should be considered at early facility development stages promoting reduction in operating costs. In addition, corrective and preventive maintenance plans necessitate a great deal of decisions taken to allocate resources needed, as well as time and space. All these requirements should be taken into consideration during the design process (Hernandez, Seepersad and Mistree, 2002).

Consequently, a complete reflection of maintenance related variables in the design would be best in improving cost and maintenance scheduling in facilities management (Olatunji and Sher, 2009). Al-Hammad, Assaf and Al-Shihah (1997) provide several recommendations to designers which result in maintenance improvements. Recommendations include providing:

- a. A suitable structural design
- b. Adequate access for maintenance staff and their equipment
- c. Appropriate exterior finishing that matches climate conditions
- d. Qualified designers to carry out design work
- e. Sufficient detail in construction drawings

Wastewater processing facilities serve as an example, presented by Olatunji and Sher (2009), of projects that require operation and maintenance considerations. All equipment and accessories (valves, piping, etc...) as well as electrical panels should be accessible for maintenance and replacement whenever necessary. Standardization of equipment and consistency in systems installed for many facilities owned by the same organization is also another example. The uniformity of systems such as HVAC, fire alarm systems, plumbing and lighting fixtures and many other equipment is greatly favoured in an effort to reduce long-term costs. Operation and maintenance reviews performed during design return the following outcomes (Operability and Maintainability Review, 2007):

- a. Decrease the number of variation orders
- b. Ensure a smooth taking over of facilities and diminish problems during commissioning
- c. Make sure that O&M costs throughout the facility life time are considered during design phase
- d. Reduce the effort of operating and maintaining all equipment
- e. Set equipment selection criteria based on quality, allocated budget and long-term O&M costs
- f. Guarantee continuous customer satisfaction, i.e. satisfaction beyond early ownership period

Considering operation and maintenance issues at early stages, affect O&M costs, equipment selection, operability and maintainability of equipment as well as customer satisfaction; all these are matters that surface during occupancy phase.

Al-Hammad, Assaf and Al-Shihah (1997) discuss defects resulting from insufficient planning and disregarding of preventive maintenance requirements during design stage. The defective outcome includes:

a. Ignoring access to equipment for maintenance

Maintenance staff should be able to access any area inside the building to carry out maintenance works. When access is not provided for the staff, maintenance cost and effort become higher.

b. Designing permanently fixed elements

Designing for permanently fixed elements in areas that require continuous maintenance works should be avoided.

c. Overlooking the availability of maintenance equipment

Maintenance equipment availability in the market should also be taken into consideration when designing so that tasks such as window cleaning or changing light bulbs at high locations can be performed.

d. Lack of incorporating maintenance requirements in design

The frequency of maintaining equipment, avoiding any obstructions during maintenance and ensuring continuous building operation while maintenance work is carried out are all concerns that require designers' attention during design stage.

In addition to considering O&M issues during design to prevent defects during occupancy phase, Gopalakrishnan et al. (2004) advise that the facility design and development approach also needs to be fully integrated, as enhancing one domain may affect the performance of another. Individually optimizing flexibility may affect material handling emerging techniques, for example. Developing an integrated

design approach will result in cost reductions, good working conditions, high employee morale, and an increase in the overall company productivity.

2.4.2.3 Space Layout and Flexibility

One of the performance measures increasingly being carried out in facilities management is spatial efficiency, a tool that is used to measure building functionality (Douglas, 1996). Functionality and the physical layout also affect flexibility related to property, as stated by Gibson (2003), who considers flexibility to be a major concern nowadays due to the rapidly changing environment. In order to adapt to the fast changes in the marketplace, organisations have managed to flatten hierarchies and focus on core competencies.

Gibson (2003) differentiates between three types of flexibility from an organisational point of view.

1. Contractual flexibility: Employment of staff is done through the use of different types of contracts such as outsourcing or fixed contracts.
2. Time flexibility: Working hours are decided based on the preferences of both employers and employees. Staff may work according to formalised hours such as part-time or term-time only or informally based on targets that must be met.
3. Locational flexibility: Work is carried out based on appropriate locations including working from home, in satellite offices or client premises.

The first two flexibility types have the least impact on space requirements within organisations while locational flexibility is the one having major implications on workplace design and management (Gibson, 2003).

Slaughter (2001) declares that designing a facility in a way to easily and efficiently accommodate change over time can enhance its value and increase client and occupant satisfaction. According to Saleh, Mark and Jordan (2009), flexibility is required to manage change and uncertainty and enables systems, processes or organisations to adjust to various conditions. Recently, there has been a direction to include the flexibility concept in engineering systems design.

Moreover, Hassanain (2006) asserts that increasing pressure is being exerted on real estate managers to create more flexible facilities, giving rise to many challenges faced by facilities management. Alexander (1996) discusses the challenge of allowing for the installation of IT tools that contribute in enhancing work quality and quantity, as well as reducing costs while increasing productivity and business competitiveness. Roelofsen (2002) handles the ongoing changes in the structure of work that forces workplace environments to adapt to the rising user requirements concerning space and layout quality and suitability.

Gibson (2003) in turn examines the loss of productive time due to the popularity of team-based work within organisations, a matter which incurs extra costs to support the team movement and relocation. Brittain et al. (2004) also presents the challenge of growing demands for relocating people/departments within buildings due to the increasing rate of business changes.

Facing all the challenges which arise due to the greater demand for flexible spaces, Hassanain (2006) affirms that emphasising flexible workplace benefits to clients, is an important matter that designers should attend to. The author also suggests the involvement of facilities management professionals in the early stages of design, to guarantee that the need for flexibility is sufficiently dealt with in the brief.

Achieving flexibility is affected by several factors that require attention during design stage. These factors include:

a. Layout

Facilities managers and designers should jointly examine layout, materials, lighting system, air quality, furniture, signage, colour selection, fixture selection, and operation and maintenance issues (Sogawa et al., 2002).

To achieve flexibility, designers should consider using mobile partitioning along with the use of furniture that can be easily moved to several locations or can easily be replaced (Brittain et al., 2004).

b. Planning

Due to the complexity of applying changes to the facility's main structure and core services, it is convenient to consider adaptability for possible later modifications at an early stage of building design (Hassanain, 2006).

c. Building Service Systems

According to Brittain et al. (2004), there are a number of flexible building service principles that can be thought of during early design stages. These principles include designing with over capacity wherever it is costly to increase space later on, providing reservations for the addition of services by future clients, allowing for provisions of "sub-tenanting" and the use of sub-metering for efficiently managing energy and facilitating individual tenant billing.

d. Information Technology Networking

Designers and facility managers should also deliberate IT networking characteristics within facilities such as the telecommunication infrastructure

that should be easily renovated and/or replaced causing minimum damage to the building structure (Hassanain, 2006).

Slaughter (2001) also presents various approaches to increase accommodation for change. Such design approaches may result in an increase to the initially set budget, but will provide cost saving throughout the facility lifetime. Physically separating building systems to ease the application of changes in one area without affecting other areas, is one approach. Another approach is to use prefabricated system components to ease change over time. A third approach would be to design systems over current required capacity in order to easily accommodate future increased demands without the need to replace or add extensions to the existing building.

2.4.2.4 Sustainability

Starik and Marcus (2000) bring up the rising attention given to the relationship between environment and organisation in both the academic and professional fields. The scientific attention directed towards this relationship is driven by the fast depletion of natural resources and the doubted sustainability of the economic system of today.

Jiménez and Lorente (2001) in their review on operational and environment management, state that concerns nowadays are over climatic change, biodiversity and the air, water, and soil pollution. This fact has led to the establishment of sustainable development strategies within organisations aiming at restructuring the social and environmental responsibilities. The fundamental ideas of sustainability, demand elimination of waste and the understanding of design limitations, while at the same time treating nature as a model and not as an inconvenience (Putnam and Price, 2004).

According to Waas et al. (2010), modern society regards sustainable development as the most suitable method to attend to all the negative impacts on the environment for the sake of both future generations and the planet. Sustainable development according to Putnam and Price (2004) involves the development, design and engineering communities as well as the FM profession. The role of FM in addressing sustainability includes the reduction of energy consumption and cost, improvements in the working environment and the reduction of operations impact on the environment.

Ding (2008) asserts that the construction industry is accused of negatively impacting the environment due to large resource use as well as environmental pollution. Kibert (2008) adds that the construction industry affects the environment in matters related to climate change, ozone depletion, desertification, soil erosion, and a number of other negative effects.

Ofori-Boadu et al. (2012) discuss methodological frameworks resulting from the efforts made in terms of promoting sustainability. There needs to be an ability to measure and monitor the performance of buildings and building processes in relation to the environment. One measurement framework developed by the United States Green Building Council (USGBC) is the LEED (Leadership in Energy and Environmental Design) program. LEED, which has become a benchmark for measuring green buildings, involves the design, construction, operation and certification of buildings. LEED offers technical assistance, accreditation systems for professionals and modern strategies for attaining water efficiency, suitable energy and material usage and appropriate indoor air quality (Paumgarten, 2003).

Another tool for addressing sustainability is the BRE Environmental Assessment Method (BREEM); one of the world's leading environmental assessment methods and rating systems. BREEM puts standards for best practice in sustainable

design, construction and operation and is currently well recognised in measuring the environmental performance of buildings (BREEAM, 2012).

Sustainability activities in construction, according to Ding (2008), encompass the efficient allocation of resources, reduced energy consumption, minimum embodied energy, increased use of recycled material, maximum re-use, and any other strategy that could ensure the sustainability of natural resources in the short and long terms.

Sustainability measures in construction also led to the development of what is called “green buildings”. According to Putnam and Price (2004), the green building concept encourages possibilities for resource and energy efficiency, lower operating costs and enhanced worker comfort and productivity through providing an appropriate indoor environment.

Green buildings, as Castro-Lacouture et al. (2009) mention, have emerged to alleviate the impact on the environment and the high contribution to carbon emissions. Results are achieved not only through the selection of proper technologies but also the selection of material. Apart from being expensive, materials selected could divert the environmental plan away from reaching its goals. The authors add that the objectives of green buildings include the use of materials which are environmentally friendly and the implementation of resource saving and waste reducing techniques.

As the green building concept is getting more popular, organisations nowadays are faced by the challenges of greening up and reducing energy costs that are continuously on the rise. In most organisations, and in order to address these hot issues, the attention is turned towards facilities management for solutions (Putnam and Price, 2004). The authors believe that a skilled group of engineering specialists could form the best organisational asset which would address issues

such as energy consumption, peak load management, greening of buildings and indoor air quality.

According to Elmualim et al. (2010), FM managers have considerably important roles in reducing the impact of built environments on the environment itself, contributing to the sustainability agenda in all three sustainability aspects, namely, economic, environmental, and social. The authors stress the fact that waste management and recycling as well as energy management are the most important issues to be considered in the sustainability policy within organizations; Followed by building disposals, ethical purchasing and carbon foot-printing in addition to the building's energy and water consumption. Ross, Lopez-Alcala and Small (2006) also present strategies to reduce O&M costs such as installing high-efficiency lighting and insulation systems.

Elmualim et al. (2010) confirm that sustainable FM should account for social and economic on top of environmental facets of sustainability in order to provide a complete service. The authors argue that FM departments are in a position to influence the way buildings are used and are therefore capable of altering technological and behavioural transformations needed to achieve environmental objectives.

Alongside training activities and tracking of building performance to promote O&M activities suitable for green buildings, one of the best practices that should be followed by FM organisations is commissioning during design phase. Carrying out commissioning at this project phase eliminates problems arising during operation caused by design setbacks (Putnam and Price, 2004). Price, Pitt and Tucker (2011) agree with Putnam and Price when stating that in order to include the environmental factor, FM organisations should plan for managing buildings in a way to ensure best use. For this to happen, various personnel and resources

should be involved in designing facilities that suit both end users and building systems.

Speaking of the importance of FM participation in design to promote sustainability, Clevenger and Haymaker (2012) affirm that designers themselves are faced with a higher demand from owners and users to maximise the value of facilities through implementing sustainability measures. However, and as said by Paumgarten (2003), experts are often separated during conventional design and construction practices, which results in disregarding the cost of operation. Hence, to overcome this separation during conventional design, Paumgarten (2003) stresses that science of buildings, technology and operation has provided designers with breakthroughs to maximise a facility's environmental and economic performance and achieve sustainability through integrating people, processes and technology.

Moreover, Castro-Lacouture et al. (2009) believe that following a vigilant design scheme accompanied by a proper material selection process, instead of greatly spending on technology, could be sufficient to realise environmental targets at minimum costs.

Despite the increasing concerns over the use of natural resources and the various sustainability initiatives underway, Olatunji and Sher (2009) declare that while design sufficiency, constructability, operability and cultural value are significantly correlated with profitability, the attention towards sustainability and climatic implications remains insufficient.

Reasons preventing an organisation from effectively managing its sustainability responsibilities, according to Elmualim et al. (2010), are mainly customer constraints, physical/historical constraints and the lack of tools.

2.4.2.5 Energy Efficiency

As mentioned in the sustainability sub-section above, energy management is one of the most important issues to be considered when dealing with the impact of facilities on the environment.

Due to the increase in demand for energy use, concerns have been surfacing around the high use of energy which in turn has led to the establishment of energy conservation regulations in many countries. Energy efficiency was introduced through these regulations due to its key contribution in energy conservation and the reduction of global carbon emissions (Hartungi and Jiang, 2012).

Considered part of the FM role, energy efficiency can be increased by using technologies such as (ORNL Review, 2007, pp.6–7; Quoted in Umstattd, 2009):

- a. Solar Panels
- b. Geothermal Energy
- c. Consolidated Utility Walls
- d. Structural Insulated Panels
- e. Controlled Ventilation
- f. Advanced Exterior Finishing

Hartungi and Jiang (2012) also discuss the use of energy-efficient lighting which serves as an example for promoting energy efficiency through saving both energy and cost. Many consumer products that have energy saving potentials are currently available in the market, such as light emitting diodes (LED), ductless heat pumps and smart meters (ACEEE, 2013).

Hartungi and Jiang (2012) discuss various provisions for fuel and power conservation, found in Part L2 of the building regulation set by the UK Government strategy to reduce greenhouse gas emissions and address global warming. Such provisions include:

- a. Limit heat loss and gain occurring in building fabric, hot water piping, hot air ducting and hot water tanks
- b. Implement heating and hot water systems that are energy-efficient
- c. Implement lighting systems that are energy-efficient
- d. Limit the building's exposure to solar overheating
- e. Implement reasonable air conditioning and ventilation systems that do not use energy more than what is needed in reasonable conditions
- f. Limit heat gains by chilled water piping, refrigerant systems and air conditioning ducts
- g. Ensure that the operation and maintenance of buildings do not consume energy more than is required in reasonable conditions

The above mentioned provisions require modifications made to the building design in order to reduce the losses and gains which affect energy consumption. Building fabric, water piping, air conditioning ducts, lighting systems, ventilation and chiller systems are all elements of a building's design. The provisions also include the aspect of operation and maintenance which should be taken into consideration as part of the energy efficiency strategy. In order to achieve high efficiency systems, proper design, installation and operation should occur (ACEEE, 2013). Therefore, energy efficiency is not achieved through only optimising design or operation processes, but is more of an overall procedure having cumulative effects starting from design and reaching operation. Carrying out design modifications to allow for energy efficiency is also confirmed by Jewell et al. (2010) who states that failing to

incorporate the future in design decisions could lead to a low level of energy performance in the long term.

A study carried out by Georgiadou and Hacking (2012) revealed various design considerations that affect the overall energy performance of facilities throughout their life cycle. Such considerations include architectural features such as exposure to natural sunlight, external shading, natural ventilation, insulation, and advanced glazing. Other electro-mechanical considerations include low energy lighting, BMS, solar thermal and photovoltaic panels, and energy storage.

Even though there are several tools that address energy efficiency, Umstattd (2009) reveals the fact that inefficiency is still greatly faced within facilities. The author identifies different barriers preventing the use of energy tools to increase efficiency; barriers such as insufficient energy storage whereby energy supply and energy demand cannot be dealt with independently. In other words, energy generated from various systems such as solar or wind cannot be stored whenever supply exceeds demand so that the stored energy would be used at later times. This barrier is addressed by Georgiadou and Hacking (2012) who found out that energy storage should be considered during design stage in order to influence energy performance.

Another barrier mentioned by Umstattd (2009) is the missing data about energy consumption due to the unavailability of individual meters of various sections or buildings, a strategy that helps in maintaining facility performance and increases facility efficiency. Again, the use of smart meters proposed by ACEEE (2013) is regarded as one of the consumer products having an energy saving potential.

2.4.2.6 Ergonomics

As Roper and Yeh (2007) mention, the subject of ergonomics has recently gained interest in the field of facilities management and has developed into an essential

area of knowledge for FM managers. The authors describe ergonomics as the applied science of equipment design performed for the purpose of reducing user discomfort or tiredness.

One of the topics often dealt with, is the issue of ergonomics at work. Many ergonomic aspects should be considered when trying to fit people to their corresponding workplaces. These aspects include (Understanding Ergonomics at Work, 2007):

- a. Appropriateness of equipment used
- b. Access to information being used
- c. Physical environment aspects (temperature, humidity, lighting, noise, vibration)
- d. Social environment aspects (teamwork and supportive management)

Whenever such aspects are not appropriately addressed, users face difficulties within their work environment which affect their well being and consequently, their productivity. Ergonomic problems related to computer tasks, for example, are mainly caused by (Safe Computing Tips, 2008):

- a. Awkward posture
- b. Frequent repetitive motion tasks
- c. Stress at workplace
- d. Vibrations
- e. Forceful movements
- f. Poor workplace setup
- g. Inadequate lower back support

When facilities managers provide employees with the right tools, they (FM) could aid organizations in saving money through cutting worker's claims for

compensation as well as increase productivity and employee satisfaction (Butler, 2001).

In a study involving the aging workforce, Roper and Yeh (2007) argue that FM managers and designers can promote ergonomics through reducing conditions that require people to work in odd positions and experience extreme muscle contractions. Ergonomic furniture could also be used to support and align the body and prevent common injuries.

2.4.3 An Example on FM-altered Design

Ransley and Ingram (2001) argue that effective hotel designs can have great influence on the number of target customers and consequently increase profit. The authors also reflect on several drivers which affect the overall cost expenditure, one being the unpredicted efforts and modifications resulting from client requirements.

An example on effective hotel designs, as presented by Ransley and Ingram (2001), would be to reduce hotel bedroom areas while maintaining efficient space management and customer satisfaction. Such an act can reduce the overall built-up area (hence decreasing the capital cost) while at the same time achieve customer satisfaction through designing to satisfy their needs/requirements.

The above presented example shows the use of FM related knowledge (space management and considering customer requirements) in hotel guest room designs. This exercise achieves a decrease in capital cost, which is to the benefit of the owner, and ensures customer satisfaction at the same time. Other similar exercises could benefit the FM staff running the hotel for example, or improve the hotel employees' well being and productivity.

2.5 FM and Design Integration

As revealed in the previous section, various FM requirements, experiences and problems faced during occupancy phase should be communicated to designers and integrated in the design solution in order to achieve customer satisfaction, efficient operation and maintenance, flexible spaces within facilities, sustainability, energy efficiency and better ergonomics.

It is insufficient to only work on improving FM processes during occupancy phase in order to achieve better services to support organisations. As stated by Horgen et al. (1998), the aim is to reach beyond maintainability and efficiency considerations, through getting FM managers to organize future building user participation in the design phase. The argument is to convey FM concerns and promote effective user participation in design, a process that should be directed by facilities managers.

2.5.1 Studies on Integration

In linking research to practice, Nutt (1999) discusses collaborative work using knowledge exchange which links post-occupancy to preoccupancy through informing designers about the main concerns of organisations related to the effectiveness of facility operations and services.

This post-to-preoccupancy link is tackled by Jensen (2009) who proposed a typology of four mechanisms for knowledge transfer, to establish an integration of building operation considerations in building design.

Jensen's mechanisms of knowledge transfer are the following:

1. Utilizing building operation experiences to create *codified knowledge*, increasing designers' awareness as a result

2. Boosting the *skills and capabilities of facilities managers*, increasing designers' awareness as a result
3. Using power to guarantee that designers seriously take into consideration building operation issues through *facilities management participation*
4. Using power to guarantee that design teams seriously utilize *codified knowledge*

The mechanisms reveal the fact that knowledge transfer might not naturally lead to FM integration in design but instead, power should be applied to force the transfer to happen; the client role in requirements definition and preparation as well as the degree of influence of the different parties involved in design affect how power can be used.

The third mechanism above, dealing with the facilities management participation in design, was previously addressed by Jaunzens et al. (2001, p. 2) who produced a guide which focuses on “overcoming the technical issues that prevent buildings from being operated optimally by promoting the facilities manager’s needs in this respect.” The guide, an output of the collaboration between the British Research Establishment (BRE) and the British Institute of Facilities Management (BIFM), handles the participation of the facilities management team that is part of a client organisation in the design of future facilities and how the FM team’s position within the client organisation, its level of expertise and relationship with the design team affect this participation.

Jaunzens et al. (2001) were able to identify issues relevant to facilities management which should be stated in the design brief, namely maintenance,

flexibility and adaptability and the environmental policy. These issues form part of the FM knowledge presented in the previous section.

Table 3 represents a comparison between the views of Jaunzens et al. (2001) and Jensen (2002; quoted in Jensen, 2009), showing the involvement of facilities managers during the various project stages starting from pre-design stages and up till occupation. Both authors agree that:

- a. User requirements and user involvement should be considered during pre-design stages
- b. The various requirements should be checked during schematic design stage to ensure they are incorporated
- c. FM personnel should participate during commissioning, towards the end of the construction stage

Jaunzens et al. (2001) discuss the participation of the facilities manager/FM team, part of a client organisation, in the design activities of future projects initiated by the same client. Jensen (2009) on the other hand proposes general transfer mechanisms, one of which is facilities management participation. This participation is denoted by the term “facilities management participation” in Jensen’s typology without specifically referring to the FM team within the client’s organisation.

It is worth noting that the typology proposed by Jensen (2009) was based on a literature review including the work done by Jaunzens (2001), as well as previous work on the subject carried out by Jensen in 2002 and 2006. On top of the literature review, Jensen (2009) also includes the results of a case study that the author was personally involved in.

Project Phase	As Viewed by Jaunzens et al. (2001)		As Viewed by Jensen (2009)	
	Project Stage	Activities to be Undertaken	Building Project Phase	FM-Specific Tasks
Pre-Design	Inception	-Contributing to pre-briefing discussions	Decision	-Incorporating real estate strategies -Information on space needs etc... -Estimation of impacts on cost of FM
	Feasibility	-Inputting to strategic requirements relating to operational issues -Giving advice on the requirements setting within the brief -Ensuring that end users' needs are incorporated into the planning process		Briefing
Schematic Design	Outline proposal and scheme design	-Ensuring that any strategic facilities requirements have been incorporated into the design -Contributing to assessment of design -Checking that the cost plan considers operational costs where this is required	Design	-Incorporation of considerations for operation, sustainability and user needs -Formulation of operational concept
Detailed Design	Detail design	-Reviewing the design and ensuring that functionality has not been compromised -Reviewing the design and ensuring that operating costs meet financial criteria -Checking design limitations		-Formulation of requirements for building automation system
Construction	Project planning	-Ensuring that the chosen tenders comply with key requirements	Construction	-Interior Planning -Prepare commissioning -Contracting-out operational tasks
	Operations on site	-Ensuring that the commissioning procedures are appropriate -Witnessing that commissioning has been properly carried out		
Handing Over	Completion	-Ensuring that handover documentation is adequate and complete -Ensuring that facilities staff and end users have been instructed in using facilities	N/A	
Occupancy	Feedback	-Ensuring that post-handover services are in place (eg post-handover commissioning) -Obtaining information on building performance; ensuring that feedback is given to the design team and appropriate follow-up action is taken	Occupation	-Move -Handling former building (s) -Implementation of operational procedures

Table 3 FM role during various project stages

Although the studies carried out by Jaunzens (2001) and Jensen (2009) both address the issue of considering FM during design stage, the work of Jensen (2009) is seen to be more inclusive. This is due to the fact that Jensen considers the broad idea of FM knowledge transfer to design taking place in different forms, while Jaunzens et al. (2001) mainly discuss this transfer of knowledge through FM participation in design, represented by an FM team that is part of the client organisation. The typology of knowledge transfer that concludes Jensen's (2009) work, compared to the personal development plan for FM managers provided by Jaunzens et al. (2001) also shows that the latter were focusing more on the role of the FM team within a client organisation and their relevant participation in design.

A third view on the FM role during design stage is presented by El-Haram and Agapiou (2002). The authors discuss two facilities manager roles in Private Finance Initiative (PFI) strategies, namely being involved in design and bidding as well as building use and services. Due to the different way facilities are designed, constructed and operated under such a procurement strategy (requiring the building contractor to service the facility for a certain period of time), FM managers become more involved in the lifecycle costing and facility planning.

FM responsibilities, as seen by by El-Haram and Agapiou (2002), throughout the design and bid development processes include:

- a. Providing a breakdown for operating, occupancy, maintenance and replacement costs along with an estimation of FM costs
- b. Reviewing and studying the design using a maintenance, operation and serviceability perspective
- c. Deciding on optimal operation and maintenance strategies

- d. Coordinating with design and construction teams in order to reach a design solution which best suits whole life facility costing
- e. Coordinating with the bidding management group

Developing a knowledge management system for the exchange of FM knowledge and facility requirements necessitates the gathering of large amounts of data such as (El-Haram and Agapiou, 2002):

- a. Building standards received through interaction with the design and construction information systems
- b. Operation standards
- c. Operation and occupancy information
- d. Maintenance and repair/replacement records
- e. Space management input
- f. Health and safety information
- g. Financial and commercial information

The role of the FM manager and the type of knowledge input provided by El-Haram and Agapiou (2002) is similar to the previously presented views on FM participation in design. However, the procurement strategy in this case is restricted to PFI, which provides a construction context that makes FM participation more likely. Because FM services are part of the contractor's responsibility, FM managers could get involved during project development phases.

Moreover, the information provided by El-Haram and Agapiou (2002), when compared to that of Jaunzen's (2001) on FM participation, is noticed to lack in detail concerning the specific tasks performed by FM during design as well as the particular knowledge content that needs to be incorporated.

Given that the overall integration of FM and design can occur based on different forms of knowledge transfer, rather than the sole FM participation in design, Jensen (2009) explains that knowledge transfer from facility operation to facility design could be perceived as a knowledge push from the operation side (senders) and a knowledge pull from the design side (receivers).

For the fact that FM and design integration is required through the transfer of knowledge from FM to design, the process of knowledge management and the types of knowledge involved must therefore be research and discussed.

2.5.2 Knowledge Management

Sun and Scott (2005) state that defining knowledge has been a challenge for many researchers but the common definition reflects content plus structure of the cognitive system of an individual. Content being the information that later becomes knowledge when given meaning provided by the cognitive system made of attitudes, beliefs, values and thoughts which shape the provided meaning.

Webb (1998) defines knowledge management as the process of identifying, optimizing, and actively managing intellectual assets to create value, increase productivity and gain and maintain competitive lead.

Another definition is provided by Awad and Ghaziri (2003), describing knowledge management as a scientific branch of management theory which deals with the systematic creation, control, sharing, and reusing of knowledge resources.

Knowledge management entails the creation, security, coordination, combination, retrieval and distribution of knowledge. Engineers are able to reuse and share this knowledge to improve construction processes and reduce the time and cost of resolving problems (Lin, Wang and Tserng, 2006). One example on tools used to capture and reuse design knowledge is Process Data Warehousing; Knowledge

being in the form of product data, work procedures, documents and decision-making practices (Brandt et al, 2008).

Mainly, knowledge management either focuses on personalisation through handling human communication and resources, or codification through collecting and organizing knowledge (McMahon, Lowe, and Culley, 2004; Quoted in Brandt et al, 2008).

When comparing the above to the FM and design integration, human communication and resources resemble the focus on facilities management skills and participation during design stage. On the other hand, codification resembles the use of codified knowledge for informing designers about FM requirements.

Two types of knowledge are involved in knowledge management as presented by Carrillo and Chinowsky (2006), explicit and tacit. Explicit knowledge can be documented and physically accumulated either on paper or electronic format. As far as the construction industry is concerned, this type of information is presented using operating procedures, best practice guides and the like.

Tacit knowledge on the other hand, is rather stored in people's brains and is attained through experience; a much more complex type to be easily documented. Again in the case of the construction industry, tacit knowledge involves the "know-how" of experienced and professional individuals such as team leaders. It is best to share tacit knowledge through communication as in face-to-face meetings, formation of practice communities and the sharing of lessons learned (Carrillo and Chinowsky, 2006).

Reflecting back again on the FM and design integration, the creation of codified FM knowledge means explicit knowledge, whereas the skills and capabilities of

FM managers and their participation in design means tacit knowledge, the experience stored in the brains of FM managers.

2.5.3 Knowledge Transfer for Achieving Integration

Knowledge integration as discussed by Love, Fong and Irani (2005) is achieved by combining knowledge from various disciplines to aid in the design decision making.

The various types of knowledge integration are as stated by Berends, Bij et al. (2006; Quoted in Wamelink and Heintz, 2007): Sequencing, Directing, Group Problem Solving and Knowledge Transfer.

- a. *Sequencing* involves categorization as well as assigning tasks to organisation members having the relevant knowledge.
- b. *Direction* involves the use of rules and operating procedures in order to guide non-specialists in a certain field or even specialists for other fields.
- c. *Group problem solving* engages collaboration and group knowledge combination in order to create new knowledge.
- d. *Knowledge transfer* necessitates actively transporting knowledge from one group to another, and what is more important in this process is the dynamic acquiring and absorption of this transferred knowledge.

In the case of FM and design integration, knowledge transfer is involved and the group receiving and absorbing the transferred knowledge is the designers group. In a study carried out by Wamelink and Heintz (2007) on building design, it was shown that design professionals prefer using success factors which are developed based on their own professional points of view instead of making use of their clients' interests. Wamelink and Heintz continue to mention the reasons behind such a fact are that design professionals are focused more on creating the correct design instead of focusing on product performance that is only measured when

the building is ready for operation. Another reason is the construction culture which stresses more on having things prepared instead of giving more attention to what exactly is being prepared.

Consequently, there should be an integrated knowledge system supplying designers with FM information beside the designers' own experiences. An integrated information management system proposed by El-Haram and Agapiou, 2002 (Figure 3) can be generated by means of combining cost and commercial data, design and construction data, and facility operation and maintenance data. The existence of such an integrated system aids facilities managers in developing proper risk management strategies through data exchange and sharing along the FM supply chain.

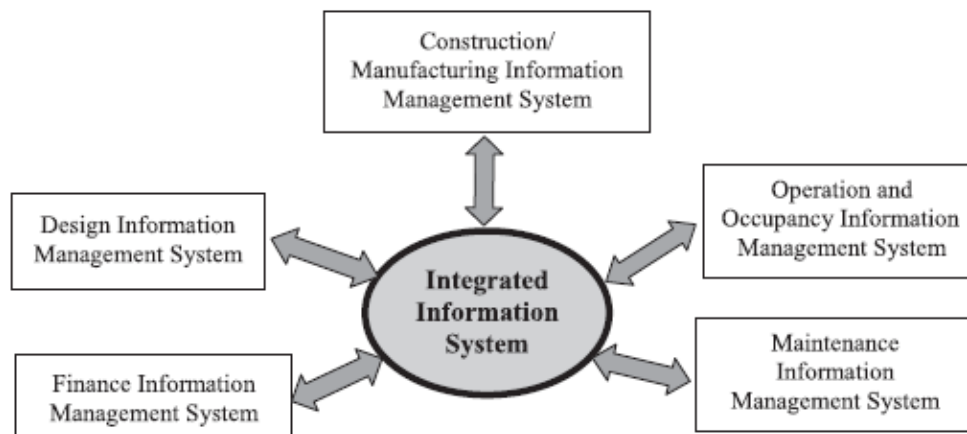


Figure 3 An integrated information management system (El-Haram and Agapiou, 2002)

To confirm the need for integration which provides FM input into design, the researcher refers to Bernard Williams Associates (1999) who stated that the involvement of facilities managers in the design process is becoming more required with the increasing awareness that facilities need to be operated and managed for a long period of time.

2.5.3.1 The Knowledge Transfer Process

Argote et al. (2000) considered knowledge transfer as one of the most important ways of learning which occurs between firms. Due to the fact that FM and design firms are mostly independent organisations, and in order to achieve knowledge integration to aid design decisions, knowledge transfer is considered as the integration technique involving a sender (FM) and a receiver (design) on each side of the transfer.

Sun and Scott (2005) discuss the levels of learning throughout the organisation being the individual, team, organizational and inter-organizational levels. Knowledge transfer usually occurs between the various levels of learning inside the organisation and between various organisations. The authors add that usually the transfer of knowledge takes place back and forth from individual to team, from team to organisation, and from organisation to inter-organisation. Some other forms also exist such as from individual to organisation but these types are less common.

Knowledge transfer, as described by Hansen et al. (1999; Quoted in Jasimuddin, 2007) is either carried out through face to face contact (personalisation) or through codified knowledge with the help of technology (codification).

Garavelli, Gorgoglione and Scozzi (2002) declare that knowledge transfer depends on the codification process (way of transfer) as well as the user's cognitive characteristics (Figure 4). Knowledge codification is the process of describing knowledge through the creation of codes even in the form of natural language.

The authors say that technologies should be used for both knowledge interpretation and codification in support of the transfer process although the involvement of the human factor in the interpretation practice also turns out to be

effective. Knowledge codification and interpretation greatly depend on the cognitive context where the transfer is taking place such as the culture and the level of education.

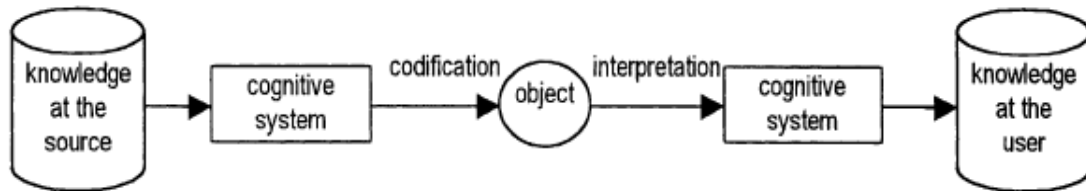


Figure 4 A schematic representation of knowledge transfer (Garavelli, Gorgoglione and Scozzi, 2002)

2.5.3.2 Factors Affecting Transfer

Reagans and McEvily (2003) state that whenever the sender and receiver involved in the knowledge transfer process share expertise in common, the absorptive capacity of new ideas increases making the transfer of knowledge easier due to the fact that people relate transferred knowledge to what they already expert in.

Strong interpersonal connections also positively influence knowledge transfer. People frequently communicating with each other facilitate the process of knowledge sharing more than those who less frequently interact. According to Hamel (1991; Quoted in Reagans and McEvily, 2003), tacit knowledge is hard to codify/transfer and in many cases cannot be conveyed except through communicating observations, demonstrations and experience.

Several factors affect the knowledge transfer between various organisational levels. These include the following:

- a. Competency: Sun and Scott (2005) discuss competency which in their opinion turned out to be an important factor affecting knowledge transfer. It

depends on how competent an individual/team is which greatly influences the flow of knowledge.

- b. Trust: According to Wood (2005), trust is essential for building successful partnerships and is a key to improving business relationships and performance as well as developing openness, cooperation and teamwork.
- c. Inter-organisational relationships: Sun and Scott (2005) argue that inter-organisational relationships should be highly collaborative in order for knowledge transfer at the inter-organisational level to properly take place

Goh (2002) also argues that competence on both sides of the knowledge transfer process is required in order to achieve a successful transfer of useful knowledge and promote effective learning practices throughout the construction industry.

2.5.3.3 Competent Facilities Management: “The Sender”

As defined by Tay and Ooi (2001), a professional facilities manager is properly trained to strategically manage a workplace. Experts from various professional disciplines are involved in FM practice which in turn requires multiple skills for carrying out the diverse tasks.

Payne (2000) discusses four areas of professional involvement in FM as follows:

1. Skills of architects, space planning experts, quantity surveyors and legal services for property and built environment related matters
2. Building services and environmental engineers along with human resources professionals to deal with the people/built environment interaction
3. Technical experts for maintenance services

4. Operational management from catering, cleaning, mail room, and security specialists for processes taking place within the facility

Moreover, Robert (2001) mentions expert roles and the various skills of facilities managers which include planning and project management, quality assessment and innovation and managing people. Facilities managers should have the ability to communicate effectively with other professionals from various fields as well as the skills required for understanding building design.

Roberts (2001) continues to explain that in order to increase facilities managers' competence and enhance their professional skills, resident FM experts as well as external FM providers will have to develop strategies at the enterprise level enabling them to promote organisational learning and involve end users in the delivery of services.

Being at one end of the knowledge transfer process, facilities managers are required to have skills and professional qualifications to be able to convey the proper knowledge that is useful for designers, in an effort to produce more efficient designs resulting in buildings which are optimized for facilities management operations.

2.5.3.4 Knowledge Pull: Designers as “The Receivers”

According to Maqsood, Walker and Finegan (2007), design competence needs to be increased so that designers are capable of pulling proper knowledge and using it to improve their design products. It is possible to improve the knowledge pull process of design professionals from external sources through:

- a. Involving senior management in the knowledge process and increasing their awareness on the various benefits which could be gained from external knowledge sources
- b. Setting up a framework to pull vital ideas and useful knowledge about clients' needs and requirements
- c. Identifying external events and conferences which are considered of benefit to the organisation

Peansupap and Walker (2009) state that learning organisations deal with both tacit and explicit knowledge and work on integrating such knowledge in work routines and standard procedures to avoid repeating past problems that cause redesign, abortive work and problems in the construction phase. Being customer-focused, commercially minded, and effective are all characteristics of a learning construction design organisation.

Moreover, Peansupap and Walker (2009) discuss strategic and operational studies performed in order to increase the learning capacity in design organisations. At the strategic level, there are organisational structures, organisational learning strategies, and partnering/joint venturing to enhance learning between organisations. At the operational level, the mixture of a construction design environment along with knowledge senders/receivers and the concentration on communication techniques can promote individual and group learning throughout the firm. Learning in design involves working skills and experience as well as theoretical knowledge.

Various problems are faced by designers at the operational level as presented in what follows (Fu, Chui and Helander, 2006):

- a. The inadequate perception of customer needs and market situations. Culture and language can also create barriers to understanding and categorizing design knowledge
- b. The formation of islands of knowledge creating distinct knowledge structures
- c. Weakly created reporting and communication systems

Therefore, and in order to create an adequate perceptive knowledge system for designers to overcome problems faced at the design stage in addition to enhancing the design process for better design output, seven influencing factors affecting the learning process in construction design are researched by Peansupap and Walker (2009) and presented and explained in what follows:

1. *Factor 1: Learning and culture organizational support*

Focusing on the support related to learning in an organisation through creating knowledge storage and databases

2. *Factor 2: Group learning*

Groups and teams formation brings together senders and receivers having common interests and facilitates the knowledge transfer of new ideas and problem solving techniques related to design practices.

3. *Factor 3: Individual learning and sharing*

Learning problems on either side of the transfer process will hinder the knowledge exchange.

4. *Factor 4: Absorptive capability*

Absorptive capability, being the ability of a learner (designer) to absorb new ideas and transferred knowledge is required in order to achieve constant learning.

5. *Factor 5: Personal relationships*

Personal relationships greatly affect the learner's attempt of attaining knowledge from the correct source.

6. *Factor 6: Characteristics of the knowledge source*

Knowledge sources are characterised by the accessibility and the credibility of knowledge.

7. *Factor 7: Learning equilibrium*

Alongside the requirement of adaptability to achieve effective learning, the knowledge transmitted by the sender should also be carried out appropriately. Therefore, the sender is also required to have an adequate knowledge level to be able to transfer new and useful design practice to the design team.

Knowledge transfer is widely recognised to be of strategic importance for gaining organisational competitive advantage (Jasimuddin, 2007) and is considered to be an important aspect of learning in an organisation (Goh, 2002). The transfer of knowledge from FM to design is required in order to convey new knowledge to designers who in turn absorb and incorporate this FM knowledge in design decisions, achieving integration.

2.5.4 Factors Affecting FM and Design Integration

Literature reveals various factors that affect the FM and design integration and the transfer of knowledge from FM to design. These factors are related to both the FM and design professions.

2.5.4.1 Design Side

The factors found to affect the FM and design integration from the design side are mainly attributed to designers' lack of interest in occupancy phase, ignoring the FM role within the design process and projects' time and budget restrictions. These factors are expanded in what follows:

1. Way (2005) mentions that designers are not usually interested in gaining any knowledge of building performance at occupancy stage; a simple truth that explains why designers and facilities managers do not usually collaborate throughout the design process, and shows the lack of FM related concerns within the design framework. This non-collaboration works against design innovation. Bertola and Teixeira (2003) state that combining internal and external knowledge in design processes helps designers to open up to knowledge developed externally and not only rely on their internally produced knowledge. Design structures need to be exposed to external user information generated outside the organisation to configure internally developed knowledge for increased innovation. Bertola and Teixeira (2003) add that the external knowledge is considered to be strategically important for innovative development of products and their functions which vary according to the various user environments. Hence, the authors recommend design practices to act more as knowledge processes so that designers are more able to advantageously pull users' and external organisations' hidden knowledge for innovation purposes.

2. Brown (2001; Quoted in Erdener, 2003) mentions that although the transfer of knowledge from FM to design for enhancing design decisions is fundamental, FM's position within the whole process is still ignored these days. Erdener (2003) argues that improving facilities design requires feedback from the occupation stage which sheds the light on wrong decisions and assumptions that took place in the design process, as well as reconsidering client/user requirements and expectations from the built facility.

3. Smith et al. (2004) discuss design-build projects stating that knowledgeable facilities managers acting as clients are able to get building providers (design-build contractor in this case) closer to client/user needs. Smith et al. (2004) assure that although the act of bridging the gap between designers and user needs is obstructed due to time and budget constraints, design-build contractors still have to acquire user knowledge, coordinate it with project resources, and apply it to their design and construction processes in order to gain competitive advantage.

2.5.4.2 Facilities Management Side

Factors affecting the FM and design integration from the FM side are mainly linked to FM's loss of identity, limited FM scope within organisations, the non-core/supportive role of FM and improper performance measurement. These factors are explained below:

1. Yiu (2008) reflects on FM's loss of identity, and according to Nutt (2000), the reason behind this loss is mainly the absence of an exclusive knowledge database comprising best practices and various advancements in the field of facilities management. Nutt (2000) reiterates that the lack of such a database affects FM performance and hinders it from fulfilling its promises.

2. Malatras et al. (2008) reveal that building services are traditionally considered to have limited scope and provisions for advancement. This reality negatively influences complex services administration leading to increased costs and the formulation of inflexible and inextensible architectural designs.

3. The third factor relates to FM's supportive role and non-core considerations. Hamel and Prahalad (1994; Quoted in Waheed and Fernie, 2009) in their description of core and non-core organizational capabilities related to customer advantage and company revenue, categorise facilities management as having a non-core capability to gain organisational competitiveness. McLennan (2000) also explains that the absence of the feedback loop (from operation back into design) is mainly due to the fact that FM is not often viewed as a core activity but instead, an activity having cost implications. The author also confirms that future opportunities for office sector FM managers are created through closing the aforesaid feedback loop; a strategy that is usually absent in projects (Preiser, 1989, 1995; Leaman and Bordass, 1999; Quoted in McLennan, 2000), which points out current operational drawbacks and ways to solve them in future designs.

4. Fleming (2004) argues that due to the quantitative nature of building performance, facilities management operations often focus on the building's technical performance rather than the observation carried out by the facility occupiers. Considering productivity as a performance measure instead of a cost factor is one example which reflects people's role as facility users and highlights the importance of their opinion.

All aforementioned aspects affect the collaboration between facilities management and design professionals, and influence the communication of FM knowledge and expertise to designers.

2.5.5 Consequences of Limited Integration

Limited integration of FM and design is shown to have consequences. Cullen (2007) reveals that whenever a project proceeds without having sufficient integration of design and operations planning, the result would be a facility facing operability problems as well as trouble in reliability and safety issues.

Jaunzens et al. (2001) detail the common operational problems which could be resolved, should the facilities management team participate during briefing and various design stages. These problems fall under the following major sub-headings:

- a. Problems with mechanical services
- b. Problems with the building fabric
- c. Problems with deliveries and waste management
- d. Problems with landscaping
- e. Problems with the procurement process
- f. Problems with public health services
- g. Problems with electrical services and equipment
- h. Problems with fixtures and fittings
- i. Problems with layout
- j. Problems with fire safety systems

Observing the various above mentioned problems shows that several design disciplines are impacted by the FM participation and input. Electrical, mechanical, plumbing, architectural, interior finishing, landscaping, fire, safety and health aspects are all affected. The procurement process itself is also influenced through

poor briefing, excessively emphasizing the project's aesthetic aspects, inadequate design change management, insufficient commissioning and handing over procedures.

2.5.6 Purposes for the Integration of FM and Design

Several purposes for communicating FM knowledge to designers are stated in the literature. These are identified to substantiate the need for achieving FM and design integration.

2.5.6.1 Resolving Complexity in Projects

Facilities management functions vary according to the context where they operate, making an effort to adapt to alterations resulting from differences in organisations of different contexts (Kaya and Alexander, 2006).

Martin and Guerin (2006) affirm that standard design processes are insufficient nowadays in resolving complex issues and requirements. Therefore, making use of the knowledge collected from FM expertise within the various business sectors will render designers more capable of fulfilling client/user requirements and producing more FM-efficient designs.

Due to the high complexity and great differences between projects, it is hard to gather customer feedback for future use (Karna, Junnonen and Sorvala, 2009). The construction industry has started making use of FM processes although the use of evaluation tools such as customer satisfaction remains premature (Torbica and Stroh, 2001).

2.5.6.2 Addressing FM Concerns

Facilities management faces a range of problems while operating a facility, whereby these problems can be eliminated if attended to during the design of new buildings.

An example on the above is an investigation on workspace design performed by Schwede, Davies and Purdey (2008). The results showed that issues related to noise suppression and visual disturbance prevention are unattended at present in designs of new facilities, bearing in mind that acoustics and visual quality are significant factors affecting productivity and comfort within a given environment.

McLennan (2000) reveals the importance of comprehending the correlation between facility performance and its impact on occupants which generates valuable knowledge used in enhancing facilities design and working environments. FM would then be conceived as a strategic organisational resource, positively affecting productivity and profitability, instead of merely being pictured as a cost centre.

Communication between FM and stakeholders is essential to achieve success in FM operations at occupancy stage whereby the margin of difference between expectations and service delivery is consequently reduced to a minimum (Barrett and Baldry, 2003). In a construction case presented in their article, Heywood and Smith (2006) reveal that the built facility turned out to meet the client's needs and expectations; an outcome which was accomplished due to the fact that best practice knowledge related to stakeholder perceptions was considered at early stages of the project.

Moreover, Jaunzens et al. (2001) discuss benefits of the involvement of the FM manger during design stage, resulting in buildings which are:

- a. Well-matched to accomplish business needs
- b. More attractive to clients
- c. Easier to maintain and commission
- d. Easier to manage and control
- e. Operated more cost-effectively

- f. Better capable of responding to occupants' needs

In addition to fulfilling client and user needs, the above list shows that the FM requirements of easier maintenance and management as well as cost-effective operation are also accomplished.

2.5.6.3 Ensuring Proper Client and User Involvement

Rayle (2005) points out the various client bodies for each of the parties involved in facilities design and management services for a certain organisation. The author describes end users as being clients of FM/real estate management and on the other hand, the organization's FM community being the client of designers and other consulting parties.

Stakeholders' points of view are rarely shared or have anything in common, due to the different role of each as described below (Rayle, 2005):

- a. *The Internal Client (End-User)*: Being the eventual user/occupier of a facility, the internal client activities represent the firm's core business.
- b. *The Facilities Management Organisation*: Often acting as service provider to the internal client and in turn, a client to designers and other consulting firms.
- c. *The Design Consultant*: Being the external source of engineering/architectural design services, the design consultant represents the outside service provider.

In addition to the abovementioned stakeholders and besides end users, owners of facilities as well as customers and company employees can also be differentiated.

Consequently, Rayle (2005) states that in order to achieve excellent relationships between stakeholders, information and experience input from all sides is required.

Two case studies presented by Kaya (2004) reflect on owner, designer and end-user requirements. Case study 1 deals with constructing a new office building for a UK energy company that was wishing to relocate. Appraisals done two years later to investigate user needs and existing space utilization revealed that the brief developed at early design stages lacked information about usability and future business growth. This drawback resulted in an increased effort of managing space within the facility as the resident company increasingly grew.

Case study 2 on the other hand discusses the relocation of an R&D centre for a high tech company into newly built headquarters. One of the project brief intentions was to react to user requirements through user participation which turned out to be a significant one. Kaya (2004, p. 250) wrote: "The results could not have been achieved if the senior managers had not supported and participated in the process."

Kaya (2004) reveals that the aforementioned case studies deal with office buildings whereby the users are the owners of the facilities themselves. Expectations and requirements vary from building type to another such as in a hospital for example, by which personnel, patients and visitors are all considered end users.

Luck and McDonnell (2006) discuss the conversations occurring between users and designers which promote the transfer of knowledge that is essential for the design process. The authors assessed these conversations in a workspace re-design exercise that is reported in their article, in order to figure out the information being exchanged between parties. Table 4 shows the various design elements

involved in an architectural design context, namely functional/structural naming, perceptual awareness, phenomenological experience and symbolic meaning.

The conversations showed that functional/structural elements were the most discussed by users whereas perceptual and phenomenological elements were mostly ignored. Users were not much aware about workspace configurations and space perception in general but instead, seemed to be more comfortable in discussing familiar functional issues of their current workspaces.

Level	Code Title	Definition
1	Functional or structural naming	Elements and properties of the building or space (floor, exposed brickwork, the tower, etc.), its objective character
2	Perceptual awareness	Attributes of the building or space that can be perceived (visual, lighting, acoustics, etc.)
3	Phenomenological experience	Feelings and associations made when experiencing the space (density, solidity)
4	Symbolic meaning	Evocation of ideas unrelated to the structural form (mystery, memory, etc.)

Table 4 The elements of design (Luck and McDonnell, 2006)

The above case is an example on the deficiency in defining user needs and requirements which are to be fed into the design, even when user involvement took place during early design stages. Users of the space often face difficulties in expressing their preferences and therefore, an experienced design participant who is aware of all the design implications should be liaising with users to convey the proper knowledge to design experts.

2.6 Previous Contributions to the Knowledge

Different concepts dealing with the FM and design integration are found in the literature. An extensive search revealed the following topics.

2.6.1 FM and User Participation in Design

Recent construction projects have shown an increasing interest in operation-related issues of buildings during design stage, a shift from the traditional concentration on only delivery and handover to clients. The reasons according to Blyth and Worthington (2010) are mainly due to:

- a- The increase in the use of procurement strategies that involve design, construction and operation. PFI is one example.

- b- Sustainability and environmental concerns which require buildings to be designed and constructed with lesser carbon emissions in mind, and operated in a sustainable way.

- c- The high energy prices which lead to a greater demand for reducing energy costs.

- d- The shift of building occupancy towards a more sophisticated and flexible approach, which in turn increases the demand for flexibility, cleaning and various other operation and maintenance tasks.

The application of FM expertise in building design was handled by Jaunzens et al. (2001) who produced a guide that suggested the benefits behind the need for facilities managers' involvement in design, the barriers preventing them from being involved and their possible contribution in the procurement process. The guide concludes with providing an FM personal development plan, to be utilized by

facilities managers to increase their empowerment within a client organisation. This development plan also provides a self assessment tool used to define facilities managers' engagement on various levels within their client organisation. Previous work on the challenge of knowledge transfer in achieving design integration of facilities management was carried out by Jensen (2009). Through studying the process of relocating a 133,000 m² public service television and radio broadcasting media centre, Jensen discussed user participation in design.

The brief included environmental and O&M dedicated chapters in relation to both design and construction. Examples of chapter section headings concerning operation and maintenance subjects were as follows:

- a. Layout and planning
- b. Cleaning
- c. Energy consumption
- d. Long lifetime
- e. Optimal management and monitoring
- f. Accessibility
- g. Flexibility

Twenty user groups participated in producing the brief and following up during conceptual and schematic design. The FM user group, one of the twenty participating groups, comprised FM and environmental experts who were in charge of checking and commenting on design drawings (Design follow-up).

Economic evaluations based on life cycle cost calculations were performed during the planning stage. Analyses concerning maintenance, energy consumption and cleaning operational costs were conducted in order to assess the facility's cost performance throughout its lifetime.

The outcome of the study led Jensen (2009) to propose four knowledge transfer mechanisms, from facilities management to design, involving raising designers' awareness, boosting FM skills and capabilities, the FM participation in design and the use of power to ensure the consideration of FM knowledge in design.

2.6.2 Participating in Brief Preparation

The Brief is prepared based on client/designer interaction (interviewing end-users, talking to facilities managers, etc...) to unveil client requirements and expectations which form a vital input into the design process (Bogers, Meel and Van der Voordt, 2008).

Barrett and Stanley (1999) discuss the different ways to improve the briefing process. Five different ways are proposed by the authors to achieve better briefing which are the following:

- a- Empowering the client
- b- Managing the project dynamics
- c- Appropriate user involvement
- d- Appropriate team building
- e- The use of appropriate visualisation techniques

An important factor that stimulates creative designing disappears if end users are not engaged in the process of design, and clients are then faced with discontented stakeholders throughout the facility lifetime. Consequently, user involvement during briefing can lead to various benefits due to the fact that users are experts in their fields of practice, give attention to the final details related to their work and can therefore introduce changes which result in genuine improvements. Moreover, getting users involved during briefing will give them a sense of ownership and make them feel that they are part of the decision making process. As a result,

users will more likely be satisfied with the built facility even though they might not get all what they asked for.

Barrett and Stanley (1999) argue that users, and after providing designers with their requirements, should be provided with feedback in order to confirm if these requirements have been properly read by designers and incorporated in the design.

Nutt (2000) argues that the facility design and management knowledge is still an emerging component of the FM knowledge track. The facilities management/facilities design interface needs to be handled without delay in order to realise how management and design of facilities actually affect each other in terms of:

- a. Informing design about management considerations
- b. Notifying design about management constraints
- c. Design consequences on management at occupation stage
- d. Limitations created by the design on management of facilities

Nutt (2000) discusses the issue of life-cycle briefing comprising management and design decision making as shown in Figure 5. Nutt assures that FM will have to gather information about organisations' operational needs to create a database containing standard knowledge to be utilised. First, at the strategic brief phase to produce property related decisions, and second, at the project brief phase to inform design at the early stages. The life-cycle brief as Nutt (2000) explains, guarantees that operation concerns are a vital design interest conveyed by the FM side that would be acting as the clever client.

Smith, Love and Heywood (2005) performed a study on "performance brief" preparation through which they had considered stakeholder needs on a project

under construction. Topics such as services, accessibility, security, effectiveness and flexibility were the main stakeholder concerns included in the performance brief which was later used to develop the project brief that constituted part of a library for the building design process. The constructed project was considered a success due to the great contribution of the performance brief prepared by stakeholders who, in turn, were given the chance to follow up on the design and execution of the project.

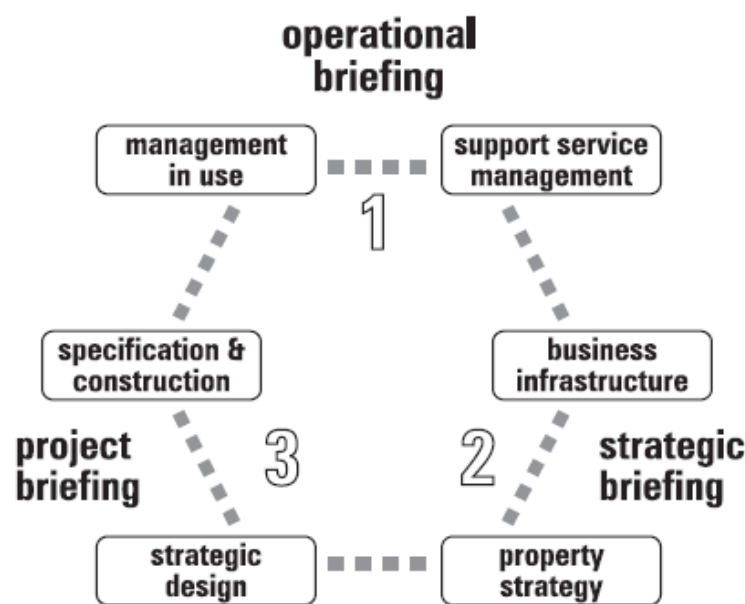


Figure 5 Life cycle briefing (Nutt, 2000)

The requirements of user groups responsible for running the facility after construction is completed are communicated to designers through the “operational brief”. Therefore, the operational brief should be developed in line with the business strategy and prior to the commencement of design. These user groups, as Blyth and Worthington (2010) state, are those responsible for carrying out the FM service, in addition to IT and property management. The operational brief should include a delivery model as to whether services will be provided in-house or outsourced, and the duration of occupancy.

As a result, Blyth and Worthington (2010) present the various issues that need to be included in an operational brief, and are presented as follows:

- a- All assets that require maintenance and cleaning such as plant, lifts, lighting and furniture.
- b- All services required such as catering, reception, security, waste management, mail delivery, recycling, etc...

According to the authors, service levels should be reflected in the operational brief and the ways to measure such levels of service. In addition, the brief should be transformed into guidelines for managing the facility operation during occupancy phase.

2.6.3 Enriching Facility Programming

Erdener (2003) brings out the definition and description of the term “programming” as set by the AIA (American Institute of Architects), being the method of determining the concerns and setbacks which should be addressed and solved by the design.

The process begins by gathering facts related to the project site, economic status as well as the legal issues. FM managers in this step can provide practical information concerning space constraints, project duration and budget, and the client requirements.

The next step in the process deals with transforming input data into anticipated physical characteristics to be achieved through design. Those physical characteristics would then be realised based on the crucial elements of needs such as amount, quality, location, time and space. Erdener (2003) deduced that by means of presenting facility-related information and acting on the client/user side

throughout project delivery, facilities managers turn out to be key members of project teams.

While the current framework pictures FM as commencing in the occupancy stage with a very limited contribution to the design stage and the decision making process, Erdener (2003) proposes a modified framework suggesting that FM be represented in programming and design as a strategic tool used to overcome inefficiency, expensive maintenance and operation, and unresponsiveness of facilities during occupation. Assessing and deciding on matters such as capacity, growth, flexibility, energy conservation, area, ambient environment and many other issues reflects the degree of involvement of clients/users in programming and design.

2.6.4 Considering Usability Issues

When discussing building performance, it is significant to shed the light on an often ignored term, usability that is. Alexander (2006) affirms that considering usability information when designing, constructing, and managing buildings is still immature.

A project carried out by Alexander (2006) was to build up ways to evaluate workplaces and examine usability ideas as well as their functioning within buildings. As occurring in ISO 9241-11 mentioned in Alexander (2006), usability is determined by efficiency (performing with optimal resources), effectiveness (achieving required outcome) and satisfaction (users' emotional and behavioural reactions towards the built facility). In addition to exploring building evaluation through the concept of usability, the abovementioned project aimed at investigating the possibility of usability knowledge integration during design briefing.

It is worth noting though that while POE and serviceability are tools used to evaluate buildings compared to their anticipated use through examining physical building characteristics, Alexander (2006) discusses functionality instead, and its relation to usability. Alexander states that functionality defines whether a building can operate on its own, belong to a complete system, satisfy the ergonomic requirements of occupants/users and aesthetically support character and values. Some of the aforementioned project's conclusions describe usability as:

- a. Approaching users and concentrating on their views regarding facility use
- b. Different from post-occupancy evaluation due to being interested in consequences instead of product expectations
- c. Dependant on varying conditions, places and time periods

2.6.5 Combining Facilities Management and Project Management

Brown, Hinks and Sneddon (2001) propose examining the chances of enhancing the project management (PM) process through making use of FM competence rather than assigning consultant project managers. This idea originates behind the reason that almost all project-related parties are only temporarily interested in a given project with the absence of such interest as soon as the building starts operation. For facilities management, this situation is not true. FM managers are always interested in the quality of operation and maintenance, running costs, space planning and many other topics which are progressively being considered significant to business strategies.

Project management processes within the UK are actually unable to consistently meet customer requirements upon project delivery, as stated by Brown, Hinks and Sneddon (2001). This has resulted in suggesting the involvement of other professions in the management of design and construction in order to achieve increased customer satisfaction. The aforementioned involvement would then be achieved by either creating a new profession which merges key elements of both

FM and PM, or forming a new management body through joining up teams from both disciplines. Such team mixing presents a rising concept in the construction industry nowadays (Brown, Hinks and Sneddon, 2001).

2.6.6 Process Design

Stempfle and Badke-Schaub (2001) talk about the content-related steps of solving a design problem; these steps are: goal clarification, solution generation, analysis, evaluation, decision and control.

The aim is creating a facilities management role in the design of buildings through involving FM in a proper design process which alters the design content. Compared to conventional designs that lack such aforementioned involvement, modified content designs endeavour to achieve an enhanced solution that more suits facility owners and users/customers as well as the support services function. When considering the modification of the design content to incorporate FM related topics and concerns, there are questions asked as to where within the content-related steps should the FM knowledge be introduced and in what form the FM/design relationship should be represented (Stempfle and Badke-Schaub, 2001).

Involving FM in the design process can be performed through Van Aken's (2005) process design. Process design, or in other words, designing the design process involves defining the various tasks of design processes and the roles of different participants.

As described by Van Aken (2005), the role of process design is to identify the tasks carried throughout the design process in addition to the different personnel participating to achieve those tasks. Process design is made up of process structure and role structure. The first cares about design steps, succession and instance of occurrence. The second deals with deciding on various players

(designers and all other stakeholders) and their corresponding roles within the design process, allowing coordination amongst them. Process design starts at the commencement of project brief preparation, after the need for a new facility has been justified and the project definition period is then required to begin. The authors argue that process design can be of great importance especially for large projects, affecting time, cost and quality.

2.6.7 Soft Landings

Way (2005, p. 23) defines Soft Landings as being “a new scope of service for building projects that embodies post occupancy evaluation.”

The soft landings approach promotes improved design and construction expertise interference throughout project handing over and beyond to ease the commencement of occupancy phase and aid clients in gaining the most from their newly constructed facility. The approach stresses the requirement of having more designer participation after the project finishes, an issue which is almost missing in conventional procurement strategies. The main stages of Soft Landings are: Briefing stage, pre handover, and aftercare during occupation.

Way (2005) states that one of the key factors of the briefing stage is related to the global idea of facilities management interference in the design processes through providing real and practical information used to enhance the design and customise it to suit clients/users. The author argues that FM experts, who are often introduced somewhere near handing over, are to be involved at early project stages leading to increased confidence in their team members and product ownership.

2.6.8 Integrated Project Delivery (IPD)

IPD surfaced in 2007, defined by McGraw-Hill Construction and The American Institute of Architects (California Council), the idea is to provide recommendations on creating an integrated project environment that goes beyond the structure of client, designer and contractor to involve other stakeholders from the beginning of the project. The implementation of building information models (BIM), to create 3-D project representations and a better sharing environment among project participants, is advised in order for the integrated approach to be effectively implemented (Integrated Project Delivery, 2007).

Whilst Integrated Project Delivery allows the consideration of user requirements at an early stage in design, IPD focuses more on making the construction process more efficient; reducing waste, construction administration and contractor requests for information. IPD also requires that the contractor be appointed at early stages of design so that integration can take place. When traditional design-bid-build project delivery processes are followed, IPD can no longer be efficiently implemented (Integrated Project Delivery, 2007).

2.6.9 Performance-Based Design

Spekkink (2005) discusses the Performance-based building (PBB) approach in design which involves working and thinking from an end-product point of view, rather than the means to reach it. Activities are oriented around the performance of a built facility in use, and getting back as far as possible along the delivery process. PBB deals with what the building should perform for clients, users and other relevant stakeholders, whereby the building should facilitate the planned usage. Consequently, the design process becomes an important aspect due to the critical decisions made during this stage of project delivery.

Spekkink (2005) argues that for the building to be fit for purpose, designers will have to recognise what the users want out of the built facility, what the operation and related process are, i.e. user requirements. User requirements could result in various performance-related requirements that should be fed into the design, as shown in Table 5.

User Requirement	Performance Requirements
1- Have meetings with a maximum of 25 people in different settings (theatre and round table)	1- Required space: 3m ² per person 2- Space shape: ratio length, width ≤ 1.5:1 3- Ventilation: min 30m ³ fresh air per person and per hour 4- Air temperature: 19°C < t < 21°C 5- Background noise: Max 35dB(A) 6- Reverberation time: 0.8 – 1.0 sec. 7- Lighting level on desktop level: min. 500 lux

Table 5 One user requirement may lead to several performance requirements (Spekkink, 2005) Users might only require a meeting space for a certain number of people, which translates into design requirements related to space, temperature, ventilation and acoustic and lighting levels.

Peterson and Svendsen (2010) mention that performance-based designs involve a flow of events (Figure 6) starting with generating a design proposal that focuses on aesthetics and space requirements. Performance is then predicted through modelling techniques in order to find out whether the proposed design meets the performance requirements initially set. The proposed design progresses into a detailed design if performance is accepted, or is discarded or adjusted if the performance evaluation results in rejecting it.

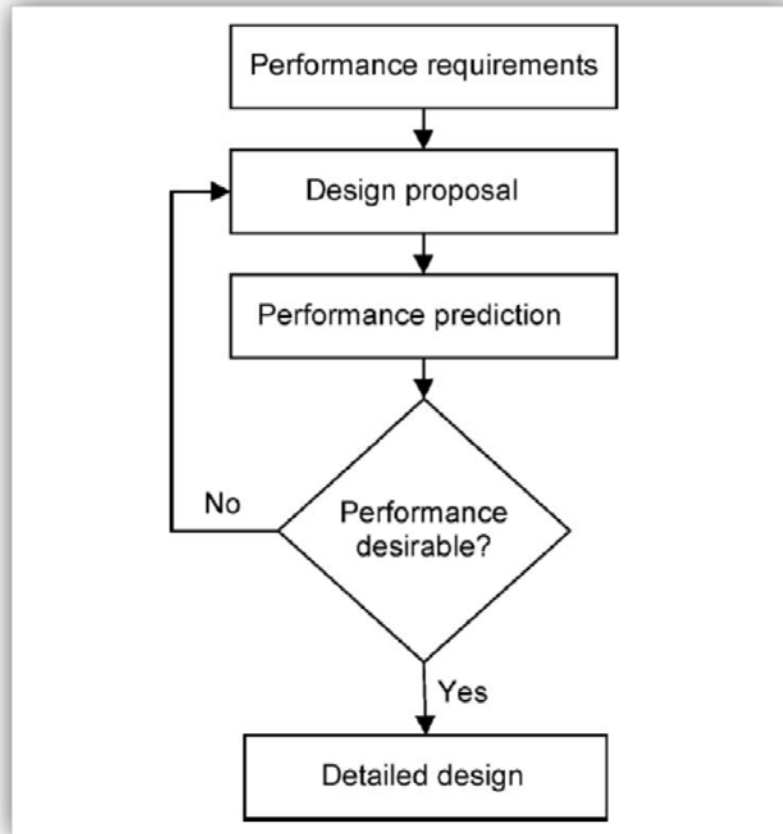


Figure 6 The workflow and subtasks in performance-based design as described by Kalay (1999)

According to Spekkink (2005), there are ten different reasons for carrying out performance-based designs (PBD), where PBDs

1. Provide a client-oriented approach during design process.
2. Aid clients and designers in gaining a better understanding of the building operation.
3. Result in cost effective solutions, better quality and client satisfaction.
4. Alter European and national building regulations to become more performance-based.

5. Prevent designers from reaching design solutions prior to understanding the actual client needs.
6. Provide architects with the tools to act as integrators within the design process.
7. Enhance the conditions suitable for creativity and added value generation.
8. Offer the opportunity to grab the knowledge of contractors and suppliers leading to more innovative and cost effective solutions.
9. Enhance the construction industry's role and responsibility towards the environment.
10. Are starting to be considered a common practice already.

2.6.10 *Construction Process Protocol Model*

Kagioglou et al. (2000) discuss the generic design and construction process which involves various principles including viewing the project as a whole whereby the entire life of a project is taken into consideration when designing the process. Various needs should be recognised as well as the operation requirements for a finished facility. The process also focuses on the project's front end where all client requirements should be identified and defined in order to reach an appropriate outcome.

The process model also allows some project issues to be considered at earlier stages rather than later as traditional processes call for. This explains why one of the principles of the construction process protocol model is the involvement of all

project stakeholders, each stakeholder providing the required input at the right time during the process extending from inception to long term operation stage.

Kagioglou et al. (2000) separate post construction from other stages within the process protocol, and highlight the need for continuous monitoring and management of maintenance needs during occupancy. The authors state that the involvement of facilities management at earlier stages in the process should result in lesser performance problems during post-construction stage.

2.7 Summary

Chapter 2 introduced both facilities management and design professions through providing history and definition, roles and responsibilities and the details related to services provided by each profession. Managing client requirements was found to be one of the major tasks required at the beginning of the design process. These requirements include the needs of various client user groups including facilities management. As a result, the content of FM requirements was uncovered highlighting those that are design-related, as well as the various methods utilised to identify these requirements during occupancy phase.

Literature revealed the need for integrating FM and design in order to enhance the supportive function of design, resulting in facilities that meet client requirements. FM and design integration was therefore addressed, detailing the process of knowledge transfer required from FM to design, showing facilities managers as senders of knowledge and designers as the receivers. Various factors affecting the integration process were also discussed as well as the consequences that could rise when this integration is limited. Finally, previous research done in relation to FM and design integration was presented.

As the various studies on design and FM integration revealed, this integration is still limited on projects in different regions of the world, however, no studies are yet carried out to address this topic in the Middle East region. The absence of research is also faced with a rapid growth of construction activity in this region, leading to an increase in the demand for efficient facilities management.

The following chapter shall detail the methodology and data collection techniques used to approach professionals and inquire about how integration is experienced on construction projects in the Middle East and what measures could possibly be implemented to improve the current situation.

CHAPTER 3 | RESEARCH METHODOLOGY

Achieving the objectives and fulfilling the aim of any research requires the utilisation of a suitable research methodology accompanied by effective data collection to generate useful data for analysis, arriving at a meaningful research output which contributes to the already existing knowledge.

This chapter leads to the selection of the research method adopted by the researcher for this study, in addition to the data collection technique used to generate the necessary data suitable for analysis and the fulfilment of the requirements set by the research questions.

3.1 Facility Design and Management Research

Martin and Guerin (2006) state that designers are required to be knowledgeable about the relationship between people and their built environment because standard design processes nowadays are insufficient in resolving multifaceted problems involving people in various environments.

The authors do mention that facilities management personnel are requesting designers to make use of research findings on design and human behaviour in order to produce solutions, although it is hard to translate such new knowledge into criteria during the different design phases. Therefore, FM personnel are not seen interfering in the production of design solutions but instead, are relying on designers to take action in benefiting from research practices in design.

However, research within facilities management does exist and based on the literature review done by Ventovuori et al. (2007), qualitative data was collected from papers published in journals related to FM between 1996 and 2005. After analyzing the papers, it appeared that the most area researched in those papers was general trends within the FM field. Research seems to be growing in areas related to environmental matters and external relationships.

From what Ventovuori et al. (2007) found, the research undertaken was more related to areas within facilities management and the FM operations rather than the interface with other stakeholders and external parties involved in facilities. However, the authors add that interest is seen to increase in areas related to the environment and external relationships, which would also cover the relationship between FM and design.

3.2 An Overview of Research in Education

When discussing research, the term epistemology is often used. Johnson and Buberley (2000) state that derived from the Greek, epistemology means the science of knowledge, or generally known to deal with knowledge about knowledge. According to Thiétart et al. (2001), epistemology pertains to studying knowledge. Therefore, it is the study of the nature, validity and value of science along with the relevant methods and scope.

Martin and Guerin (2006, p. 168) define research as a “systematic inquiry into an issue to investigate or resolve a problem.” Research revolves around the researcher’s vision, involves the use of a method to attain a certain result. Thus, the research problem is generated in order to create a question requiring an answer through reaching the aforementioned result (Figure 7). Choosing a research methodology and designing the overall research process is conventionally directed by the research problem (Thiétart et al., 2001).

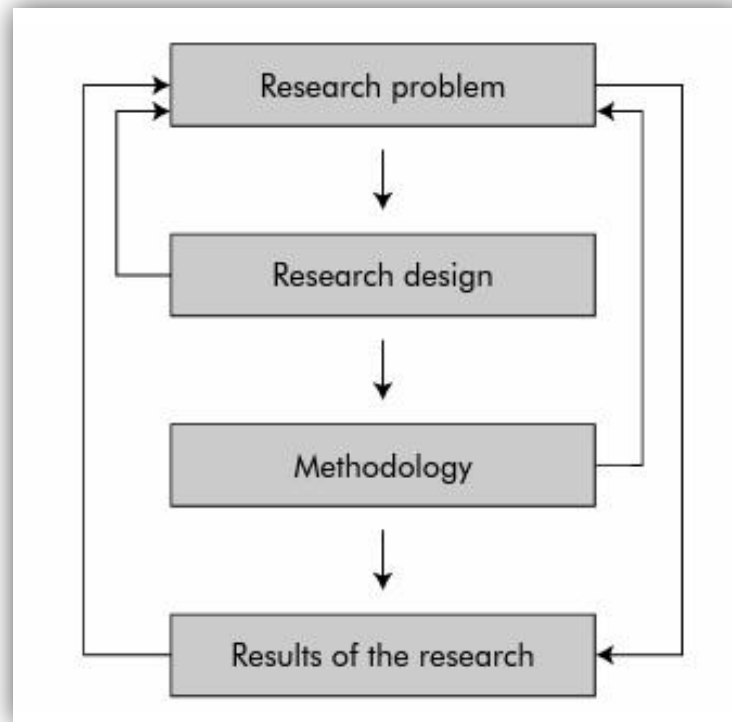


Figure 7 Research problem as an essential part of the research process (Thiéart et al., 2001)

3.2.1 Approaches to Research

Different approaches leading to a specific epistemological assumption in relation to the research problem are found in the literature. Approaches to research differ according to the researcher's views of the reality under study.

According to Lee (1989), research may fall under three categories:

1. Subjective: The researcher's personal perception of research participants
2. Interpretative: The researcher's perception of research participants' subjective views
3. Positivist: The objective perception of facts within a certain situation

Thiétart et al. (2001) in turn state that the knowledge types sought by a researcher differ according to whether the epistemological suppositions are made based on a positivist, interpretive or constructivist view. The author handles both the positivist and interpretive views discussed above, but introduces the constructivist view.

1. Positivist views involve investigating facts to uncover the primary causes
2. Interpretive views deal with getting deeper inside phenomena to understand people's relationships with reality
 - Constructivist views aim at building a problem through detailing a knowledge plan and attempting to satisfy through research

Several assumptions about the nature of reality are shared between interpretivism and constructivism. However, they differ in knowledge creation processes and research validation. Thiétart et al. (2001) describe the three major paradigms as follows:

Positivism aims at explaining reality, *interpretativism* mainly focuses on understanding it and *constructivism* basically to construct it. Table 6 below shows the various epistemological questions and answers related to the three paradigms.

There is a slight difference between the two aforementioned sets of categories which aim at defining the research orientation. Lee (1989) tends to use the researcher's participation level as a criterion for classification, whereas Thiétart et al. (2001) refer to the nature of work done in research.

Epistemological questions	Paradigms		
	Positivism	Interpretativism	Constructivism
Status of knowledge	Ontological hypothesis: The knowledge object has its own essence	Phenomenological hypothesis: The essence of the object is multiple (interpretativism), cannot be attained (moderate constructivism) or does not exist (radical constructivism)	
	Independence of subject and object	Dependence of subject and object	
Nature of 'reality'	Determinist hypothesis: The world is made up of necessities	Intentionalist hypothesis The world is made up of possibilities	
How is knowledge generated?	Discovery The research question is formulated in terms of 'for what reasons ...'	Interpretation The research question is formulated in terms of 'what motivates actors to ...'	Construction The research question is formulated in terms of 'to what ends does ...'
	Privileged status of explanation	Privileged status of understanding	Privileged status of construction
What is the value of knowledge? (Validity criteria)	Degree of confirmation Refutability Logical consistency	Credibility Transferability Dependability Confirmability	Adequacy 'Teachability'

Table 6 Epistemological positions of the positivist, interpretativist and constructivist paradigms (Thiétart et al., 2001)

A third view presented by McNeill and Chapman (2005) describes different philosophical models depending on the various assumptions taken during the research process about the different aspects of the world. As a result, McNeill and Chapman (2005) handle both positivism and interpretative sociology.

1. Positivism

Mainly regards society as more central than the individual, positivism ought to generate quantitative data used in statistical analysis and graphical representations. Such data is most expectedly produced using surveys and structured interviews.

Utilizing this data to generate correlations, patterns or trends aids positivists in arriving at conclusions concerning laws about social/behavioural aspects. The causes of human behaviour as seen by positivists are mainly external and not subjective to individuals under study. This fact results in a macro mode of researching the social composition.

2. Phenomenology and Interpretative Sociology

The difference between social and natural sciences is that social sciences regard humans as dynamic individuals who are attentive to surrounding situations while natural sciences (positivism) disregard such an aspect.

Interpretativists should understand the construction of true lives of people under study, a matter which introduced ethnographic studies and participant observation, in particular. Data collection is consequently a qualitative practice, in words not numbers, describing the quality of descriptions about life instead of producing statistical outcomes.

3.2.2 Qualitative versus Quantitative Data

Thiétart et al. (2001) reveal that researchers are required to choose the structure of data collection and analysis. In management, research is either an investigation (qualitative) or verification (quantitative) of a theoretical object.

Lee (1991) differentiates between interpretative (qualitative) and positivist (quantitative) methodologies by stating that qualitative researchers seek to investigate not only objective issues related to people and their behaviour, but also the people's subjective views concerning their own behaviour. According to Silverman (1998), qualitative research is concerned with analysis methods relying on words and away from statistics and numbers.

Lee (1991) asserts that the quantitative approach is based on objective data gathering and analysis, and that quantitative researchers argue that their natural science methods are the only true methods of research. While the study of people and organizations, as claimed by qualitative researchers, requires methods distant from natural science.

3.2.3 Research Design

As reflected in Figure 7 of sub-section 3.2, it is important to design the research process after deciding on the research problem and before commencing with the implementation of any chosen methodology/data collection exercises leading to the formulation of the final output.

According to Cohen, Manion and Morrison (2000), research design engages the following steps:

1. Establishing research questions
2. Choosing suitable methodologies
3. Choosing appropriate data collection techniques
4. Figuring out the sample for the study
5. Attending to validation and reliability
6. Attending to ethical concerns
7. Selecting data analysis methods
8. Document and explain results

These steps are followed in carrying out this research to attain an organised research process. Following the establishment of the research questions, the researcher moves on through the process to choose a suitable research methodology.

3.3 Research Methodology

Following the definition of the research problem and shedding the light on the various steps of research design which will guide the researcher throughout the research process, deciding on the research methodology to be adopted should then follow.

McNeill and Chapman (2005) state that studying aspects of the world requires that a researcher chooses a method based on the kind of study to be undertaken. In order to select a suitable methodology, the researcher should evaluate the kind of study, the participants involved and the nature of data required against various assumptions.

3.3.1 Assumptions Correlated with Social Science Research

Hitchcock and Hughes (1995) state that ontological assumptions lead to epistemological assumptions which in turn lead to methodological assumptions ending in the selection of instrumentation and data collection techniques. Figure 8 below graphically represents the above mentioned string of assumptions leading to the selection of the proper research methodology based on the objective versus subjective view of social reality.

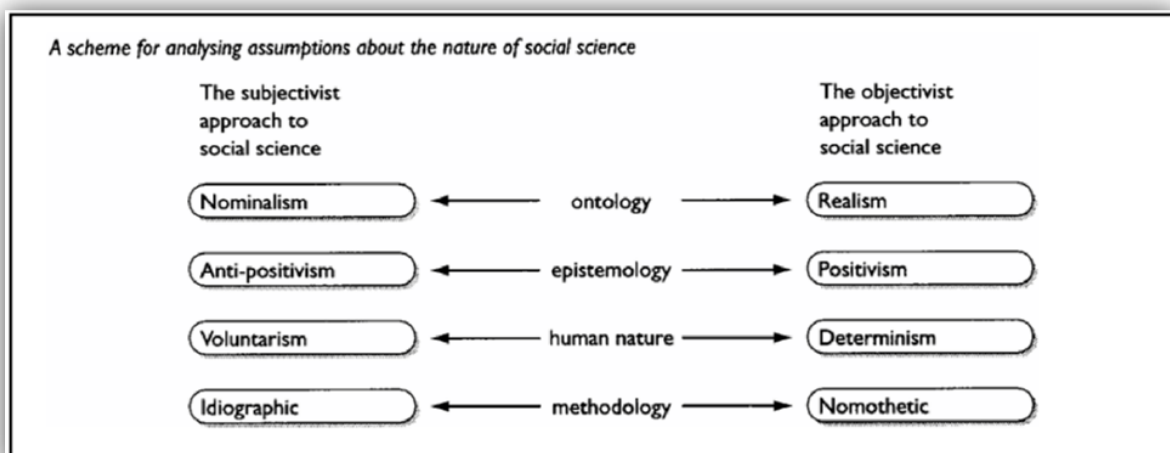


Figure 8 The Subjective - Objective Dimension (Burrell and Morgan, 1979)

Burrell and Morgan (1979) analyse the various assumptions as follows:

- a. Ontological assumptions address the nature of the social occurrence under investigation, and whether social reality is externally affecting individuals (objective nature) or being created by their own perceptions (individual cognition). A realist argues that an object exists independently as opposed to the nominalism view.
- b. Moving on to the epistemological assumptions, these are mainly concerned with the nature of knowledge; the different ways this knowledge is acquired and communicated to others. When the knowledge is seen as being objective, hard and tangible and thus requiring the researcher to be more of an observer, this knowledge belongs more to the natural sciences. The researcher in this case is a positivist. On the other hand, seeing knowledge as unique, personal and subjective requires researchers to get involved with their subjects as opposed to a natural scientist, and therefore would be regarded as anti-positivists.
- c. When it comes to assumptions related to the human nature, either that humans are viewed as mechanically responding to their environment or that they are the originators of their own acts. The former regards humans and their experiences as a product of external circumstances, while the latter gives them more of a creative role and a free will to control their acts.
- d. Following an objectivist route leads to applying methods which are designed to discover general laws of reality, an approach referred to as nomothetic. Whereas subjectivists apply methods designed to understand the human creation, modification and interpretation of the world, an approach represented as idiographic.

Upon observing all aforementioned assumptions, the researcher is then able to decide on the most suitable research methodology and corresponding data collection techniques to be used for the study.

With respect to this research and the subject of FM and design integration, the investigation is not related to the researcher's view of the situation or problem. Instead, feedback should be gathered from relevant professionals in order to understand current practices and the extent of existing communication. Moreover, recommendations will have to be collected from those professionals on improving the current situation.

In view of the above concerning the type of data to be collected, participants' perceptions are therefore essential to build up an understanding of the facilities managers and designers current relationship status. This, in addition to what those participants would suggest for increasing the chances of effective integration.

Hence, this research deals with participants' behaviours within a specific context and their extent of communication and information exchange. The data gathered cannot as a result be objectively analysed leaving out the actual participant input about reality and contribution towards changing it.

Referring back to Figure 8, this research is therefore characterised by nominalism as reality is created through participants' perceptions. An interpretivist or anti-positivist approach is followed reflecting on subjective views of participants. Voluntarism characterises human nature as participants behaviours are not a result of external factors, but are originated from those participants themselves. As a result, the approach to research is idiographic involving the collection of qualitative data.

3.3.2 Types of Research Methods

Numerous methodologies used to carry out research are found in the literature. These methodologies include: Surveys, Experiments, Quasi-experiments and Single-case Research, Case studies, Correlational Research and Action Research.

3.3.2.1 Surveys

Cohen, Manion and Morrison (2000) argue that for comparing existing conditions to standard ones or building relationships between events at specific points in time, the survey is the method to be used to gather the needed data. As a result, various survey types exist depending on how complex the situation is; varying from straightforward frequency counts reaching more difficult relational analysis.

According to Oppenheim (1992), there are generally two different types of surveys; the descriptive survey which deals with census-type data and the analytical survey. The reason for using descriptive surveys is to count, asking the question of “how many”. When the purpose of the research shifts from counting and describing to answering the question “why”, the analytical survey is then used to perform an analysis of causality.

Martin and Guerin (2006) discuss that when human behaviour cannot be directly observed or experimented, the survey method would be used. Surveys are used to gather data about people; thoughts, actions, beliefs, etc...

Survey data is collected using questionnaires as well as interviews, as declared by Martin and Guerin (2006). Cohen, Manion and Morrison (2000) also list instruments used to gather data under the survey methods of research, whether of large or small scale, including the following:

- a. Structured or semi-structured interviews

- b. Self-completion or postal questionnaires
- c. Standardized tests of attainment or performance
- d. Attitude scales

3.3.2.2 Experiments, Quasi-experiments and Single-case Research

The essence of experimentation, according to Cohen, Manion and Morrison (2000), is that researchers get to manoeuvre the situations which lead to the incidents under study. The simple form of experiments, they say, involves manipulating one variable (independent) and recording the effect on some other variable (dependant).

Martin and Guerin (2006) discuss that experimentation is carried out to record how various dependant variables are affected by one or more independent variable; Experiments are used to test alternatives.

Cohen, Manion and Morrison (2000) also discuss Quasi-experiments and Single-case Research as follows:

- a. Quasi-experimental studies are often used instead of true experiments, with a single difference, that samples used for quasi-experiments are not selected randomly.
- b. Single-case research, extending to fields such as clinical psychology, medicine, education, etc..., is characterized by the following:
 - Continuously assessing human behaviour and recording findings on various instances over a certain period of time
 - Repeatedly applying interventions and assessing the resulting effects on subjects

Experiments tend more to serve testing purposes and prove theories, instead of aiding researchers in theory building.

3.3.2.3 Case Studies

The technical definition of a case study as given out by Yin (2003, p.13) is an 'empirical inquiry' which examines an event 'within its real life context'.

Yin (2003) lists five different uses of case studies. Case studies are used to:

- a. Explain the complex causes of interventions in real life
- b. Describe the abovementioned interventions within specific contexts
- c. Illustrate particular topics within a study
- d. Explore situations where interventions occur
- e. Evaluate evaluation studies, a meta-evaluation

As stated by Flyvbjerg (2006), being close to situations in real life and involving a good deal of details, renders case studies essential for several reasons. Understanding human behaviour through forming a certain perception of reality which cannot be achieved through theories is one reason. A second reason would be that case studies enhance researchers' learning practices in favour of producing high-quality research.

Cepeda and Martin (2005) express that case study research is considered practical for two main reasons discussed in what follows. The first reason is that case studies provide the opportunity of studying objects in their natural environment in order to produce theoretical outcomes from practical data. The second reason behind regarding case studies as convenient is that case studies enable the researcher to understand the complex processes taking place in a certain environment and the reasons behind their occurrence.

From within the interpretive approach to research, case studies involve data collection techniques that include the following (Cohen, Manion and Morrison, 2000):

- a. Semi-structured and open interviews
- b. Observation
- c. Narrative accounts and documents
- d. Diaries
- e. Tests

3.3.2.4 Correlational Research

Correlation research is utilized typically to detect a relationship between two variables/data sets. If such a relationship exists, its direction and magnitude are then investigated. Measuring several variables and their relationships concurrently renders the correlation research method useful in dealing with educational and social science problems (Cohen, Manion and Morrison, 2000).

3.3.2.5 Action Research

Kemmis and McTaggart (1988, p. 5) define action research as “a form of collective, self-reflective inquiry that participants in social situations undertake to improve: (1) the rationality and justice of their own social or educational practices; (2) the participants' understanding of these practices and the situations in which they carry out these practices.”

Action research participants should be groups of people with shared concerns and the study is of the action research type when collaboration takes place and the actions of group members are observed.

Altrichter et al. (2002) consider that action research has been increasingly recognized for breadth and depth, but there is no definition that is widely

established due to the fact that action research is considered a very broad movement.

3.3.3 Choosing a Suitable Methodology

Referring back to the research problem, research question and the nature of the investigation, the researcher is required to investigate FM and design integration within in specific region.

The investigation should therefore involve designers and facilities managers operating within a certain context. In order to attain a research output that could be generally applied to design and facilities management within a defined context, the survey method is utilized. In addition, and based on the analysis made in Section 3.3.1, qualitative data about people's experiences and opinions is found to be the required data type to be collected.

While the statistical survey is commonly used for quantitative approaches, a qualitative survey is utilised to research the diversity in a certain population rather than counting people sharing the same characteristics, and explore experiences rather than establish frequencies (Jansen, 2010).

Qualitative survey methods began to gain popularity during the 1980s, responding to the shortcomings of surveys relying on questionnaires. The questionnaire surveys are rather considered time consuming and unsuitable for presenting a thorough interpretation of a certain subject (Chambers, 1983 and 1994; Pretty et al 1995; quoted in Marsland et al., 2000). The divergence between the traditional quantitative and qualitative techniques resulted in unsatisfactory findings and conclusions, whilst there was also a recognition that both types of methods can actually benefit from one another.

According to Marsland et al. (2000), qualitative survey types enable qualitative and quantitative tools and attitudes to be swapped. Due to this merging of both tools, the researcher is then able to consider a research sample for qualitative data collection. The collected data obtained from open-ended questions can therefore be coded to develop categories as well as attain statistical outputs such as frequency tables.

The selection of the survey method was done based on the following additional observations. Case studies are essential for gathering details and understanding human behaviour, but the results obtained remain specific to a certain situation or project. Action research is mainly applied on a small scale, while correlational research aims at measuring the degree of a relationship between variables or datasets; none of the above mentioned methods satisfy the aims of this research which call for a thorough investigation of a situation involving qualitative data gathering and the production of a generalised research outcome. Moreover, no experimentation is required in this research to recognize the effect of variables on other variables, as this study is concerned with investigating the FM and design integration and aims at providing recommendations to improve the current situation.

3.3.3.1 Survey Research Type and Design

Appropriate research design and the correct choice of target population are both required if the research findings are to be generalised (Oppenheim, 1992). The author presents the different stages of survey research as follows:

1. Establishing the general aims of the research
2. Reviewing related literature

3. Research conceptualization, succeeded by exploratory work, which in turn helps produce revised conceptualization and research objectives
4. Designing the study and reflecting on the research aims with respect to time, cost and staffing constraints
5. Determining the hypotheses, specific to this study, to be investigated. Stating the variables to be addressed/measured
6. Designing the data collection techniques
7. Performing pilot work to examine data collection and make adjustments
8. Designing the sample and who it should represent i.e. population. Considering sampling frames.
9. Forming the sample; selecting research participants
10. Carrying out field-work; the physical data collection practice
11. Data processing; preparing collected data for analysis
12. Analysing data collected
13. Pulling the results together
14. Writing up the research report; interpreting the results and arriving to conclusions

An agenda forming the basis of discussion topics with research participants needs to be developed. Based on those topics, the type of data is identified and the suitable data collection technique is chosen accordingly. With reference to the research aims, a population for the study is then identified comprising all members to which this research and its aims apply. This is eventually followed by deciding on the research sample criteria which leads later on to the selection of the research participants forming a research sample that is meant to represent the whole population.

3.3.4 Data Collection Methods

Upon selecting a research methodology to adopt in carrying out the research, data collection techniques should then be considered depending on the type of methodology used.

Three important issues need to be considered when deciding on data collection techniques; to be in line with the selected research methodology and result in obtaining the right data needed for a successful outcome. McNeill and Chapman (2005) discuss the following:

a. Reliability

A method is considered reliable whenever other researchers use it or the same researcher uses it again, and the obtained results turn out to be the same. When using participant observation, for example, the risks are always high that this technique is considered unreliable as it cannot be repeated.

b. Validity

Whenever the collected data reflects truly what is being studied, then this data is considered valid. People respond to questions within a study, but their answers might not actually reflect the truth about them.

c. Representativeness

If the results achieved relevant to the group of people or the situation under study, are also relevant to other people outside the group, then representativeness is achieved. Hence, one should then be able to generalise from the sample under study.

The data collection technique should be checked against the research problem to determine if it actually gathers the data required by the research questions, and whether this data is reliable, valid and representative of a population under study.

Data collection techniques include: Questionnaires, interviews and observation. Figure 9 gives an example on the range of methods used in data collection, depending on the degree of involvement of the researcher with the participants being studied.

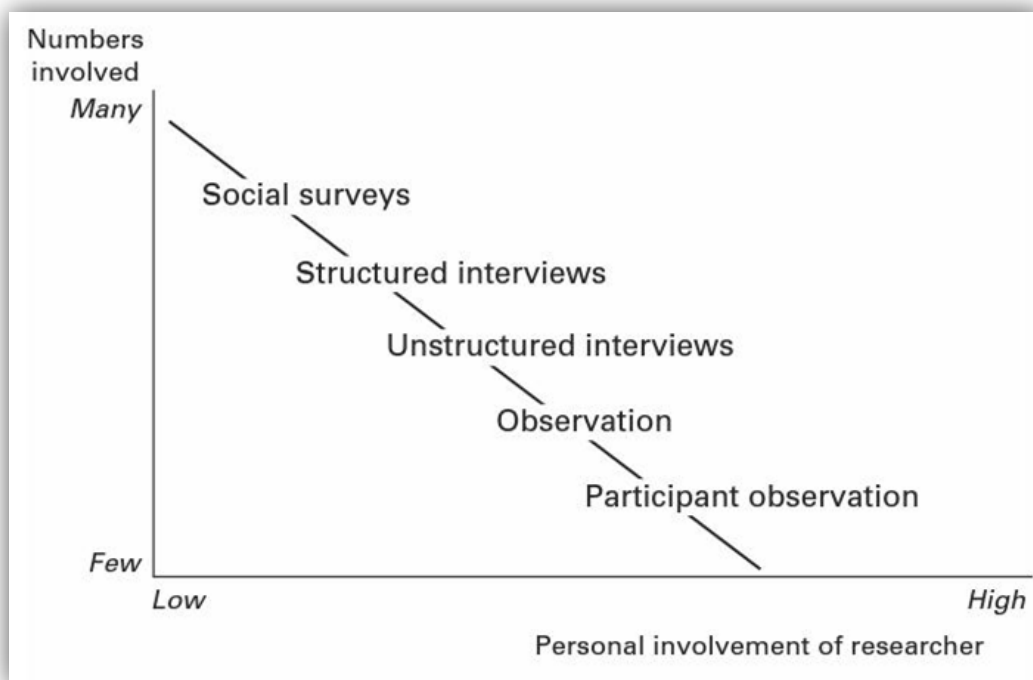


Figure 9 An example on data collection methods (McNeill and Chapman, 2005)

3.3.4.1 Questionnaires

Questionnaires are commonly used techniques in gathering survey data, often numerical, which is mainly easy to examine (Wilson and McLean, 1994).

Oppenheim (1993) and Sapsford (1999) both quoted in Boynton and Greenhalgh (2004) interpret that questionnaires give researchers the option of collecting objective data about people, their behaviour, attitudes and knowledge they possess.

As reported by Cohen, Manion and Morrison (2000), questionnaires are of three types:

1. **Structured Questionnaires:** Involve closed questions which help in the analyses of statistical data due to the generation of response frequencies.
2. **Semi structured Questionnaires:** Involve open-ended questions framed within a certain structure and sequence enabling the respondents to focus their answers in certain required ways while responding in their own words.
3. **Unstructured Questionnaires:** Involve completely open ended questions allowing respondents to write whatever they want while guided by minimal structuring.

3.3.4.2 Interviews

Bogdan and Biklen (1982) define the interview as ‘...a purposeful conversation usually between two people that is directed by one in order to get information from the other’.

The interview is a technique which deals with information generated between people through contact and dialogue rather than just regarding individuals as

entities subject to manipulation (Kvale, 1996). The author discusses that an interview, involving the exchange of information between people having common interest in a certain issue, promotes knowledge creation through human relations as well as reflects the social characteristics of gathered data.

Alvesson (2003) defines an interview as being a social situation created by the person carrying out the research, and discusses the purpose of an interview through referring back to Baker (1997, p. 130) who states that this social setting is created "in order that the respondent speaks openly, authentically or truthfully, to produce valid reporting on some interior or exterior state of affairs". Input provided by the interviewee, Alvesson (2003) says, is crucial for validity and reliability of data which will be used by the researcher in arriving to conclusions.

LeCompte and Preissle (1993) provide six types of interviews:

1. Standardized interviews
2. In-depth interviews
3. Ethnographic interviews
4. Elite interviews
5. Life history interviews
6. Focus groups

Interviews are helpful in collecting and documenting people's thoughts, experiences and knowledge (Bryman, Bresnen, Beardsworth, & Keil, 1988; Fontana & Frey, 1994; Holstein & Gubrium, 1997; Martin & Turner, 1986; quoted in Alvesson, 2003). The interviewer should take into account the social aspects and location where the interview will be carried out, in order to achieve validity when producing knowledge.

There are various purposes for interviews, which include (Cohen, Manion and Morrison, 2000):

- a. Appraising people in some way
- b. Choosing employees or for promotion purposes
- c. Inducing healing effect, as in psychiatry
- d. Developing and testing hypotheses
- e. Gathering data for research purposes
- f. Collecting people's opinions about specific topics

Kvale (1996) mentions characteristics of what is called qualitative interviews. Such a type of interviews is used to gather knowledge that is qualitative, in the form of ordinary language, and not related to quantities. These interviews endeavour to describe a person's perception of the diverse facets of the world.

Through in-depth ethnographic interviews, researchers are able to understand aspects of the world as viewed by interviewees who inform researchers about their own behavioural characteristics (Ely et al., 1991).

3.3.4.3 Observation

Patton (1990) declares that observing engages live data gathering of ongoing situations, whereby the researcher gets to access information about what is happening on the scene rather than getting the information from a different source.

Observing, by means of looking and listening, are considered largely indispensable for collection ethnographic data. Researchers are required to focus on details through being curious and aware while observing participants and processes (Ely et al., 1991).

Observation offers researchers the opportunity to obtain private knowledge and be in contact with information which cannot be gathered using different techniques. For example, information not freely communicated during an interview and hidden data not often perceived when analysing people's responses (Cohen, Manion and Morrison, 2000).

Martin and Guerin (2006) write about observation as being a tool used to determine how environments are utilized, a matter that is achieved through observing and documenting human behaviour.

Three observation manners are presented by Wolcott (1988; quoted in Ely et al., 1991):

1. Active participant: Takes a role within settings created for the research, apart from actually conducting the study itself
2. Privileged observer: A known and trusted researcher given privilege to access specific information about certain situations
3. Limited observer: The common researcher who observes and asks questions without being related to the context

Participant observation is considered by a number of researchers to be correlated with qualitative data collection instruments (Ely et al., 1991). As per Cohen, Manion and Morrison (2000), qualitative approaches tend to rely on observation in order to understand the underlying connections, relationships and causes over a specific time period. Observations can also be used to study narrow samples in parts or sections, in order to produce variables necessary for quantitative research and investigation.

3.3.4.4 Audio/Videotaping

In addition to collecting words written during interviews, several researchers tend to use audio and video taping to record peoples' voices, gestures and facial expressions and many other aspects of a conversation which cannot be conveyed through written material (Ely et al., 1991). Certainly, many other audio/video recording techniques can also be used nowadays due to technological advancements and the availability of a large selection of recording devices.

3.3.4.5 Methodological Pluralism and Triangulation

Not being a data collection technique by itself, Scandura and Williams (2000) discuss triangulation as a process involving the use of more than one method for assessment and validation. They also state that triangulation can indicate the use of more than one data collection methods. Cohen, Manion and Morrison (2000) also mention that although not many use it in practice, triangulation could be described as utilizing more than one data collection method when investigating aspects of human behaviour.

McNeill and Chapman (2005) present ideas about the use of multiple methods in research, namely methodological pluralism and triangulation. Methodological pluralism, they say, involves utilizing two or more research methods to develop broader view of social life. While triangulation according to McNeill and Chapman (2005), involves the use of a number of methods (usually both qualitative and quantitative) for checking the reliability of a research method and the validity of gathered data. The authors continue to state that although they might be helpful, the use of multiple methods is somewhat expensive and results in enormous data sets requiring complex analysis procedures. In addition, Devine and Heath (1999) reflect on the truth that using multiple methods can also lead to contradicting outcomes.

The use of triangulation is believed to aid researchers in better reaching conclusions from their research. Using several research methods leads to a more general result whether used in qualitative or quantitative types of research (Scandura and Williams, 2000).

3.3.5 Choosing an Appropriate Data Collection Technique

Oppenheim (1992) discusses data collection techniques linked to survey research, namely standardized interviews, questionnaires and attitude scales. The author describes attitude scales as tools to measure opinions, beliefs or positions of “for or against” concerning certain issues. While this study is not concerned about measuring whether people are for or against FM and design integration, for example, but rather calls for an investigation, attitude scales are not the suitable tool to gather information for this type of research.

The literature review shows that questionnaires are often used to gather numerical data that is easy to examine; data collected is more of the objective nature and is rather quantitative. Oppenheim (1992) states that even though questionnaires involve low cost data collection/processing and a greater ability to reach people at scattered and far locations, the questionnaire suffers from a low response rate and the absence of control over the order of questions being asked. Both disadvantages strongly affect data collection for this study due to the fact that first, high response rate is actually required and second, responses need to be comprehensive in order to get significant input related to how FM and design integration is experienced in practice, for instance.

Speaking of the order of questions being asked, if questionnaires are used and participants arrive to questions that discuss limited FM and design integration before actually answering questions on how they view the FM and design relationship, then answers obtained concerning the current relationship will most

probably be biased. As a result, questionnaires proved to be an unsuitable tool for gathering data required for this study.

Observation in turn, is a tool mainly used for collecting information related to a specific situation where activities observed would be ongoing. Observing particular circumstances over a period of time does not lead to collecting sufficient data which results in a research outcome that is applicable to specified contexts and individuals.

As for conducting standardized interviews, literature review revealed that interviews are helpful in collecting and documenting people's thoughts, experiences and knowledge. In addition, Oppenheim (1992) states that interviews provide answers to open ended questions, i.e. qualitative data of greater richness, related to people's thoughts, experiences and knowledge which are all needed for achieving the aim of this research.

Based on the above analysis of data collection techniques, the standardized interview turns out to be the most suitable data collection tool for this research.

3.3.5.1 Semi-Structured Interviews for Data Collection

Having decided on using interviews to conduct data collection for this research of qualitative nature, there is still a need to discuss the structure of the interview used.

Gillham (2005) presents the advantages and disadvantages of the three main interview structures used in social research. While the *unstructured interview* is good as an exploratory tool, *structured interviews* on the other hand are quicker and the analysis of collected data is rather simple, but the discussion is usually limited and information gathered often shallow.

Semi-structured interviews provide more equilibrium between structure and the open discussion. Coverage could be equally achieved among all interviews through the use of prompts leading to an easier analysis of gathered data.

Since the objectives of this research impose a structure for investigating specific themes based on information from the literature, and collection of data that is rich enough to uncover participant experiences and views in relation to the research problem, semi-structured interviews were used by the researcher to perform data collection.

Despite the fact that using interviews overcomes drawbacks caused by other data collection techniques, conducting interviews and the later analysis of the collected data has disadvantages as well. According to Oppenheim (1992), carrying out interviews is more expensive than distributing questionnaires, and the processing of the responses to open-ended questions might be costly and time consuming as well. The collected data must also be carefully observed and analysed, taking into consideration participants' different perceptions of the questions asked during the interview, which affect how they respond and what information they provide.

3.4 Research Context

In order to proceed through the stages of survey research presented earlier in Sub-section 3.2.3; to design data collection techniques and utilise them for approaching selected participants of a sample representing a larger target population, the context for data collection needs to be defined.

Since design and occupancy phases are both stages within a larger procurement strategy for delivering and running facilities, it is worth stopping at the various procurement systems and identifying ones which apply to the topic of this research.

3.4.1 Categorisation of Procurement Systems

Masterman (2002) presents several approaches to categorise procurement systems as presented below, and deduces that the fourth is the most appropriate:

- 1- Categorisation based on risk allocation – “the amount of risk taken by each of the participating parties”.
- 2- Categorisation based on information needed at the time when contracts are awarded, a matter which relates to the extent of design/construction overlap.
- 3- Categorisation based on contractor reimbursement — considered invalid for the reason that it fails to identify individual systems.
- 4- Categorisation based on managing the approaches of interaction between a project’s design, construction, funding and operation.

In view of the above, and based on the fourth categorisation method, Masterman (2002) presents the different procurement systems in the following manner:

- a. Separated procurement systems—Separate organisations are responsible for design and construction. Project funding and operation are the responsibility of the client. The conventional system is included in this category.
- b. Integrated procurement systems—One organisation, the contractor in most of the cases, is responsible for both the design and construction. The client deals solely with this contractor.

Systems classified under this category include:

- *Design and build*
 - *Novated design and build*
 - *Develop and construct*
 - *Package deal method*
 - *Turnkey approach*: This approach mainly involves a contractor responsible for building development from design through handing over to the client. It is also possible that the contractor takes responsibility of project funding and consequent facility operation. Types of the turnkey procurement approach that materialize such a possibility include: BOO (build, own and operate), BOT (build, operate and transfer or build, own and transfer), BOOT (build, own, operate and transfer), DBFO (design, build, finance and operate), BRT/BLT (build, rent/lease and transfer) and BTO (build, transfer and operate).
- c. Management-orientated procurement systems—Project is managed by an organisation working with the designer and any other consultant to generate the design and manage the construction operations performed by the contractor executing the works or the various package contractors.

Systems listed under this category include management contracting, construction management and design and manage.

- d. Discretionary systems— The client is the one to decide on the specific procurement strategy to be followed, which might include a combination of aspects extracted from the three aforementioned categories.

Partnering and the British Property Federation systems mainly constitute this category. This procurement system is either based on one or more of

the previously mentioned procurement systems, or designed in a way to suit a specific project.

Observing all the aforementioned procurement strategies, the link between facility development and operation phase can be detected. It is noticed that through implementing certain types of procurement strategies under the turnkey approach, the design and operation are performed by a single entity. For the fact that the design and facilities management services are provided by the same party, the problem of FM input into design created by project delivery processes that separate design from operation, does not practically exist.

3.4.2 Context for Data Collection

The context for this study's data collection process shall therefore include any procurement strategy of the segregated nature (separated/conventional and management-oriented procurement systems) or design and build strategies where operation is not part of the services provided by the design-build contractor.

Whenever a project is not designed, built and operated by one entity or organisational body, firms involved in design and operation are presumably separated and would most probably be two distinct companies. This reality has led to the establishment of firms only involved in design of facilities with no experience or involvement during occupancy phase, and other firms only involved in performing facilities management when the facility starts operating. The separated nature of service provided by those two types of firms creates a challenge in communication and integration between FM and design.

3.5 Research Sample

In order to carry out the data collection exercise and gather participant experiences and opinions, it is essential to first decide on the population pertaining

to the previously mentioned context that this research targets. Population, as defined by Oppenheim (1992), refers to all those who the study is concerned about. As it is impossible to approach all members of a population, the research sample which practically represents a smaller group of this larger population, is developed.

For this sample to truly represent the population, its characteristics should match those of the target population. Based on those shared characteristics, participants forming the research sample are selected and approached for data collection.

While the phase of applying sampling frames and forming the research sample come later in the process, as shown previously in the stages of survey research (Sub-section 3.3.3.1), discussing population and the sampling process at this stage is important prior to designing data collection techniques and carrying out pilot work.

3.5.1 Target Population

Research objectives require designers and facilities management professionals to be interviewed for the sake of gathering previous experiences to describe the current consideration of facilities management in design. Keeping in mind the issue of context and the fact that design and FM firms should be separated entities in case an investigation is to take place, the target population can therefore be deduced to comprise the following:

- a- All design firms offering services for the design or design and construction of facilities, but not any facilities management services:-

Designers approached during data collection are personnel working for the type of design firms described above.

- b- All facilities management firms offering facilities management services during occupancy phase, but do not offer any design services:-

Facilities managers approached during data collection are personnel working for the type of FM firms described above.

3.5.2 Construction Industry in the Middle East

In his study on the emergence of new urbanism in Saudi Arabian culture, Eben Saleh (2002) mentioned that the traditional designs of Arabia and the arrangement of the urban fabric in the Islamic community had four different aspects: social structure, defense requirements, climatic adaptation and the economic necessity. The built environment back then was not established based on geometrical relationships and arithmetic measures seen by architects today. However, and with the discovery of oil in 1938, urban development phases had started to rise and since the 1950s, drastic changes to the physical arrangement were influenced by the urbanization happening in the United States of America and Europe.

As it is the case in all other oil-rich countries in the Middle East, the construction industry has witnessed a major growth over the past years and the development of construction projects has expanded significantly. Molavi (2006) asserts that due to the rise in oil prices, the Institute of International Finance reported a growth of seventy five percent (75%) in the gross domestic product of Saudi Arabia, Oman, Qatar, Kuwait, the United Arab Emirates and Bahrain from 2003-2006. Earnings of the aforementioned countries, mostly coming from oil and gas exports, were expected to reach half a trillion US Dollars in the year 2006.

Stensgaard (2006) discusses the flourishing growth of the construction industry in the Middle East, which in turn is setting a pressing demand for facilities management in the region. According to Al Bawaba (2007), although facilities management is still relatively in its infancy in the Middle East, the rapid

development is suggested to lead facilities management in surpassing the construction industry growth in the region.

Frost & Sullivan report on the Middle East Facilities Management Market shows that the FM industry will continue to grow at a rate of 20% every year for the next five years (Kumar, 2010). This reflects the increase in demand for facilities management as more projects are being delivered and require FM services as a result.

While facilities management practices in Europe are well established resulting in a trend to invest at the beginning of project delivery process to achieve cost savings in the long run, Stensgaard (2006) considers that the situation in the Middle East has been a different one. Managing services in the Middle East has been carried out without enough concentration on efficient integrated facilities management which affects long term costs and FM service standards.

Along with the increase in facilities management demand, and according to Al Bawaba (2007), there is a demand for higher standards of FM services, security, energy usage and environmental impact initiated by a new type of real estate owners. The reasons behind the emergence of such a new owner profile are mainly foreign ownership and the increase in owner-occupiers of facilities. The major difference between occupiers who own a facility compared to occupiers who rent facilities is that owners expect higher standards and better service and are not willing to tolerate a lower-than-expected service. Owners are starting to increasingly realise the need for performing full facilities maintenance.

Due to this rapid growth in construction activity across the Middle East, and the resulting demand for facilities management services, a greater understanding of FM and ways to save money are needed (Stensgaard, 2006). Moreover, the Middle East Facilities Management Association (MEFMA) “will develop benchmarking

reports and work with the government to set minimum design requirements that help ensure facilities management is introduced at the design stage of any new development” as stated by MEFMA’s board member Ali Al Suwaidi in the year 2011 (Eagle, 2011).

Serving the Middle East region, MEFMA provides a “standardized framework” for FM people and other construction professionals, as mentioned on its website (MEFMA, 2012). That being said, it is shown that although there is an interest in introducing facilities management in design within the Middle East, the process is still undeveloped.

In what has preceded, it was shown that both the construction and FM industries are on the rise generally in the Middle East. Along with this increased activity comes a lack in the availability of initiatives that target the issue of FM involvement during project development in general, and the design phase in particular.

3.5.3 Sample Frame

Examining sample frame, sample formation techniques and sample characteristics shared with the target population aids in the preparation of questions for data collection and the selection of participants for pilot work.

In order to extract a sample for survey research, which represents a population, the sampling frame needs to be considered first in order to set the border line around such a population. As discussed previously, design and facilities management firms involved in this research do not represent the entire industry of design and facilities management services. The number of design and FM firms is not readily available through a previously prepared list, but the members of the population are known to belong to specific types of companies

Research on facilities management in general, is still limited in the Middle East. An undersized amount of research has been performed to address the industry and relevant market growth. As a result, the data existing on the FM sector is doubted to be reliable and sufficient to arrive to conclusions concerning the FM industry (Facilities Management in the Middle East, 2011).

In addition, Reina and Tulacz (2010) in their listing of the Top 200 International Design Firms show that 116 out of 200 (nearly 60%) top international designers operate in the Middle East region. This is clearly related to the increase in construction activities in the region which attracts designers operating outside their home land.

The enormous increase in commercial and residential construction projects is also leading to a bigger demand for FM services in the Middle East (Facilities Management in the Middle East, 2011). Thus the increase in construction activity generates an involvement of both local and international firms all operating within the same region to provide design as well as FM services. Having those firms involved in facility development and operation, results in a naturally occurring segregated process of project delivery to clients within the Middle East.

The limited research on facilities management, faced with the increase in demand and coupled with the existence of segregated project delivery processes, has led to the establishment of a sample frame for this study which covers design and facilities management firms operating within the Middle East. This sample frame is particularly chosen in an endeavour to narrow down the research population into a homogeneous set and collect data that is related and comparable.

3.5.4 Ensuring Population Homogeneity

According to Mellahi, Demirbag and Riddle (2011), there are no precise borders for the socio-political and cultural area known as Middle East, a term first used by U.S. admiral Alfred Mahan in 1901.

While Encyclopaedia Britannica (2012) defines the Middle East as “lands around the southern and eastern shores of the Mediterranean Sea, extending from Morocco to the Arabian Peninsula and Iran and sometimes beyond”, it also states that the term Middle East is still “unsettled”.

While the Middle East Region also covers part of the Arab world, Barakat (1993) argues that the Arab society shares cultural and social connections rather than having separate identities, when not viewed as a collection of independent states using national boundaries and political formations. Covering around 5.25 million square miles from the Gulf to the Atlantic and comprising 21 countries, the Arab world links Asia to Africa and has also historically acted as an access to Europe.

In a previous research carried out on the Arab world, Patai (1971) also regarded the Arab culture to be coherent and having balance and inner consistency. Socially rather than politically speaking, the reality is quite different from what the western orientalist view the Arab society, as a collection of sects, ethnic groups, tribes, local communities and regional units. The situation is rather a potential for both unity and disagreement (Barakat, 1993). In addition, Patai (1976) considered that Arabs are quite homogenous and that the Middle East in general is an area of one essentially indistinguishable culture, despite the fact that it is formed of a variety of people having diverse physical characteristics.

Besides the society and culture coherence connecting the Arab countries, there exists an economical integration as well throughout the Middle East, and North Africa region comprising Arab countries as well. According to Bley (2007), most of

the Middle East and North Africa (MENA) governments have chosen to strengthen their economic connections to face the increasing demands of the ongoing globalisation. This strategy has come into practice in January 2005, when the Arab free trade zone including the GCC and the rest of the Arab countries was established.

The plans set to increase economic transactions among the countries within the Middle East, and the establishment of the Arab trade zone show an ongoing economic integration among those countries. In addition, Bley (2007) confirms that the economic improvements and efforts made towards liberalisation in the region have also forced a higher level of integration of the MENA stock markets starting in the year 2000, and accelerating considerably between 2002 and 2004. This increase in economic integration is also reflected through the enhanced co-movement between the MENA stock markets that were previously segmented.

MEFMA is currently one of the best established platforms serving facilities management in the Middle East, if not the only one. For the sake of this research, the countries where MEFMA has established offices or spread knowledge shall be regarded as the countries having a significant facilities management existence within the Middle East. Those countries include but are not limited to (MEFMA, 2012): Bahrain, Jordan, KSA, Kuwait, Lebanon, Oman, Qatar and United Arab Emirates.

Observing the Top 200 International Design Firms list prepared by Reina and Tulacz (2010), it is noticed that nearly 45% of the international firms operating in the countries chosen above, operate in more than half of these countries simultaneously. This means that a significant number of firms have ongoing business spread over a large area, resulting in higher exposure and greater experience inside the markets of these chosen countries.

The larger degree of involvement in the market and the various resulting experiences increases the chances of collecting data that is generalisable. The greater amount of shared experiences and common practices collected for this research leads to a data set which is more likely to be representative of the countries under study.

Based on Barakat's (1993, p. xii) view of the Arab world as a "single, overarching society rather than a collection of several independent nation-states that increasingly, and particularly in times of crisis, assert their differences and separate identities" and Bley's (2007) observation that the overall MENA market integration is expected to increase drastically in the coming few years aided by the launching of the Arab free trade zone which is seen to economically pull the MENA region together and can be regarded as a first step towards economic unity, the following conclusion is reached:

The sample frame for this research shall be formed of all organisations belonging to the target population defined in Sub-section 3.5.1 and operating in the countries of Bahrain, Jordan, KSA, Kuwait, Lebanon, Oman, Qatar and United Arab Emirates.

These countries belong to both the Arab world and the Middle East, and therefore provide a homogeneous context through sharing social and cultural similarities in addition to experiencing a continuous increase in market integration.

3.5.5 Sampling Techniques

This research aims at developing results which are generalisable; applied to all members of the target population. Therefore, the sample for this research should be a representative one in order to accomplish such generalisation. Oppenheim (1992) discusses several methods of drawing a sample out of a larger population.

a. Probability Sampling

Using this method, the sample members are chosen randomly using random numbers/tables from a defined list, register, etc. of all members of the population. This results in what is called the simple random sample.

If the population happens to be larger than a few thousands, generating a simple random sample and carrying out data collection becomes much more expensive. An alternative to simple sampling could therefore be used, cluster sampling that is. Cluster sampling applies random selection on a population's subdivisions created based on various characteristics. This provides the benefit of having sample members grouped geographically, making it easier to collect data.

b. Quota Sampling

Using this method, research participants are not selected based on lists but based on certain quota instead. The "quota" used in this method represents a common socio-demographic characteristic between both the sample and the actual population. The sample would then contain the same proportions of characteristics as found in the target population.

c. Snowballing and Judgment Sampling

These two methods are used when none of the population characteristics is actually known. The border line around the target population cannot be drawn and consequently, it becomes impossible to come up with a sampling frame. In this case, the population is either inaccurately or partially represented by samples produced using those two methods.

Probability and quota sampling methods deal with the distribution and proportions of samples in relation to the target population. This kind of sampling is performed in order to ensure accurate ratios and people counts related to statistical surveys.

As Jansen (2010) argues, with respect to qualitative surveys, a large random sample is not very efficient in representing diversity.

Jansen (2010) argues that it is more efficient and reasonable to select what is called a “diversity sample”. Selection of the sample members is done in a purposive manner, and is performed until saturation is reached. To reach saturation, new gathered data is observed and the data collection stops when, after a defined number of interviews conducted, no new significant information is obtained.

As a result, FM and design market leaders were purposively selected when forming the research sample. The reason behind such an approach is to gather information from firms which have the most influence on defining market procedures and setting the standards of common practice. Choosing from a list of top firms would be more effective than randomly selecting participants from a consolidated list of firms operating in all countries within the Middle East. Gathered experiences about current practices involving FM engagement in design would be more reliable, valid and representative when collected from firms with higher revenue, greater exposure and wider experience.

Participants interviewed were professionals holding managerial positions related to core business operations within firms that satisfy the population criteria. Senior staff having significant amount of experience within the fields of either FM or design, and who have worked in more than one country within the Middle East region were the ones targeted. Being at a senior management level, company personnel would have the best overview of the entire company operations within participating countries.

Two main lists of companies were used for the purpose of research participant selection. The list of founding and corporate members of MEFMA was used for

selecting facilities managers meant to participate in this study. While Reina and Tulacz (2010) listing of the Top 200 International Design Firms was used to select designers. Design firms operating in the Middle East were identified and extracted from the overall listing, to form the designers' list used in this research.

Key personnel (General Managers, Managing Directors, Senior Project Managers, Senior Technical Advisors, Design Managers, Operations Managers, etc...) working for the firms mentioned in the above two lists were targeted and were mostly contacted via e-mail. Participants were provided with the subject area only, not to disclose any information prior to carrying out the actual interview. Other forms of communication involved telephone calls whenever e-mail addresses were not available.

CHAPTER 4 | DATA COLLECTION AND ANALYSIS

An agenda forming the basis of discussion topics with research participants is developed. The topics listed under the agenda are derived from the literature review, and in line with the research objectives.

Questions are written and organised, with the help of prompts, to produce a semi-structured interview. The agenda and the interview questions are tested through pilot work and modified to achieve a standardized interview form used for data collection.

4.1 Agenda

After performing the literature review and stating the aims and objectives of this research, an agenda comprising topics to be addressed through exploratory work is developed to further conceptualize the study.

The topics listed under the agenda are informed by the literature review exercise. These topics are in line with the research objectives and form the basis of investigation during data collection.

Based on the literature review, the following general topics are identified which need to be addressed when approaching participants during pilot work, and later used to produce the agenda in final form.

4.1.1 Topics Discussed with Designers

The literature review presents the various design stages within the design process and emphasizes on the design's front end, being a critical period where changes can be applied with minimum abortive work and variation order production later during construction stage. It is valuable, as a result, to discuss the early stages of design with designers, investigate their role in defining client/user requirements and question their openness to FM-related input.

Discussion topics involving designers during pilot work are the following:

- a. What role do designers play in defining client and user requirements during the preparation of the project program and schematic design?
- b. What are measures taken for addressing client/user needs defined during project programming (pre-design) and schematic design phases prior to the commencement of actual design development?
- c. How is the occupancy phase viewed by designers? In what aspects is the design linked to operation?
- d. FM related concerns as mentioned in the literature review are the following:
 - o Client and User Satisfaction
 - o Operation and Maintenance
 - o Space Layout and Flexibility
 - o Sustainability
 - o Energy Efficiency
 - o Ergonomics

Are FM-related issues tackled by designers during design development? Who is involved? What are the sources of information used in producing solutions?

Inquiring about the above mentioned topics was meant to provide facts about designers' role in defining client and user requirements, how they currently deal with client/user requirements in general and FM concerns in particular when designing, and information sources they refer to when making decisions.

4.1.2 Topics Discussed with Facilities Managers

Whenever user needs are not addressed properly, the resulting facility would not satisfy the purpose it was designed for. After facilities management starts operation during occupancy phase, facilities managers need to carry out occupancy evaluations in order to evaluate building performance and user satisfaction. This leads to the modification of their services provided as well as the application of best practices, to enhance their services provided and address problems arising from occupancy evaluations.

Consequently, and in order to investigate the FM and design integration, FM managers need to be asked about their evaluations performed during occupancy phase to point out their concerns related to facility performance, part of which is design-related.

Discussion topics involving facilities managers during pilot work are the following:

- a. What evaluation practices are carried out by FM personnel during occupancy phase of a facility?
- b. Are there any post occupancy evaluation tools used to measure performance and user satisfaction?
- c. FM concerns as represented in the literature review include the following:
 - Client and User Satisfaction
 - Operation and Maintenance
 - Space Layout and Flexibility
 - Sustainability
 - Energy Efficiency
 - Ergonomics

What are the measures taken to address the above mentioned concerns or other concerns arising from post occupancy evaluation?

- d. Is participating in design of future construction works planned by the client an available measure? Is it included in FM scope of work?
- e. Is there any participation during design stage of newly built facilities, refurbishments, expansions etc.? What kind of participation? Who is involved? At what stage?

All the above listed questions represent general topics related to investigating the FM role in conducting facility evaluation during occupancy phase, the various FM-related concerns arising during operation, and the possible FM participation during design stage.

4.1.3 Agenda in Final Form

Based on the aforementioned topics and questions that are developed for discussion purposes with both FM and design professionals, an agenda is developed and used to produce a pilot interview. Pilot work resulted in modifications to the agenda and led to the final form presented below, which is utilised by the researcher to develop the standardised interview and carry out the entire data collection exercise.

The different topics comprising the agenda in final form are presented in what follows:

1. FM/Design Relationship

- a. General inquiry about the FM and design relationship in the Middle East
- b. Current status of FM participation during design stage

- c. Previous experiences on presence/absence of FM during design

2. Facility Evaluation during Occupancy Phase

- a. Carrying out facility evaluation during occupancy phase
- b. Future use of evaluation outcomes
- c. Evaluation tools used

3. FM Knowledge and Expertise Consideration in Design

- a. FM-related Concerns
 - i. Arising concerns during occupancy phase as seen by FM and design professionals
 - ii. Examples from practice on literature-revealed types of FM concerns
 - iii. Current consideration in design
- b. Designers' current sources of FM knowledge
- c. Barriers to FM knowledge and expertise integration in design
- d. Consequences resulting from the limited integration

4. FM Inclusion in Design

- a. Purpose
- b. Ways to promote FM Inclusion in design
 - i. Possible contractual agreements
 - ii. Involvement of a third party
 - iii. Project management role
- c. Timing of FM participation during design stage and why
- d. Mechanisms of FM Participation
 - i. FM and designer roles in practice
 - a) Levels of Interaction
 - b) Capacity
- e. Benefits
 - i. Who would benefit and why

- ii. Facility-related benefits
- iii. How is project complexity resolved

5. General Knowledge and Expertise Exchange

- a. Measures taken to promote FM/Design knowledge and expertise exchange
 - i. Knowledge push/pull from FM to design

6. Any extra information that the interviewee might want to add

4.2 Pilot Work

At the beginning of pilot work stage, further information is required to determine how and when to gather participant opinions regarding means of promoting knowledge transfer to enhance integration. The reason behind this is due to the fact that suggesting ways to address limited integration have to be raised after limited integration is detected from gathered participant experiences. Conducting pilot work is also needed to figure out whether gathering both participant experiences and suggestions should be done during a single data collection session held with participants, or more than one session is required.

Pilot work is carried out through interviewing four industry professionals, two from the facilities management sector and two from design. The chosen participants are work for four different companies.

Interview responses are then recorded and transcribed for analysis. Information is extracted from the transcripts and grouped under different headings in preparation of a coded data set for analysis. This pilot exercise and eventually the analysis of the gathered data are necessary to verify whether the chosen research method and data collection technique are starting to prove their effectiveness and suitability.

4.2.1 Observing Data Obtained from Pilot Work

Following coding of responses and classifying data collected according to the various research topics listed in the agenda, several observations are made and presented as follows:

- a. Answers to questions like “*What would you say about communication between both parties?*” did not provide clear information on knowledge transfer and FM participation during the design stage. The word “communication” was therefore omitted. The interviewees during data collection that followed pilot work were instead asked about the relationship between FM and design in general as an open-ended question allowing participants to provide thoughts based on what they have already experienced. The FM participation in design was then prompted, in case it was not mentioned through the response to the question on relationship.
- b. A slightly different set of questions was being asked to designers on one hand, and facilities managers on the other in relation to post occupancy evaluation. The responses obtained were not answers to identical questions and found to create a problem in analysis of both views concerning the purpose and the use of evaluation results. Therefore the questions were rewritten so that the same is asked to both FM and design participants. This resulted in the creation of a standardised interview used to interview all research participants of this study.
- c. Responses such as “the soonest possible” provided to the question “*When do you think it is best for FM participation to occur during design stage?*” were found to be insufficient in providing details or adding to the existing knowledge. More details were required in order to compile a meaningful outcome based on practical experience. It was deduced that

the interviewee had to be further prompted for additional details to obtain richer information.

- d. A new set of questions was added to deeply investigate the issue of FM participation during design stage. This set was introduced to examine how knowledge transfer should take place during the design stage, what mechanisms should be involved and what should the corresponding roles of both designers and facilities managers be.

Based on the abovementioned observations, the agenda is revisited and modified and the pilot interview changed accordingly to arrive at a standardised interview suitable for data collection.

4.3 The Standardized Interview

The preparation of the standardized interview questions is performed following Gillham's (2005) interview question development. Broad topics that the researcher needs to inquire about are identified first. Broad descriptions are then further detailed to arrive to specific questions. The questions formed are then reviewed and organized with the aid of input from pilot work. The standardised interview used for this research is included in Appendix A of this thesis.

Questions which are essentially the same or have the same meaning are detected and reduced to eliminate redundancy. Questions related to similar topics are grouped together in order to create a logical flow of thoughts and information during the interview conversations. After the grouping is done, the various topics are sequenced in a logical order so as to have a narrative progression and questions would lead one into the other.

Fifteen designers and fifteen facilities managers are interviewed by the researcher, as part of the data collection; each participant works for a different firm and therefore the number of firms involved in this research is thirty firms, fifteen design and fifteen FM different organisations operating throughout the Middle East region. Participants are interviewed using the standardised interview and responses recorded then transcribed to reflect the full conversations taking place. A sequence of data editing, coding and analysis then follow data collection in order to document the findings.

For data collection to end, saturation has to be detected as mentioned earlier by Jansen (2010). The selection of the diversity sample members should continue until a point is reached when after a defined number of interviews conducted, no new significant information is obtained.

Data collection for this study is performed in 3 stages. Sixteen (16) interviews (8 designers and 8 facilities managers involved) are performed in the first stage. Collected data is processed and analysed to produce the research's preliminary findings. At this stage, the information database is still being formed and a significant amount of new information is also continuously being obtained after conducting each new interview.

The second data collection stage is carried out involving ten (10) additional interviews in an effort to increase the size of the information database and simultaneously, have a significant amount of interviews carried out to reflect consensus and provide meaningful comparisons when documenting the final research findings. Towards the end of the second data collection stage, the researcher begins to detect a gradual decrease in the availability of new information and specifically, the new information obtained from the last four interviews conducted.

As a result, the researcher decides to conduct four additional interviews and observe again the level of new information obtained, to ensure that saturation is reached. The last four interviews resulted in less than 2% increase in research findings documentation (300 additional words written, compared to an 18,000-word findings section already developed). The information provided by the last four interviews mainly affected the percentages and frequencies established, due to changing the total number of participants from 26 to 30. Reaching this stage, the researcher decides to terminate data collection.

4.4 Analysis of Interview Data

Following the selection of a suitable research approach and the collection of data using the semi-structured interviews technique, the analysis of the collected data takes place in three stages, following the stages of data collection mentioned in Section 4.3.

Analysis is performed for the purpose of documenting research findings which answer the research questions set at the beginning of the research project, as required by the research design.

Ely et al., (1991) states that data analysis engages creating categories and subcategories in order to determine associations between data sets and get more acquainted with the gathered data. Yin (2003) expands more by talking about data analysis as consisting of examining, categorizing, tabulating, and testing in addition to utilizing both qualitative and quantitative data to tackle the initially set research propositions. The analysis phase produces an outcome which deeply conveys the acquired learning (Ely et al., 1991).

As presented by Bryman and Burgess (1994), data analysis involves several processes of which include the following:

a. Coding

Regarded as the first step in data conceptualization, coding (or indexing) is considered an essential practice applied for purposes of organizing the collected data such as documents, transcripts, notes, etc...

b. Conceptualization

Qualitative research revolves around generating concepts for building theories (Glaser and Strauss, 1967; quoted in Bryman and Burgess, 1994). They do not form the aimed-at theories though.

c. Grounded Theory

Grounded theory is often considered the technique through which researchers disclose the findings of the study they are undertaking.

According to Richards and Richards (Contributors to Bryman and Burgess, 1994), grounded theory is associated with the tendency of generating theories from data rather than providing ways to manage data.

In relation to data gathered from carrying out interviews, Gillham (2005) discusses a procedure for editing the transcripts and reducing the data keeping the meaning untouched. The editing involves the removal of repetitions and the reorganisation of phrases in chronological order. Sometimes an interviewee discusses issues related to previously asked questions, and those responses need to be ordered under relevant questions. A few words to complete the grammatical structure of sentences are also added using brackets '[]' to distinguish them from the actual words said by the interviewee.

The above mentioned process is applied to the 30 interview transcripts in order to identify the information that is of value for analysis. According to Gillham (2005),

this process enables further analysis levels and presents the transcripts in a tidy manner for interpreting the data and arriving at conclusions and theories.

The transcripts are then imported into NVIVO, a qualitative data analysis software produced by QSR International. In order to eliminate any subjective perception or bias that the researcher might develop about the participants during interviews, information imported to the analysis software is sequentially labelled D1 to D15 and FM1 to FM15 and not using actual participant names. This way, responses provided by each participant are given equal value and importance, through keeping the names intentionally hidden.

Coding of the response data is then performed and the information accumulated into different categories. Due to the semi-structured nature of the interview used, a preliminary structure for the various categories already existed as identified through the themes presented in the agenda. These categories are further developed and refined later on based on the analysis performed on the collected data.

Developing categorical data after each data collection stage prepare the grounds for the relevant analysis of the content and further development of the research findings.

The categories formed are organised and content analysis performed, to respond to the requirements set by the research objectives. Gillham (2005) describes the writing up of interview data as being a narrative, telling the story of what is found. The narrative is woven together with the help of quotations from interview transcripts which help illustrate the findings.

Statements extracted from the interviewees' responses are quoted in the findings with the intention of backing up the interpretation of the accumulated data. Gillham

(2005) argues that the researcher should ensure that the evidence (quotations in this case) is presented in order to substantiate what has been done. Normally, quotations extracted from interview transcripts should not be less than a third and not more than two thirds of the total narrative. In the end, the reason behind writing up the findings is to convey what people said in order to satisfy the research aims and objectives.

Quantitative analysis through calculating frequencies and percentages is also developed in order to tabulate the frequency of occurrence of obtained responses and reflect magnitude and significance. As Marsland et al. (2000) explain (Sub-section 3.3.3), collected data obtained from open-ended questions can be coded to develop categories as well as attain statistical outputs such as frequency tables.

In addition, a certain degree of “quasi-quantification” is also utilised making use of the obtained frequencies mentioned above. As Bryman and Bell (2007) explain, qualitative researchers apply 'quasi-quantification' using terms such as 'many', 'frequently', 'rarely', 'often', and 'some'. The relative frequency of the phenomena that the researcher is referring to should be determined in order to make references to quantities. This limited engagement in quantification is suitable when quantity expressions promote discussion.

CHAPTER 5 | **RESEARCH FINDINGS**

Throughout the preceding chapters, the topic of FM and design integration was presented highlighting the limited measures taken to implement this integration on construction projects, as conveyed by the literature. Literature reveals the existence of a small amount of research addressing integration, none of which is carried out to investigate the process of design and FM integration in the Middle East.

Previous chapters disclose a significant implementation of segregated project delivery strategies within the Middle East region which result in a separation between the design and operation phases of facilities. In addition, a certain degree of social, cultural and economical homogeneity is found among the various countries within the aforementioned region. The large use of segregated strategies, coupled with the availability of a homogeneous environment provides a suitable context for carrying out this research.

Consequently, the aim of this research is established to investigate FM and design integration within the Middle East region, and obtain professional recommendations on how to improve the process of integration.

The research findings are presented in five main headings:

- 1- **FM and Design Relationship:** Reveals the current collaboration between facilities managers and designers and highlights the FM participation in design

- 2- **Facility Evaluation during Occupancy Phase:** Handles the initiatives taken by both FM and design professionals towards evaluating project outcomes to enhance future designs

- 3- **FM Knowledge and Expertise Integration in Design:** Identifies the FM-related issues arising during occupancy phase and their current consideration in design. This heading also discloses the various barriers to integration and the resulting consequences

- 4- **Promoting FM Inclusion in Design:** Analyses the various reasons behind promoting FM and design integration and provides various means to achieve integration, including FM participation during project delivery phases

- 5- **Achieving Integration outside Facility Boundaries:** Discusses different ways to promote integration through encouraging knowledge exchange and interaction between FM and design professionals outside the boundaries of a facility under construction

The findings obtained from the collection and analysis of data, are presented in what follows to answer the questions established for this research.

5.1 FM and Design Relationship

Both facilities management and design participants were asked generally about the relationship between FM and design, and the FM participation in design in particular.

5.1.1 Relationship in General

Designers

All designer responses revolved around the fact that it is uncommon to deal with facilities management and that the communication is rare. The relationship is mostly independent.

“There is hardly any communication between the facilities management and the designer in this area (Middle East).”

“In the Middle East [the relationship] I would say distant. I don’t think that there is a significant connection at the present moment between primary designers and those who will inherit an asset for maintaining an up-keep on an ongoing basis.”

The party managing the facility is in many times unknown to the designer during design stage. According to the designers, this is due to one or more reasons including the client’s lack of knowledge of what facilities management is, the FM party not being appointed yet at design stage, or the FM being regarded as a secondary stakeholder.

One of the designers stated that they as designers, and when any communication takes place during design stage, they consult the operation and maintenance personnel and not FM companies.

“Theoretically, we consult the O&M guys... not FM companies.”

It can also be noticed that designers were positive about the issue of dealing and communicating with FM personnel, when stating that this relationship is currently not as expected but it needs to be established and improved.

“I think there is still weakness and the relationship as we believe should be improved in the Middle East to reach the level of good interaction.”

“FM has to be defined in the same way as the building has got to be designed. You’re coming to a point from two different functions, primary design and FM... Coming together and they run in parallel but integrated for an optimum design solution which can fit a business case that the client can afford.”

This reflects designers' views regarding the importance of the availability of FM knowledge during design stage, even though this information is currently not being adequately integrated.

"We believe that it (FM/design relationship) should be enforced, and as designers we wish that this relationship extends to cover the whole duration of the project during construction as well as maintenance."

Designers and FM managers are more likely to coordinate during occupancy phase, when preparing for a certain event which requires the involvement of designers.

"We get to be in contact with them (FM) more... When you're planning on how the facility should run under a certain event, then you have to coordinate with the FM who would then have an integral role to how do you run the processes... But in the phase of designing for a new building they are not considered."

Facilities Managers

Facilities managers' responses regarding the relationship were similar to those of designers that the relationship is distant, but more towards being non-existent. Facilities management professionals emphasized that they enter a building only after the design and construction are complete.

"[The relationship is] non-existent, very poor. Facilities management are usually the last function to be brought into the process which is criminal really..."

"In the Middle East, it pretty doesn't exist."

Facilities managers also mentioned that the involvement in design is an aspect missing from their career, and the fact that they enter a facility at a late stage

happens because sometimes clients and designers do not look at the long term operation.

“Sometimes clients do not look at the long term thing because they’re not trained to do that. So... and the designer is not trained to do that either...”

Moreover, FM responses show that while on one hand the FM service provider hasn’t still been appointed and will not be until the facility is complete, designers on the other hand have a job for a certain period of time where they do their part as per what the client wants and then move on. This chronology of events is also affecting the relationship between designers and FM personnel and preventing them from meeting and communicating, and the result is a built facility which is lacking input from the party that will run it.

“The first thing that I observed in the Middle East in general is that the designers do their part as per what the clients want.”

“The issue here is that the designers have a job for a certain period of time and then they move on, and the FM inherits everything afterwards.”

Signs of communication are beginning to show through the sustainability input into design; sustainability being a shared concern of both designers and facilities managers. The general relationship is also starting to appear through the communities being established like MEFMA, for example, and the discussions being initiated by such communities.

5.1.2 FM Participation in Design

Designers

As for the facilities management participation in design, it is common for designers to develop the design without dealing with facilities management. 12 out of 15

designers stated that dealing with FM people during design stage is uncommon, rare or not there. The other 3 designers stated that communicating with FM during design stage would often happen if the client is the end user of the facility, already having FM as part of the client operations.

There is a disconnect resulting in designers not being informed about FM requirements due to the non-involvement of FM at an early design stage. Meetings do take place though between designers and users of facilities, but the facilities management procedures in particular would not be in place during design stage.

“The end users do, I think. The departmental heads actually advise more on that rather than the FM managers. I haven’t had that much interface with those people. More with the director level of the departments... they make the decisions.”

Some facilities management issues are part of the design brief already; life cycle costing, operation and maintenance issues, flexibility of IT systems to accommodate new technologies. These issues form part of the design service provided and are shared with facilities management.

The collaboration between FM and design during design stage is most likely to take place if FM personnel are already part of the client organisation and not acting as third party consultants for example. One of the designers stated that facilities management provides input mostly related to material and MEP systems.

“Well, they’re usually there. I’ve never had a facilities person as a consultant coming in, it has always been part of the client organisation and we talk to them. I haven’t here [talked to them]...”

Moreover, input from the operation of facilities into design has higher chances to occur if the project is a hotel. Due to the fact that hotels follow specific

international standards, input from the hotel operator becomes a design requirement.

“There is only one thing related to doing it from the beginning, and that is building hotels. You must know the needs of the operators before you design your building, because each hotel brand has its own standards.”

Designers also spoke about efforts made to try to consider facilities management in design, mainly through talking to clients, trying to get information from them or convince them to engage facilities management early on in the design.

“Do we engage the FM? We try to talk to the client and tell him about the importance of FM. We try to impart that. That’s not necessarily taken up by the client.”

“It takes a lot of persuasion to get an owner to bring an FM on board while the building is still in the design.”

Responses also reveal that the FM/Design collaboration during design stage is affected by aspects such as a specific client-designer relationship and whether clients are “first-timers” in the construction business. When a business relationship is established between a certain designer and client, the flow of knowledge about operation issues is enhanced.

“We have been in the business for 35 years now, and many of our clients since then have remained our clients. So through the life of the building we have feedback from the clients, the challenges they faced... That remains as a knowledge base for us to continue the improvement in design.”

In addition, when the client is new to the business, the chances are low for any FM involvement in design to take place.

“With a lot of first time clients, there is always a disconnect.”

Facilities Managers

Facilities management views concerning the participation in design were not very different from how they see the overall relationship. An additional expression provided was that FM and design are two separate entities and that facilities management is not considered in design, but rather neglected.

“They are two separate entities.”

“During the construction and during the design, facilities management is being neglected.”

All FM participants stated that they were unaware of any FM participation in design, the practice was uncommon, or the participation was not present during design stage.

One FM participant discussed the issue of the design, build and operate type of projects where clients in North America and Europe mandate the involvement of the FM body as part of the design process, due to the nature of project procurement involving operation.

“In general in the Middle East it is (FM participation) not present almost. However if you look at North America and Europe, there’s the design build and operate projects and so on, it is mandatory to have the FM as part of the design.”

5.1.3 Middle Eastern Countries Involved

Participants were asked whether the situation they were describing was the same throughout the Middle East. The responses mainly stated that the situation in the Middle East is worse than other places, but clients in the Middle East are starting to realise the importance of FM. Efforts are being made to bring the FM into the design stage although the situation is not at a very mature stage yet.

Gulf countries are similar in relation to having FM services provided, as they are financially stronger than other countries within the Middle East region.

“Gulf areas are almost the same. But they are better than the other countries in the Middle East. They are financially strong and some have facilities management.”

United Arab Emirates (Dubai in particular) seem to have the most mature FM market and some client awareness on the importance of FM. It is most probably followed by Saudi Arabia then Qatar.

5.1.4 Incidents on FM Participation during Design Stage

Designers

Out of the 15 designers who were interviewed, 5 reported having interacted with facilities management and 2 with operation and maintenance personnel, on one or more occasions. In total, 47% of designers experienced at least one FM involvement during design stage.

The issue of experienced developers appears again in the responses of designers, where developers who previously built projects and looking for new developments are more likely to be the ones to involve FM during design stage. In addition, owners of these new developments would also have their FM team

already established and working on existing buildings owned by the same client. This would facilitate the participation of FM personnel in newly designed facilities.

“My only experience here was with the facilities managers for a new building, and these FM would be people from the existing building owned by the same client.”

Renovation projects were among the reported cases as well, having FM already in place and involved in the operations of existing buildings. While on the other hand, first time clients would not understand the need to involve FM.

Clients associated with the reported incidents on FM participation in design were either governmental (academic institutions, electricity and water, substations, etc...), hotel owners or owners of large-sized mixed use developments. Such client types also suggest the aspect of previous experience in project development and its effect on FM participation during design stage.

FM either had a role in reviewing the drawings or providing input on various systems within the building.

“FM there on the project we were involved in was actually leading the whole design discussion. He was involved through all design phases and all through to the tender documentation stage. I sat with him and did a page-turn review.”

FM made input on sustainability, energy efficiency, spare parts, retail store distribution and requirements, material selection, maintenance team access to different areas, accessibility for changing equipment filters, Building Management Systems (BMS), and other systems. Input was also made on facilities required such as laundries, cafeterias and staff facilities.

Facilities managers

Out of the 15 facilities managers who were interviewed, 7 reported having participated during design stage, nearing 47% of all FM participants.

Two of the participants were recruited on an individual basis, by a property developer on previous projects, specifically to work with designers from concept through to detailed design.

“I worked for a property developer, and I was specifically recruited to exactly work with designers right from concept through to detailed design, and look at how best we can operate the development”.

One of those two facilities managers mentioned that the reason for getting involved in design was the advantage for the developer who was going to own and maintain and run the development after it is finished.

“...they saw value in getting in the FM on board, because it reduces the operational cost. And anything you can do to reduce the cost of the operation is important”.

The various roles of FM during participation in design were to influence and critique the design, advise on access to equipment for checks and maintenance, talk to users to see what works and what doesn't, review specifications to suggest improvements on the technical aspects, develop the operational procedures and policies to suit the design and get involved in the design and management of the space.

“I'll give you an example, the designer had a very unique view of a classroom... we had our own view of what a classroom would be, so when the design came and you talk to the professors and you see that this doesn't work...how can you twist it

to make the design more flowing and more adaptive and I believe we've got an excellent building because of that".

This participation took place mainly through organising design workshops during the briefing of the design team and later where there were evolving strategies and design principles, in addition to reviewing every drawing that the designers produced. Weekly or monthly design meetings also took place between FM and design teams to go through design drawings and later the drawings that were issued for construction.

A difficulty facing facilities managers, when participating during design stage, was the issue of tight project schedule which in many times prevented the FM input from being taken into consideration.

"They were impressed about the cost savings but they always said we have no time to change because we have a tight schedule. The project schedule is not initially designed to allow for a review by the FM consultant. That was often the problem. They couldn't take care about good ideas because they had no time for it."

5.1.5 Incidents on Absence of FM during Design Stage

Designers

Several designers reported cases of an absence of FM participation during design stage on specific projects they previously worked on. In their opinion, FM should have been present to avoid undesirable outcomes.

Incident 1

"A tower we were working on. The client didn't involve a FM team to understand how things work in reality. They went from a horizontal format to a tower format, and what happened is that people were travelling back and forth

between the floors and they wanted to use the stairs so that not to use the lift to go up and down only one floor. And they were using the fire escapes, and they wanted the fire escapes to remain open all the time and of course this wasn't acceptable. So this is a direct example of a project which if they had involved an FM team early on to know how work will happen they wouldn't have faced such a problem."

Incident 2

"I was working for a developer, they were undergoing a renovation of one of their primary office facilities, the FM proposed that you need this much money to upgrade your cooling towers, which need to be upgraded... the decision was made to keep nursing the existing cooling towers than to do the upgrade. The cooling towers never failed but the owner did spend a lot of time and money to keep them in operation."

Incident 3

"...an FM consultant actually acting on behalf of the client on one of the projects. All technical documents were sent to him to look at the maintenance impacts and BMS, HVAC and MEP related issues. He quite produced a lengthy report but in a lot of times they would tell him thank you... and he actually took serious "NO's"; because they think FM... What's that? The client overrode him. And then later on many things were being done later on found in this FM guy's report, but were not taken into account during design."

Facilities managers

The same for facilities managers, there were several incidents reported where facilities managers involved during occupancy phase had experienced problems which in their opinion could have been avoided had an FM participation taken place during the design stage.

Incident 1

“When I first came here, what I found was that I’m used to have separate units of chillers, condensers and cooling towers. All separated units. Here they have built an integrated system having all chillers, pumps, condensers etc... So I asked them, why did you build it like this? They came back to me to say the design has to ensure maximum viability. I said yes OK, but this has caused the system to be of minimum reliability; because one single event in any part of the installation could take out the whole system capacity. During installation, we discovered that the system was far from optimal hydraulically, mechanically and even electrically. After 3 months of running the tower, we found that the relationship between the cooling tower and the pumps was not a sufficient one, for the pumps to run. When the pumps are running they are sucking air in because not enough pressure is coming in. So we had to overcome this problem by running 2 cooling towers for one chiller, which meant in the worst case scenario, we can only run 2 chillers out of 4 installed.”

Incident 2

“I worked in a building where they put down a matt finish marble floor without sealing the floor and every time anybody walked on it, it had footprints all over. So you can have a full time cleaner there but you can never get it cleaned, whereas a facilities manager would have looked at a sample, tested it, spent some time working with it and looked at how could it be cleaned and would have maybe made a different choice or looked at how that might be sealed once installed.”

Incident 3

“They have lighting at the top of the atrium, 7 stories high from the floor. How will we reach up there to replace a bulb? It’s not impossible. We could reach there through rope access. The problem is that at construction if some latch points were actually incorporated at construction, if those subtle small

additions were made then have 7 stories, have 10 stories no problem. But just give us somewhere to tie off and do the work.”

In what has preceded, various incidents on the absence of FM participation during design stage were presented. The narrative provided by participants is provided as is, to preserve the meaning and provide the readers with the real life description that the participants wished to convey.

These incidents show a negative impact on the facility due to the absence of FM during design stage. Several operational issues such as the coordination between floors, chillers operation and maintenance, access to lighting at high levels and cleaning are faced by the FM during occupancy due to the absence of certain FM provisions and requirements from the facility design.

Participants also discussed the absence of clients' role in providing empowerment to their FM teams. In a couple of these incidents, participants presented examples where the FM was present during the design of new or renovated buildings, but the FM input was rather overlooked by the client.

Although incidents on the presence and absence of FM participation were presented in this Sub-section, fuller and more comprehensive lists of purposes and consequences shall be discussed later in this chapter.

5.2 Facility Evaluation during Occupancy Phase

Participants were asked about facility evaluation after the building is occupied, the tools used for evaluation, and the future utilization of the results obtained from evaluation exercises.

5.2.1 Carrying out Evaluation Exercises

Designers

8 out of 15 design participants confirmed that they had a certain involvement after the building was handed over to the client. The involvement mainly represented walkthroughs with the client and operator to check for snags and defects after construction finishes or return back during the defects notification/liability period following the completion of construction to help in rectifying any defects. Post Occupancy and Post Design Evaluations were also carried out, whereby certain projects every year are selected by a design firm and evaluated in order to identify the lessons learned.

One designer only clearly stated his personal involvement during operation phase, through spending time with the client and the facility operator.

“As a project manager, I make sure to spend some time with the client and the facilities operator during operation. In one of the hospitals I actually sat in a wheel chair, to see what it’s like in a wheel chair and see how the transportation network works. That’s about all.”

Clients sometimes call back designers if specific equipment is not giving the desired output, or in case no FM is present to address a specific problem.

“As a designer, if there are issues with the maintenance or the design, we get called back!”

Designers also reported sending out questionnaires to clients asking about their satisfaction. Although questionnaires are sent out after the project construction is complete, these questionnaires may be sent before the building is effectively occupied or a year after the building has been occupied, depending on the designer sending it.

Certainly, sending questionnaires before the building is occupied would gather feedback about the client satisfaction with the end product, but not the experiences of users and FM body actually occupying the building.

“In a lot of times the project has not gone live or hasn’t been occupied yet... so that experience would not have been had.”

In addition, designers sometimes perform post occupancy evaluation and return back to the client after construction is complete for strategic business reasons, this was emphasized by 3 designers.

“We (designers) don’t do enough of it. I mean everybody goes to the opening but no one actually goes and uses the facility and see how things go. Six months later nobody goes and knocks the door, apart from management people because it’s part of their business strategy.”

Designers revealed several reasons for their non-involvement during occupancy phase, including the following:

- a. Designers were not requested by the client to evaluate the design
- b. The operation phase is seen as an “owner’s responsibility”
- c. No design fees are paid beyond Defects Notification Period
- d. In some cases, designers’ role stops before construction starts
- e. Relationship may fall apart between clients and designers towards the end of the project preventing any further involvement from the designers side

Facilities Managers

As for facilities management, the main task identified when asked about performance evaluation of facilities was the regular preventive and corrective

maintenance carried out, usually on a monthly basis and according to the O&M manuals. Various systems and equipment are checked, heating, ventilation and air conditioning (HVAC) is monitored, equipment is cleaned and filters changed and voltages for motors are checked. BMS and fire alarm systems are utilized to identify any faults occurring, so that technical assistance is called.

In addition, snag lists are also produced by FM before entering the facility to start providing services. This is mainly done to report the building condition to the client prior to the commencement of FM services.

All FM responses showed that evaluating building performance from a design perspective was an uncommon task to carry out. Facilities managers responded to the question on performance evaluation with answers related to the performance of their service being provided, whether it is the level and quality of service, or the regular systems and equipment checking and maintenance. There were no clear answers related to building performance handling design issues.

“Basically with every contract that you let, there should be a set of key performance indicators (KPIs). And those indicators are the measures of success. You can have 40 or 50 KPIs per service provided. Not the performance of the building...”

As confirmed by 4 out of the 15 FM interviewees, evaluation during post occupancy is not an FM requirement within the service provided.

“We have no separate KPIs on plant performance.”

The only indicators on building performance mentioned were related to HVAC system monitoring and the data generated from energy management systems used. Both those monitoring tasks though are considered part of the service

provided by FM and are not specifically meant to evaluate the performance of a facility.

As it is seen from an FM point of view, clients are not formally involved in post occupancy evaluation, but facilities managers assert that facility evaluation is a task that needs to be performed more.

“This sort of work is something that we need to do more of... to monitor and record the performance of various types of equipment. Technological advances give us an opportunity to photograph and record.”

5.2.2 Evaluation Tools Used

Research participants were asked about ways to gather information on facility performance, if they had inquired about design-related aspects during occupancy phase.

Designers

Designers' means or tools used to touch on occupancy phase include the following:

- a- Client Satisfaction Surveys
- b- Client Questionnaires for feedback on quality, efficiency, utility costs and user satisfaction
- c- On-site design evaluation exercise (2 or 3 days duration)
- d- Post Occupancy Evaluation as part of lessons learned
- e- KPIs on comfort conditions, temperature and other performance issues

One of the designers stated that the technical knowledge and experience are mainly the designer tools used after project construction is completed.

“We are adding value to the FM in providing technical solutions for the defects that they detect, that may arise and are detected.”

Several designers also stated that in some cases the feedback on operation comes from the client instead of them carrying out design evaluation.

“I don’t have any documented records of evaluation. No system of evaluation to my knowledge... but there’s the informal feedback from clients who provide valuable data for improving the design.”

Facilities Managers

Facilities management approaches, followed when providing facility services, which could provide data on design performance, include:

- 1- Monitoring tools and asset databases:
 - a- **Asset Registers/Asset Management Systems** such as PAS 55 and INFOR. Asset management tools contain databases on equipment and the related maintenance history. Equipment service history detailing the number of times the equipment has been serviced, what parts were replaced, etc... would serve as an indicator of asset performance and the related costs incurred.
 - b- **BMS and Energy Management System** data generated. The gathered data would provide information on energy consumption and various equipment efficiencies.

- 2- Building and service evaluation methods:
 - a- **Audits** to evaluate the FM services provided
 - b- **Building Condition Reports:** These reports are prepared by FM before moving into a building. They could also reveal information about design performance
 - c- **Key Performance Indicators (KPI)** on quality of services provided. These indicators could reveal design factors affecting services provided
 - d- **Service Level Assessments:** Benchmarking services provided to measure success. These assessments could reveal design aspects affecting services provided
 - e- **Occupancy Analyses** to analyse and report on the bad and good practice during occupancy phase, in relation to the FM service provided
- 3- Soft Landings Approach followed during handing over of facilities. This approach was recognised by 1 participant only, who considered Soft Landings a means to get designers involved during occupancy phase and promote communication between FM and design professionals

5.2.3 Future Utilisation of Evaluation Results

Participants were also asked about the future use of information gathered from evaluations made during occupancy or the feedback received from clients.

Designers

Lessons learned from past projects, are collected and used to impact the designs of future projects. A practice reported by all designers.

“The feedback we get on problems, we check if these can be incorporated in future designs. I can’t say that they will be utilised in future designs globally, because it depends on what the problem is, what happened, can this be changed in future designs... these questions should be asked.”

Experiences from various projects are gathered, along with any problems faced and the solutions implemented, and sent back to the design firms’ databases to be stored as lessons learned. This allows designers to know what they could have done better, and what worked well that they want to keep doing.

A barrier to the generation and storage of lessons learned i.e. the tacit knowledge that exists in the form of know-how and personal experience, was presented by one of the designers, in relation to the Gulf area.

“The problem in the Gulf is maintaining your staff... the know-how in design companies is not easily maintained. You can maintain drawings or standards... but the know-how itself and lessons learned is very unlikely to be saved. And I have seen it... big names with international experience have mistakes repeated in other designs because they do not maintain their staff.”

As stated above, design firms face the problem of not being able to maintain their staff and therefore lose the know-how related to problems and mistakes encountered in the constructed facility.

Facilities Managers

Facilities managers use the gathered data from regular checkups and system monitoring mainly to:

- a- Develop a Master Maintenance Plan based on building and equipment assessments

- b- Identify the power and water consumption of various systems and areas. Monthly and yearly consumption averages are calculated for comparison with previous periods.
- c- Benchmark one building against the other and improve the performance throughout the lifecycle.
- d- Respond to client inquiries on building performance.
- e- Determine the liability and cost of operating and maintaining various types of equipment, when preparing tenders for future FM service contracts.

Recording information on performance depends on the FM contract with the client and what the client requirements are concerning performance measurement of equipment.

No FM responses were directly related to the use of data gathered from evaluation in any future designs. An FM manager “suggested” the use of recorded information to point out to clients the problems related to design.

“And this can be used to show the client the problems arising whether because of design issues or anything else. We will be able to convince the client that there are problems in equipment operation because the designer did not take into consideration any FM recommendation.”

The idea of compiling evaluation results for use in future designs was generally welcomed by facilities managers.

“It is a good concept to get these information to the designers so that they know the consequences of the systems they are about to use in a particular building.”

5.2.4 The Soft Landings Approach

Out of the 30 interviewed participants, only 1 FM professional suggested Soft Landings as an approach when asked about the tools used for evaluation of facility performance. The rest of the participants did not recognise the term or what it means.

“I know about the approach but it is very rarely implemented especially over here, I’ve never heard of it being implemented at all in the Middle East. But the whole point of it is that it identifies the performance of the building against the design criteria, and actually you retain funds from both the contractor and the designer until the end of maybe 2 or 3 years when they can demonstrate that the building is achieving the design criteria. 9 times out of 10 the building doesn’t achieve the design criteria.”

The approach targets the performance of the facility against design, and gets the designers in contact with FM during occupancy phase. This creates a communication channel for knowledge exchange between designers and facilities managers and facilitates the transfer of operation-related information from FM to design. As revealed above, the approach has nearly never been used in the Middle East so far.

5.3 FM Knowledge and Expertise Integration in Design

5.3.1 FM-related Concerns

Participants were asked about the FM-related issues that should be addressed by the design. The resulting FM and design participants’ views are presented in this

section. Issues stated in common between FM and design professionals are displayed in bold text to show the extent of similarity.

5.3.1.1 Client and User Satisfaction

Designers

1. **Ability to control an individual's environment**
2. **Access for maintenance without disturbing occupants**
3. **Client's budget and expectations**
4. **Degree of comfort felt in the surrounding environment**
5. **Ease of Parking**
6. **Office layouts: open-plan or individual closed offices**
7. Access to facility through different entrances
8. Location of cafeterias in large buildings
9. No. of employees encountered before reaching "Manager's" office
10. Safety of the workplace
11. Type of glazing used on external facades
12. Use of operable windows

Facilities Managers

1. **Thermostats location inside rooms rather than outside**
2. **Services located in pantry or washing room not to disturb tenants**
3. **Safeguarding the increase in client's profit**
4. **Degree of comfort felt in the surrounding environment**
5. **Car park design, getting in and out**
6. **Easy of process and movement within offices**
7. Ability to deliver services to tenants
8. Attending to user needs in the Middle East by Western designers
9. Availability of amenities such as club houses, etc... in residential compounds
10. Car parking spaces to be wider for women and children

11. Efficiently working air-conditioning
12. Filing space and shelves inside individual offices
13. FM response time to tenant complaints
14. Furniture considerations (beautiful furniture but not practical)
15. Hassle-free transportation of tenants within floors
16. Proper use and selection of indoor carpets (hygienic purposes)
17. Space planning based on specific user requirements
18. Tenant Convenience

5.3.1.2 Operation and Maintenance

Designers

- 1. Access for maintaining HVAC systems**
- 2. Cleaning windows and external elevations**
- 3. Creating a redundancy system**
- 4. Distance to nearest FM service point**
- 5. Equipment selection**
- 6. Hose and cable lengths (for fuelling, irrigations, electrical connections, etc...)**
- 7. Material selection and availability in the local market**
- 8. O&M manuals data content**
- 9. Operation costs**
- 10. Spare part availability**
11. Electrical Loads for different spaces
12. Equipment maintenance
13. Operation lifetime of equipment
14. Optimising number of equipment used to reduce maintenance and equipment breakdown
15. Types of finishing for cleaning purposes
16. Ventilation and drainage requirements for different building functions

Facilities Managers

- 1. Access hatches for HVAC**
- 2. Cleaning windows**
- 3. Creating a redundancy system**
- 4. Identifying nearest FM service points for each area**
- 5. Equipment Selection (Chillers system, etc...)**
- 6. Proper distribution of electrical sockets (Due to cable length limitations)**
- 7. Material Selection**
- 8. Stating design criteria in O&M Manuals**
- 9. Maintenance costs**
- 10. Spare parts and their availability in the local market**
11. Access for cleaning and replacing light bulbs
12. Choice of Water Distribution Systems (booster pumps, gravity systems, etc...)
13. HVAC duct material above ceiling to prevent condensation leakage
14. Safety of operation

5.3.1.3 Space Layout and Flexibility*Designers*

- 1. Access to equipment for maintenance**
- 2. Ensure availability of janitor closets**
- 3. Ensure optimum usage of space**
- 4. Fire and emergency exit locations and how people move to escape**
- 5. Flexible space layout to accommodate future needs**
- 6. Office Layouts (Cellular vs. Open plan)**
- 7. Providing sufficient workspace for FM**
8. Ability to use a facility in independent sections based on demand
9. Accessing back of house areas
10. Adjacencies of different departments within facilities
11. Minimizing exposure to hazardous material, gases and waste

12. Walkways around facilities

Facilities Managers

- 1. Access for maintenance**
- 2. Ensure availability of janitor closets**
- 3. Avoiding corners and dead space for optimum space usage**
- 4. Ensure proper egress and ingress**
- 5. Creating future-proof buildings to allow for expansion**
- 6. Efficient office layouts**
- 7. Providing sufficient workspace and manoeuvrability for FM**
8. Ability to change layouts and easily move people
9. Accommodate for fluctuations in the number of workforce
10. Allowing for storage rooms
11. Building storage wall partitions
12. Considering the functionality of spaces (making a space up to the place)
13. Effect of façades on FM (whether facades are round or have corners)
14. Sizes of hallways to better accommodate the traffic
15. Use of raised floors to create a flexible space for different uses
16. Use of reconfigurable furniture that is easy to assemble

5.3.1.4 Sustainability

Designers

- 1. Recycling**
2. Consider the energy embodiment
3. Considering facility location and orientation
4. Greenery around facility and on the roof
5. Having car parks underground to create green areas outside instead
6. Minimising water consumption losses
7. Treating the sun's ultra violet rays

8. Use of sustainable materials

Facilities Managers

- 1. Reusing and recycling water**
2. Fittings to allow for use of LED lighting (less energy costs)
3. Installation of solar cells for electricity generation
4. Insulation in external facility walls
5. Use of natural lighting
6. Use of water treatment plants to replace septic tanks
7. Water for irrigation system (refrain from using potable water)

5.3.1.5 Energy Efficiency

Designers

- 1. Installing consumption meters**
- 2. Reducing energy consumption from light bulbs**
3. Achieving central control through BMS to save in number of personnel
4. Energy saving solutions
5. Facade insulation
6. Optimising energy consumption

Facilities Managers

- 1. Installation of consumption meters to monitor cost**
- 2. Use of LED lighting and other energy efficient light bulbs**
3. Providing separate switches to turn off lighting of unused parking floors
4. Reducing fan speeds according to demand (Winter vs. Summer)
5. Use of motion detectors and light dimmers to save energy
6. Use of Variable Frequency Drives to regulate chilled water circulation and save energy

5.3.1.6 Ergonomics

Designers

- 1. Manoeuvrability**
- 2. Selection of furniture to meet user requirements**
3. Creating mock-ups to check for ergonomics
4. Enhancing design of stairs to be used instead of elevators
5. Height restrictions on furniture
6. Toilets location to be away from users to introduce activity

Facilities Managers

- 1. Ensuring accessibility to various areas to reduce strain and increase productivity**
- 2. Furniture design to suit user needs**
3. Considering the lifestyle of facility users
4. Creating spaces for people to socialise
5. Effective disability access
6. Increase number of handicapped toilets in certain areas based on FM experience

5.3.1.7 Other Issues

Designers

- 1. Providing manufacturer and local agent contact details**
2. Addressing solid waste
3. Data shown on As-Built drawings
4. Relation between floors and services

Facilities Managers

- 1. Supplier technical backup**
2. Design of elevators to handle traffic

3. Grouping keys based on common space use
4. Integrating Security Systems: Guards, access control, CCTV cameras and people recognition systems
5. Life cycle management
6. Location of flower beds to prevent leakage

All the aforementioned points, as stated by both FM and design professionals, are regarded as FM-related issues to be taken into consideration when designing for new facilities. However, when comparing the views of facilities managers to those of designers, the common points stated vary from one type of concern to the other as shown in the following table (Sorted according to the rightmost column):

Concern Type	FM Responses (No.)	Design Responses (No.)	Common Responses (No.)	Combined Responses (No.)	Common to Total Response Ratio (%)
Operation and Maintenance	14	16	10	20	50.00%
Space Layout and Flexibility	16	12	7	21	33.33%
Client/User Satisfaction	18	12	6	24	25.00%
Energy Efficiency	6	6	2	10	20.00%
Ergonomics	6	6	2	10	20.00%
Other Issues	6	4	1	9	11.11%
Sustainability	7	8	1	14	7.14%
Combined Total	73	64	29	108	26.85%

Table 7 FM-related Issues: Facilities managers vs. Designers Responses

Table 7 above reveals that there is a minimum of 108 different occupancy-related FM issues that require consideration when designing for a new facility. Designers and facilities managers agree most on operation and maintenance issues,

followed by space layout and flexibility then client/user satisfaction. The individual ratios for these three types are also nearly equal or greater than the ratio calculated (26.85%) when combining all types of concerns.

Figure 10 also shows that the three aforementioned types constitute the majority of FM-related issues reported by facilities managers as well as designers.

Facilities managers provided more issues than designers (73 vs. 64 responses), which would be logically explained due to the greater involvement of FM during occupancy phase. Nonetheless, the two numbers remain considerably close to each other and this shows that designers are also knowledgeable about occupancy-related issues even if they do not always take them into explicit account when designing.

The more noticeable difference can be detected when observing the calculated ratio of combined common-to-total issues reported. A percentage as low as 26.85% being issues commonly reported by both FM and design professionals, suggests the wide divergence between the points of views of both designers and facilities managers. This also confirms the facts stated previously concerning the distant relationship between FM and design, leading designers to wish for more FM engagement in design and facilities managers to complain that their concerns are not properly incorporated into the completed facility.

5.3.2 Current Consideration of FM Issues in Design

When asked whether the issues they stated were actually considered in the design of facilities, the replies from designers and facilities managers resulted in what follows.

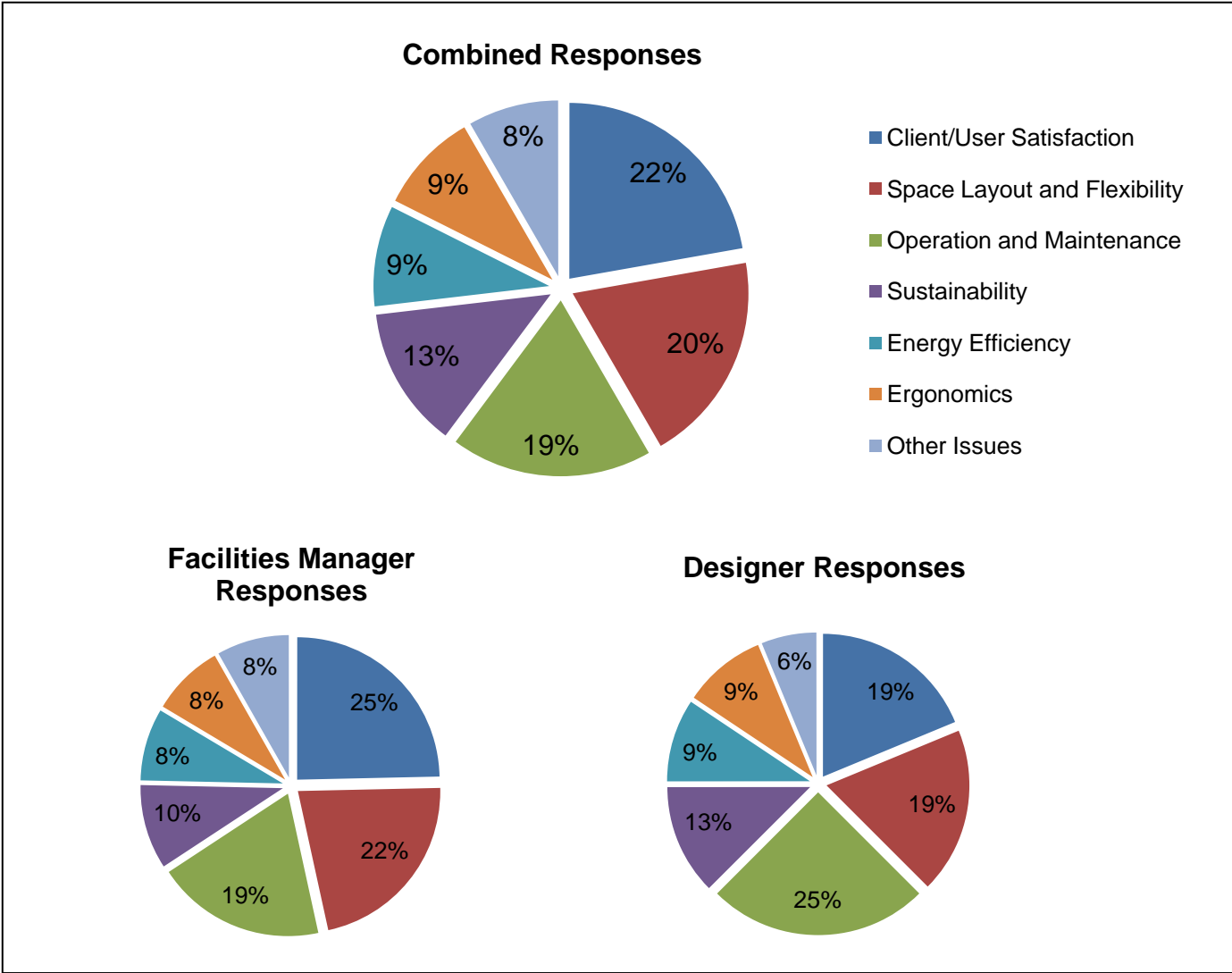


Figure 10 The distribution of various FM-related issues as reported by participants

Designers

Considering FM related issues when designing is mainly driven by what the client requires. Designers would suggest implementing FM related measures in their designs but it all depends on how much the client is willing to pay for those measures. When the design brief prepared by the client and given to the designers clearly states requirements related to occupancy, these are almost always accounted for when designing.

“With one of our clients we do this most of the time, and their brief is very stringent”.

Designers emphasise the fact that issues such as external facade cleaning and access to air conditioning systems are not specifically required by clients. Clients do not very much care to include energy efficiency and sustainability matters as well. Many clients do not want sustainability to be implemented as they don't see benefits for themselves, but rather want to “show off” that their building is certified.

“The clients don't want this (sustainability) because they can't see a benefit for themselves... they want to show off that there building is certified.”

Some of the FM related issues are usually part of the client program and are therefore accounted for by designers. Some FM issues are also part of the design's quality checklist used by designers to check their designs.

Value engineering exercises might also account for FM aspects when the design is checked to see if the building will deliver the required technical and financial benefits.

Sustainability and energy efficiency are more likely to be accounted for when the design firm holds a sustainability certificate.

“Our company is LEED certified. We are members. Energy efficiency and sustainability are covered.”

One of the designers discussed the importance of coordination between various design disciplines. FM related concerns could be faced due to this lack of coordination.

“From a structural point of view, you might look at an equipment room and say, why do you need a room this large? But when it comes down to it, you’ve got people working in there and they need space. So the coordination between the structural, architectural, and mechanical again is very important.”

Facilities Managers

When stating FM related concerns listed in the previous Sub-section, facilities managers were mostly pointing out problems faced on current or previous projects.

“What I really want in my office is a small meeting table and chairs so that my team can come in here and meet with me, but what I’ve got is a very large sofa that when you sit on it your feet can’t touch the ground, and a chair that looks a little bit like a deck chair.”

Problems stated are project specific and conclusions cannot be drawn to say that these reported problems are not at all being addressed by the design.

As is the case with designers, FM managers also state that allowing for FM issues in the design depends on what clients want and how much they are willing to pay. If the client does not specify FM requirements, these are not required by law and will not be implemented.

In addition, the desire for sustainability and energy efficiency is not great, because the energy costs are not seen to be excessive in certain countries within the Middle East. The use of LED lighting instead of fluorescent tubes and spot light types is still very minimal. Facade insulation is not a matter that is being widely addressed as well, especially with the use of glass facades that relate more to aesthetics than energy saving. On the other hand, the use of dimmers and motion detectors are seen to be already considered in design of facilities.

FM related issues are sometimes not incorporated in new designs, due to the fact that designers rely on work done on previous projects.

“I think designers have their own databases for their designs. Many times for example for towers, it is simply a copy paste process.”

5.3.3 Designers’ Sources of FM Knowledge

Designers were asked about the information sources they rely on to get FM related information and address the FM issues they listed previously.

On the other hand, facilities managers were asked about their opinion regarding what sources designers are using to get information on FM related issues.

Designers

The main sources of information used by designers to access FM related knowledge are the following (ranked according to highest number of designer responses):

1. International standards provided by architectural and engineering associations such as IEEE, ASHRAE, NFPA, etc...
2. Codes provided by sustainability organisations such as LEED and other local sustainability associations and green councils

3. Independent design work based on design calculations, experience and knowledge databases
4. Building codes and regulations associated with each country
5. Clients input and requirements in addition to owner guidelines for various industry groups
6. Manufacturers data sheets and research done by manufacturers on various types of equipment

Other sources include (1 response only):

7. Consulting FM on O&M issues
8. Data collected by designers from end users and departments using questionnaires and interviews during project kickoff
9. Specifications
10. Sustainability consultants providing design review services
11. Seminars

Also reflected in designers' responses was that the design knowledge sits on top of all other facility-related knowledge available. Designers seem to be confident about their ability to solve all problems arising based on their experience.

“Designer knowledge is higher than any other because designers know how things have been built and on what basis. If there are any problems or defects, a designer would know why this happened. The cause of any problem is easily detected by designers because of their knowledge about the building and their experience in general.”

One designer only stated that information on operation and maintenance is obtained from FM operators. The day to day experience is not integrated in design due to absence of feedback, as illustrated below.

“Designer: There is another face... the day to day experience... what to do... how to do it... these simple things that facilitate the work of operators and facilitate things for the maintenance.

Researcher: So how do you get to integrate those experiences in your design then?

Designer: No. We don't get feedback on those experiences.”

Another designer stated that the absence of information related to FM operation is due to a lack of FM references available for designers to use. The reason behind that in his opinion is because FM people are not doing their homework and advertising their know-how.

Facilities Managers

FM managers regard designer experiences and personal knowledge as the main source of information used when designing.

Other sources of information as viewed by FM managers are as follows:

- a. Information about problems encountered during the defects notification period
- b. Regulatory requirements which could induce changes to the design in favour of facilities management
- c. Clients input and requirements
- d. Talking to end-users
- e. Product catalogues
- f. O&M Manuals

Facilities managers agree that manufacturer information and product catalogues do provide information related to operation and maintenance. Nevertheless, this information could sometimes be misleading, depending on the product installation conditions.

“Most information from the product catalogues... maintenance procedures for different equipments and catalogues... but if I’m a manufacturer, I always show you the good picture of maintenance. But the actual people who are maintaining that, it is different. The procedure says that it is very easy to replace that light bulb, but if it is installed in high places, then how will you get up there to replace it?”

This implies that it is better to obtain information from the actual people who are involved and do the actual maintenance, than getting the information from catalogues. This was also specifically stated by one of the FM interviewees.

“Designers should consult FM while they are designing concerning these various [FM-related] issues. This is the best way I think.”

5.3.4 Barriers to Integration

The barriers to integration provided by participants were mainly classified into three categories: FM-related, Design-related and Client-related. Other barriers are also seen to prevent FM and design integration and are listed separately.

5.3.4.1 FM-related Barriers

Designers

One of the main barriers that designers see affecting integration from the FM side is the issue of cost. There is an additional fee charged by FM companies in order to engage early on in design, to attend workshops and review drawings. This additional cost to the client is not being presented as a saving on the long run. The knowledge on savings is not available and designers are not being able to prove

that the engagement will actually lead to saving money in the future. It is not enough to only promote the FM services provided during occupancy phase, it is also essential for FM personnel to convince clients about the value of their engagement early on, as stated by one of the designers:

“There are some organisations coming out from the west [into the Middle East], who promote facilities management... but at the end of the day, it rests on the fact that if you can promote the value of engaging FM in design in an efficient way to clients.”

Another barrier affecting integration is the fact that FM is immature in the Middle East. The FM industry is still in its infancy and not well established, with the exception of FM operations on some mega projects. In addition, the FM service provided to clients affects how clients see facilities management and how they value the FM contribution to organisations.

“It’s related to the FM organisations and the organisations they are working for. I mean if they see them as someone that is just going to make sure there’s enough toilet paper in the bathrooms and the photocopiers are all working, that’s kind of maybe a little short sighted.”

The above reality drives clients towards regarding FM as a secondary stakeholder when it comes to project development. This also affects FM contribution during design stage and consequently the integration of FM knowledge in design decisions.

A third barrier which would be affecting the knowledge transfer from FM to design is that FM people keep information to themselves and do not document it, because they think if they document the knowledge then they will not be asked for their expertise anymore.

“..and this is totally wrong because you need someone to always be signing off, to be accepting the information.”

One of the designers also stated that FM managers sometimes think the designer is the enemy, going crazy with a design that is inappropriate and difficult to manage from an FM point of view. Such an issue would also widen the gap between FM and design and harm their relationship. Communication and collaboration should rather be encouraged to the benefit of achieving facilities that are better fit for purpose.

Facilities Managers

The most noticeable barrier discussed by facilities managers in relation to their early engagement during project development, was the issue of perception. There are companies who call themselves FM companies but in reality they are only caterers or cleaners; as opposed to companies that provide integrated facilities management, i.e. management of an entire facility including mechanical, electrical and plumbing (MEP), cleaning, security, parking management, etc... Company registration also encourages this false FM identity as companies are sometimes registered as FM, but in fact they are not; and they end up being inappropriately skilled for the requirements.

“I’m sure that you’ve been in places before and the security guard will let you in, and if there’s a problem with the cupboard door and the security guard is trying to fix that, then you have a problem with the air conditioning and the security guard is trying to fix that and then he’s in the car park washing the cars.”

“FM are not cleaners, are not security people, and are not two guys with a bucket and a mop calling themselves facilities managers.”

Clients see similar approaches as the one above all the time, and this creates a problem in the recognition of FM value. FM instead is seen as an added cost that clients do not need.

FM managers also state that FM is still a young profession and the FM market is not mature enough, creating a second important barrier to integration. This affects what building owners know about FM as well as FM's own practical performance and contribution.

“If you asked five people what facilities management means you’d definitely get 5 different answers! So people are not quite aware of what it is, firstly. And secondly, they’re not convinced about the value of FM.”

At the end of the day, the client is the one to decide on engaging FM and eventually paying for services provided, whether during occupancy stage only or all the way from the start. If clients’ knowledge is insufficient concerning what FM is and what value it could offer to facilities, the FM challenge of getting engaged becomes greater.

Being a young profession also affects the FM managers’ performance in practice. There is still a lack of knowledge on practical application and experience as well as academic education. Therefore, FM managers with experience specifically related to design and construction of facilities are also very few.

“...so we are not mature enough to take our place at the table. I see it occasionally when I must go and review projects and jobs; the FM company assigned to do the work has no understanding of the technicality and the nuances of the design or construction and the buildability of the project. If we are to engage during the design stage which is the concept design, we’ve got to be professional about it and make sure we are represented by professional people”.

A third barrier to integration discussed by FM participants is that sometimes construction contractors are awarded contracts to carry out FM services on a building they previously constructed, eliminating by that any FM company role. This problem causes FM not to appear on the radar, and the case usually ends up being a client and a designer communicating to build something that looks pretty.

A fourth barrier stated by several FM participants relates to the fact that FM is seen as a poor or second cousin to design and that the relationship between FM and design is more of a lower level relationship rather than being equals. FM managers are therefore neglected and are not expected to advise designers on matters related to decisions taken during design stage.

5.3.4.2 Design-related Barriers

Designers

Three barriers from the design side are seen affecting FM and design integration as stated by designers.

The first barrier deals with the designers' interest in FM operations. Designers do not see that it is their personal responsibility to attend to FM issues. This fact could be caused by either that they do not see a benefit for themselves in getting the FM engaged in design or the extra cost incurred due to retrieving information from facilities managers.

“The engineer here would take 2% and the owner here would negotiate to drop this to even 1.5%... while the contractor takes the rest of the construction cost. I’m talking here about the mentality... I will not enter into this hassle of getting information from FM people because the owner will not appreciate what I’m doing.”

In some cases, this matter also forces designers not to meet with all parties that should be involved in a project, blocking the transfer of FM feedback and other end-user requirements.

The second barrier relates to the designers' perception of what the requirements for building usage and operation actually mean. FM managers might have requirements for durable equipment, which could be interpreted by designers as equipment with the highest cost and the longest warranty. A second example is illustrated below:

“For example if I know that I need only 4 outlets or exits for people to leave a parking area or a stadium, the designer would probably provide 10. The designer thinks that if there were 10 then it’s convenient.”

This interpretation of what “durable” or “convenient” actually means, sometimes does not align with FM requirements or exact needs, distorting the information transferred from facilities managers to designers.

As stated by one of the designers, the specifications should be more aligned with the end-user requirements, FM included, so that the requirements are properly interpreted and the design is developed accordingly.

A third barrier to integration relates to design students. One of the designers, and after being involved with some design students in the Middle East, stated that design students are not told about the importance of FM services, and FM issues are not something that design students would ever think of.

Facilities Managers

The most serious barrier which FM managers regard as being design-related is that designers focus only on the design, more on designing a facility that looks fancy or pretty and which satisfies the client, and are not interested in issues

related to operation. This was translated through different types of responses that FM participants provided:

- a. Designers do not usually appreciate the challenges accompanying space usage or flexibility and do not take the operational day-to-day real life into consideration.

“Designers, they’re obviously just concentrating on something that looks nice, but no operational day to day real life.”

- b. Designers would not like someone to tell them what to do.

“It looks like the FM is telling the designer what to do... it’s terrible. People work to just do the same thing over and over again, and when the FM comes in and asks about this and that, they’re breaking the norm that these designers are following.”

- c. Designers care more about completing the project rather than thinking about the long term operation.

“From a design perspective they want to come in design it and do it as quickly and effectively as they can and then get their payment and go.”

- d. Facilities managers are also not sure designers are vigilant enough in seeing MEP systems for example, actually installed as they should be.

The second barrier to integration deals with how designers perceive FM and FM managers. FM participants think that designers see FM as an additional work load for them. In addition, designers should not be too proud to consult FM personnel and have initial meetings with them for exchanging information at the beginning of

the project. This also relates back to FM being regarded as a second or poor cousin, a barrier stated in the previous section.

A third barrier to the design involvement during operation phase relates to the design role and their period of involvement on projects. Quite often designers leave the project before snagging starts, which would be more of a project management role; a matter which also affects knowledge exchange between designers and operators and prevents occupancy-related information from being transferred to designers.

5.3.4.3 Client-related Barriers

Designers

The first client-related barrier to FM and design integration, mentioned by almost all designers, is the lower-than-expected client education and their insufficient required knowledge about FM and the operation phase in general. This barrier is reflected through the following expressions:

- a. No full client understanding of how to operate a facility
- b. No client understanding of the whole building life cycle
- c. Clients might not be educated on FM
- d. Lack of experience in relation to asset maintenance costs
- e. Clients believe they are saving money by not getting the FM early on
- f. Clients consider engaging FM to be a cost incurred rather than an investment
- g. Clients have to realise the value of FM, not just the costs incurred by FM
- h. Clients' main priority is the commercial aspect and making profit. Maintenance comes later
- i. No clear need for having long term planning
- j. Absence of the concept of consulting an FM at early stages
- k. Clients are relying on designers to tell them what they need

- l. Clients do not realise that designers and FM personnel need to talk
- m. It is a hurdle to convince clients to get FM during design stage

Although clients are not currently giving a lot of attention to FM engagement, mainly due to their lack of knowledge about FM, this is expected to change. Due to the increase in competition, it is just a matter of time until owners realise that FM needs to be engaged at early stages.

The second most important barrier to integration is related to culture, and the attitude of clients towards construction in the Middle East. Several designers discussed the fact that many clients are not used to having an asset lasting more than 25 years. They sometimes build facilities and sell them after 4 or 5 years, caring most about quick profit and rather than long term operation.

“This tear-down and reconstruct culture that we have in this region is not facilitating the involvement of facilities management at an early stage because you’re not in many cases planning for this asset to maintain for very long.”

The high budgets available in some Middle Eastern countries as opposed to the more limited budgets in Western countries also make it easier to demolish a facility and build a new one. FM then would not be on the top of the client’s agenda and the attitude towards maintenance in general gets affected.

“The attitude towards maintenance, although labour is inexpensive, if the system is working so leave it.”

In addition, clients’ spending on FM is seen to be correlated with business performance, rather than facility performance and longevity. When a client’s business is impacted due to lack of FM, clients tend to spend more to reduce the impact.

A third barrier to integration is the fact that clients are not hiring FM at early stages, so that FM participation would take place during design.

“Clients do not have FM in place by the time design is finished... no one to talk to.”

This could also be related to the fact that clients regard FM as a secondary stakeholder, due to other primary concerns. The first client priority is mainly aesthetics that attract customers, as part of the marketing strategy to sell their product.

The clients' vision about what the end product would be could also hinder the hiring of an FM until a late stage. This vision depends on how much the client is actually sure of what he needs as well as the market demand that could result in modifications and changes to the building usage, transforming residential flats to offices, for example.

Other barriers to integration deal with the client's internal organisation. Even though some industrial buildings and hotel clients are better in communicating their requirements, internal organisational barriers might prevent procurement and operation departments from communicating. Communicating requirements also depends on the client's experience gained through developing several buildings, whereby these barriers are overcome whenever a client is mature enough to realise the need to maintain, in order to improve.

Clients also prevent modifications to the design made during schematic and design development stages, because they get emotionally attached to their designs and do not want to sacrifice it. The FM input in this case would also be obstructed in favour of the design proposed and developed by designers.

FM engagement during design stage also depends on whether the client is also the occupier of the facility being designed and later constructed and operated.

“If the client is a developer-occupier for a 25 year period for example, he would be more aware of the considerations required for what it is to make a building as economic as possible.”

This idea is in line with what was previously mentioned by designers earlier in this Sub-section, that whenever a client is interested in making profit only and selling the property afterwards, long term operation gets neglected and FM engagement would not be facilitated.

Facilities Managers

The major client-related barrier to FM and design integration mentioned by most FM managers is the fact that clients lack the knowledge regarding the need for FM, an issue similar to client education discussed by designers. FM managers state that clients:

- a. Are not fully aware of what FM actually does
- b. Do not know if FM is important or not
- c. Do not hold a long term view of what the benefits of FM would be
- d. Do not fully understand the need for FM
- e. Do not see the cost benefit of FM; FM is seen as an unnecessary expense
- f. Do not see the true value of FM
- g. Do not understand that modifications during design phases are cheaper than those during occupancy phase

The second major barrier is related to clients' attitude and culture. There is a mentality of *“just wait till it's broken and then we fix it”*; similar to that mentioned by designers. In addition, spending on FM services also depends on the occupancy level within a facility, i.e. business performance. This matter was also stated by

designers earlier in this Sub-section. It was also mentioned by several FM participants that some facilities are built to last only ten years, with no long term operation in mind.

The third barrier is the fact that clients' main concern, especially when the facility is still in the design and construction phases, is profit. Clients do fast construction to finish and start earning profit, without giving much attention to maintenance and caring for the asset. The issue of engaging an FM early on is therefore not being imposed, thus leading to a limited integration of FM knowledge and expertise in design.

The matter of whether the client is also the occupier of the facility being designed and constructed was also raised by some FM participants. Developers gain interest in getting the FM involved at early design stages, when they are the ones to later occupy the facility and pay the operational costs.

(a) Clients' experience in property development, (b) their clear views of what they require out of the facilities they are developing and (b) their degree of interest in aesthetics and external facades are all factors affecting the early engagement of FM during design stage, and are all mentioned by FM participants as they are as well stated by designers.

Examples to illustrate what FM participants say regarding the three above mentioned factors are as follows:

a. Client Experience

"I think it really comes back to the experience of the property developer. If they appreciate the need to have a designed building that is easy to maintain and they

engage hopefully an FM company or somebody with an FM experience to oversee the design and to input at the design stage.”

b. Clients' Clear Views on Requirements

“It really comes back down to building owners not knowing what they want, or what they need or maybe don't appreciate what they need. They might know but don't appreciate what they need.”

c. Clients' Interest in Aesthetics

“One of the things in the Middle East in general is about the facade; it's about how it looks. It's about how the building is going to look on the outside. And then what happens inside doesn't really matter.”

When observing the various barriers to integration provided by facilities managers on one hand and designers on the other, it is noticed that the types of client-related factors affecting integration are nearly identical. This also shows that designers and facilities managers share the same ideas regarding the factors affecting the integration of both their views, when it comes to clients.

5.3.4.4 Other Barriers to Integration

Designers

Designers mention barriers to integration without referring to client, FM or designer as being the party involved. These barriers include the following:

- a. FM engagement in design is not weighted high enough in life cycle costing
- b. Highly competitive market which forces designers to hit on the price.
Therefore, if nobody pushes it, nobody is going to include it

- c. Blame culture within clients. FM avoid getting involved so that they are not blamed for operational problems
- d. Price limitations forced by contractual agreements
- e. Schedule limitations to deliver the project as soon as possible
- f. Contractual agreements that define parties involved during design, leaving out the FM
- g. Design is based on space planning, never on operations
- h. Building sustainability is hard to achieve in the Middle East due to the high cost of special material being shipped in from other countries
- i. The misperception of what the other does

All the factors above affect the designer/FM relationship and consequently their collaboration on projects. It is evident that using contract conditions in their current forms would hinder the involvement of FM from both the time and budget perspectives. This is due to the fact that no allowance is initially made for FM engagement during design stage.

Facilities Managers

One factor discussed by several FM participants, relates to the implementation of sustainability in the Middle East. As mentioned by designers, it is hard to build sustainability due to the higher costs incurred. FM participants discuss low fuel costs in oil-rich countries within the Middle East, as being a primary cause rather than the high material costs mentioned by designers. Due to the complicated systems involved in sustainability, maintenance costs tend to be higher and the

energy generated by these systems would not prove to be cheaper than that produced using fuel.

“LEED, BREEAM and the green council in Australia for example, all of them have fundamental flaws when it comes to cost effectiveness; and because they are based on environments or areas where fuel and labour are expensive, here in the Middle East neither of those two applies. So financially, it’s viable for me to meet the sustainability target in Europe for example, here it actually costs me more...”

FM managers also mention the following additional barriers affecting integration:

- a. In the Middle East, FM are only operational (as operation and maintenance only)
- b. Conflict between project management and FM on advising the client
- c. A mutual understanding between client and designer that all requirements are being incorporated. Whereas the actual reality is lost in between
- d. It is all green fields. Middle East is new to high rise buildings
- e. The lack of understanding on operation and use of space, by the end user
- f. The wide gap between the school of design and the school of operations
- g. The very tough job of selling the owner now, what has a return in 50 years

The fact that FM is mainly operation and maintenance in the Middle East is also reflected in participants’ responses when asked about the FM-related concerns that need to be included in facility designs. Table 7 shows that designers agree

with facilities managers on operation and maintenance more than on any other issue related to facilities management. Moreover, Table 7 also shows that the suggested sustainability issues are not too many and that FM and design research participants agree the least on this topic. This also confirms what was previously mentioned regarding the weak implementation of sustainability and the associated difficulties faced when attempts are made.

5.3.5 Consequences of Limited Integration

Participants were asked about their experiences regarding the resulting consequences of limited integration. Their responses were analysed and organised in order to know what consequences were more significant than others.

Designers

Designers provided numerous consequences based on their experiences on previous projects, and the results came as follows:

Consequence	Participants (Designers)
Dissatisfied Customers	33.33%
High Maintenance Cost	20.00%
Designers' Wrong Interpretation of FM Requirements	20.00%
Systems Inefficiency	20.00%
FM Requirements Unmet	13.33%
Clients' Loss of Profit	13.33%

Table 8 Consequences Due to Lack of Integration (Designers)

The most occurring consequence mentioned by 33% of designers who were interviewed, is the issue of dissatisfied customers and unhappy facility users. The interruption caused to users of facilities due to problems in operation, their disappointment due to them paying for something that is lower than their expectations, the discomfort they feel in their environment and the difficulties they

face when parking their cars or finding a parking space are all issues leading to dissatisfaction.

The rest of the consequences not mentioned in Table 8, only occurred once among the designers' responses. These are listed below in alphabetical order:

- a. Abortive Work
- b. Access problems for maintenance
- c. BMS control problems
- d. Chillers operation problems
- e. Design intent lacking operational guidelines
- f. Designers' bad reputation due to dissatisfied clients
- g. FM's lack of interest in operation due to non-involvement earlier in the project
- h. Higher rate of equipment breakdown
- i. Lack of storage spaces
- j. Negative effects on design due to deficits related to facility operation
- k. Retrofitting costs
- l. Underutilization of a facility's full potential
- m. Wrong data provided to designers
- n. Wrong equipment selection
- o. Wrong material selection and the absence of unified products
- p. Wrong translation of end-user requirements into technical input

Providing all these negative consequences of FM's non-involvement in design shows that designers are well aware that the design output is facing problems due to the absence of FM input during design stage. In addition, it is revealed that

designers are also aware of the negative effect on their firms and their reputation when FM is not integrated into design decisions.

Designers' concerns are illustrated through the following extracts:

"There is nothing worse than a client meeting you and saying what is this thing that you designed for me that doesn't work! I don't know how to maintain, its broken two weeks after you've left... there's nothing worse. You get a bad reputation and you don't get ongoing work. So it really is important."

"The consequences are drastic. If the design was not reflecting the whole objective of the project and all stakeholders and end users, then there must be a deficit in the design or the quality of the project."

Facilities Managers

A similar exercise was carried out on all FM responses related to consequences due to lack of integration, and it is noticed that the number of consequences provided by all facilities managers as compared to those provided by designers was nearly double.

It is not very clear whether this large difference is attributed to the higher exposure of facilities managers to problems occurring during occupancy phase, or designers' keenness about protecting their design reputation by not discussing problematic design outcomes.

FM responses reveal the outcome shown in Table 9. The most occurring consequence mentioned by 40% of facilities managers who were interviewed, is the problem of access for maintenance. Whether the task is maintaining HVAC equipment, changing filters, replacing light bulbs, maintaining pumps or attending to leakage problems, facilities managers face problems during occupancy phase when trying to access different systems.

Consequence	Participants (Facilities managers)
Access problems for maintenance	40.00%
Dissatisfied customers	33.33%
Unavailability of spare parts	26.67%
FM service affected	20.00%
Clients' loss of profit	20.00%
Poor quality of documents (As built drawings, O&M manuals, etc...)	20.00%
Retrofitting cost	20.00%

Table 9 Consequences Due to Lack of Integration (FM)

The rest of the consequences not mentioned in the table above, only occurred once among facilities managers' responses as listed below in alphabetical order:

- a. Absent/insufficient spaces allocated for FM staff
- b. BMS control problems
- c. Chillers operation problems
- d. Designers' reputation negatively affected
- e. Façade cleaning problems
- f. FM companies' bad reputation
- g. FM forced to experiment with new products
- h. Higher operation and maintenance costs
- i. Higher operation complexity (large amounts of keys and master key groups)
- j. Inappropriate space allocations
- k. Insufficient parking spaces
- l. Insufficient system redundancy

- m. Inability to accommodate space changes (Lack of flexibility)
- n. Lack of comfort spaces for users to take breaks
- o. Lack of janitor closets
- p. Lack of storage space
- q. Outdated material
- r. Shorter facility life
- s. Systems integration problems (e.g. CCTV and Access control integration, or Fire alarm and lifts integration)
- t. System Inefficiency
- u. Wrong material selection
- v. Wrong systems installed

The aspect of reputation was found to be an issue among FM participants' responses as well as designers. The reputation of both design and FM companies are at stake when clients and users are dissatisfied due to problems occurring during occupancy phase.

Dissatisfied customers and the loss of clients' profit are among the more significant consequences also mentioned by both FM and design research participants. However, when looking at the type of consequences provided, it is noticed that facilities managers provided slightly more details. Rather than only stating that the FM requirements would be unmet or that wrong equipment would be selected, facilities managers point out what the wrong requirements are instead.

"Executive offices are meant to look good, but they are not practical. So you can't sit and talk to a student about a disciplinary issue, and do that sitting on a sofa where your feet can't touch the floor!"

The availability of spare parts, integration of various security systems, the cooling system types (chillers versus split units), facade cleaning, keys and master key groups, the quality of as-built drawings and O&M manuals, etc... Again, the greater detail provided could be correlated with greater FM exposure to the design's end product and the resulting experiences gained during occupancy phase.

It is also worth noting that none of the participants reported any positive consequences related to non-integration. All reported responses actually resembled problems faced during occupancy phase.

Moreover, FM and design participants were asked to point out the most serious and most frequent consequences which occur due to lack of FM and design integration.

5.3.5.1 Most Serious Consequences

Participants consider that the most serious consequences resulting from lack of integration include:

Designers

- a. Interruption to tenants
- b. FM requirements being unmet
- c. Access difficulties to HVAC equipment and ducts
- d. Developing systems solutions inappropriate to requirements
- e. Breakdown in air-conditioning

Facilities managers

- a. Access difficulties for maintenance purposes
- b. Chillers system problems

- c. Incomplete generator testing (generators do not feed all panel boards)
- d. Cost of modifications and retrofitting
- e. Difficulties in coping with leakage problems
- f. Decreasing equipments' operation lifetime
- g. Lack in unifying materials and equipment; results in increasing spare part requirements and dropping the FM efficiency
- h. Unavailability of spare parts

“One of the biggest things that cause us problems is that we go into a development and there are 10 different types of lifts! That means we have to carry 10 different types of spares, and train our people to look after 10 different types of lifts”

5.3.5.2 Most Frequent Consequences

The most frequent consequences that the participants have experienced or are aware of include:

Designers

- a. Missing FM requirements regarding space planning
- b. Modifications to the facility during occupancy phase
- c. Lack of training provided to FM operators due to absence of designer/FM overlap during handing over
- d. Difficulty in standardising materials
- e. Equipment O&M problems due to wrong selection of equipment

Facilities managers

- a. Unavailability of spare parts
- b. Tenant complaints due to equipment breakdown
- c. Safety hazards due to retrofitting

- d. Narrow parking ramps
- e. Roof water leaks (in desert areas, roofs are not adequately designed to prevent water ingress)
- f. Cleaning difficulties (especially external facade cleaning)
- g. Access difficulties for maintenance
- h. Lack of coordination between design disciplines
- i. Compatibility issues
- j. Limited control over AC regulation (especially in open-plan office layouts)

5.4 FM Inclusion during Design Stage

All research participants agreed that FM participation in design should be achieved on construction projects.

5.4.1 Purposes for Achieving FM Participation in Design

Participants were also asked why they consider that FM participation should be achieved during design stages, the different purposes are presented next.

Designers

From a design point of view, the various purposes listed in Table 10 are ranked according to the number of design participants mentioning them.

67% out of all designers recommend that FM participation be achieved during design stage, in order to properly identify client requirements and translate them into useful design information. This would therefore result in having more satisfied clients and users. Being the most occurring purpose among all designer responses also suggests that designers are facing difficulties with defining what client requirements are and trying to meet them when designing, an issue that is also in line with what the findings revealed earlier concerning the most significant

consequences of non-involvement of FM during design stage. Unsatisfied clients and unhappy customers made the top of list of consequences stated by designers.

Purpose	Participants (Designers)
Proper addressing of client requirements (including those of users and FM) to achieve satisfaction	66.67%
Address sophistication in modern buildings and reducing complexity	46.67%
Improve the design output and increase design efficiency	33.33%
Minimize abortive work during construction and operation	26.67%
Achieve cost savings throughout the facility lifecycle	26.67%
Better selection of equipment and materials	20.00%
Extend facility lifetime	13.33%
Increase accessibility to various equipment for maintenance	13.33%
Optimize design decisions (Number of elevators or exits required, for example)	13.33%
Achieve a safe conflict-free hand-over of facilities	6.67%
Eliminate negative responses to designer questionnaires	6.67%
Optimize redundancy systems to reduce costs	6.67%
Produce a tangible brief measurable against the design	6.67%
Solve adjacency problems and how facility elements are related	6.67%

Table 10 Purposes of FM participation in design (as viewed by designers)

It is also worth noting that nearly 34% of designers are recommending FM involvement in order to increase the FM/design dialogue that leads to improvements in design and increases in design efficiency. This also shows that around one third of all designers interviewed are accepting the idea of introducing changes to their designs, triggered by FM input, in order to achieve a better output.

Facilities Managers

The same analysis was performed on responses provided by facilities managers regarding purposes for achieving FM participation in design, and the result came as follows.

Purpose	Participants (Facilities managers)
Achieve cost savings throughout the facility lifecycle	86.67%
Achieve efficient operation and maintenance	46.67%
Benefit from FM experience and knowledge	46.67%
Extend the facility lifetime	46.67%
Proper addressing of client and FM requirements to achieve satisfaction	40.00%
Increase accessibility for replacements and maintenance	26.67%
Increase clients' profit	26.67%
Reduce abortive work and retrofitting	13.33%
Increase the asset value	13.33%
Create a design selling point (having FM on design teams)	13.33%
Enhance the reputation of clients, FM and design firms	13.33%
Promote safety	13.33%
Ensure availability of spare parts	13.33%
Promote sustainability and environmental issues	13.33%
Achieve better designs	6.67%
FM are client's first hand and should be involved	6.67%
Increase coordination between design disciplines	6.67%
Provide FM with knowledge about systems early on	6.67%
Address leakage problems	6.67%
Address technological advancements in modern buildings	6.67%

Table 11 Benefits of FM participation in design (as viewed by facilities managers)

Nearly 87% of facilities managers mentioned cost savings in their responses. Whether it is through avoiding high operation and maintenance costs, optimising the FM service fees and personnel required, dropping the likelihood of failure or reducing cleaning costs, FM participation in design should result in reducing the costs incurred by the client.

“At the end of the day the design and construction part and land acquisition of a project normally only count for about 20% of the whole lifecycle cost of the building. FM counts for 80%, the operation and the delivery of the service. So obviously, if we can impact on that 20% we can reduce the cost and improve the efficiency of the facility whatever it is.

Results also show that facilities managers do care about the efficiency of systems operation as well as the efficient maintenance procedures that need to be carried out. Nearly 47% of them believe that participating in design would positively influence the efficiency during occupancy phase.

As it is significant for designers, 40% of facilities managers also consider client satisfaction and meeting client requirements to be one of the reasons behind their involvement during early project development stages.

Furthermore, designers and facilities managers were asked about the benefits of FM participation in addressing **project complexity**.

Several designers considered FM participation in design to be essential when it comes to multi-use facilities involving a large amount of different users. In addition, reducing the number of elevators, for example, could be achieved based on FM knowledge of traffic inside the building. Managing access according to the various facility functions and consequent users is another example.

Facilities managers stated that solving access problems, achieving system integration and communication, avoiding the use of scaffolding to maintain ceiling lighting systems, and insuring the availability of spare parts would contribute to solving complexity. One of the FM participants said that when it comes to chillers, the system may become more complex but would achieve simpler operation and maintenance.

5.4.2 Ways to Promote Inclusion

Based on participant responses, the best way to promote FM inclusion in design is the commitment of the client to get FM on board. “Clients should get the FM on board early on” was suggested by nearly 44% of all participants. The various ways to promote FM inclusion in design are displayed in Table 12.

In many cases, the FM team forms a part of the client organisation and is not necessarily an external firm carrying out FM services. Whether the FM is an in-house team or an external organisation where FM services are being outsourced, research participants consider that it is the responsibility of the client to trigger the issue of FM participation during design stage. The second most significant way to promote engagement is to have an FM consultant acting on behalf of the client during design stage. This solution also requires a client’s decision to get an FM body on board that is capable of advising the design in matters related to occupancy phase. In order for clients to make decisions involving FM engagement, they should be educated on importance of FM and the value of its engagement early on during project development. This relationship between clients’ education and the decisions made to engage FM also explains why client education is also significant, ranking third in Table 12.

Ways to Promote FM Inclusion	Participants
Client should get the FM on board early on	43.33%
FM could act as a specialised consultant on behalf of the client	20.00%
Clients should be educated on importance of FM at early stages	16.67%
Establish regulations, codes of practice and legislation forcing clients to consider FM during design	10.00%
Designers should encourage clients to engage FM early on	6.67%
Industry bodies (MEFMA, Global FM, etc...) should push standards	6.67%
FM Requirements should be documented and measured against the design (The preparation of FM-requirement manuals, etc...)	6.67%
Influence of investors and finance institutions in promoting FM input to increase asset value in the long run	6.67%
FM could act as a Commissioning Authority involved in advisory design review, value engineering, handover and contractors' post completion obligations	6.67%
FM should assure clients financially that the FM way is better	6.67%
Design contracts to mention that design should be FM-compliant	3.33%
Extend the design liability period, forcing designers to consider building use more	3.33%
FM consultants could be part of the design team	3.33%
FM should become certified to be competent in providing consulting services	3.33%
Push the use of Building Information Modelling through Integrated Project Delivery, to integrate the FM input	3.33%

Table 12 Ways to promote FM inclusion in design

5.4.2.1 Role of Project Management

Participants were asked about the role of project management in promoting FM participation in design. 71% of participants agreed that project management can help in promoting FM participation and the other 29% stated that PM has a different role to carry out.

According to participant responses, PM can promote FM participation through:

- a. Collaborating with design and FM consultants to create a link for the transfer of FM knowledge
- b. Enforcing FM participation as part of their role
- c. Helping in preparation of building condition reports that are necessary for FM take-over
- d. Incorporating FM within the PM team
- e. Informing clients about the risks associated with FM absence during design stage
- f. Recommending FM engagement to clients

It is evident that project management can influence the decisions of clients regarding FM engagement, and could also have a role in liaising between design and FM consultants. Nevertheless, no previous experiences were mentioned regarding any FM/PM collaboration. Participants instead welcomed the idea as having a positive effect if it were to happen on future construction projects.

As for participants who think project management rather has a different role, it is noticed that the issue of budget and schedule were thought to be the main concerns of project management. Introducing FM during design stage will most probably increase the construction cost and extend the time for completion, irrespective of what the effects on the finished facility and the long term operations would be. This increase in cost and extension in time act against PM and is not in their interest to suggest the involvement of FM, when at the same time their role is to ensure that the project is delivered according to budget and on time.

5.4.3 Mechanisms of FM Participation

Participants' responses reveal five alternatives related to the form of FM participation during design. FM participation may be performed through a:

1. FM team part of the client organisation (hired in-house)
2. FM company providing outsourced FM services to the client
3. FM company hired by the client to provide consultancy services
4. FM company/consultants hired by the designer as part of the sub-consultancy agreements
5. FM company/consultants hired by the project management organisation

This shows that the FM party meant to participate in design could be hired by the client, designer, or project management organisation involved during project delivery (Figure 11); although having the FM team hired by the designer may create a master-servant relationship. Such a relationship might negatively affect the FM's ability to influence the design in a situation where the FM entity is not an independent third party acting on behalf of the client. Figure 11 shows the different employers (blue) of the possible FM participating teams (green).

In addition, if the FM participating team is hired by the client, three different scenarios may arise. The FM team may:

1. Comprise FM personnel hired in-house
2. Be part of an FM organisation providing outsourced FM services
3. Be part of a third party consulting organisation

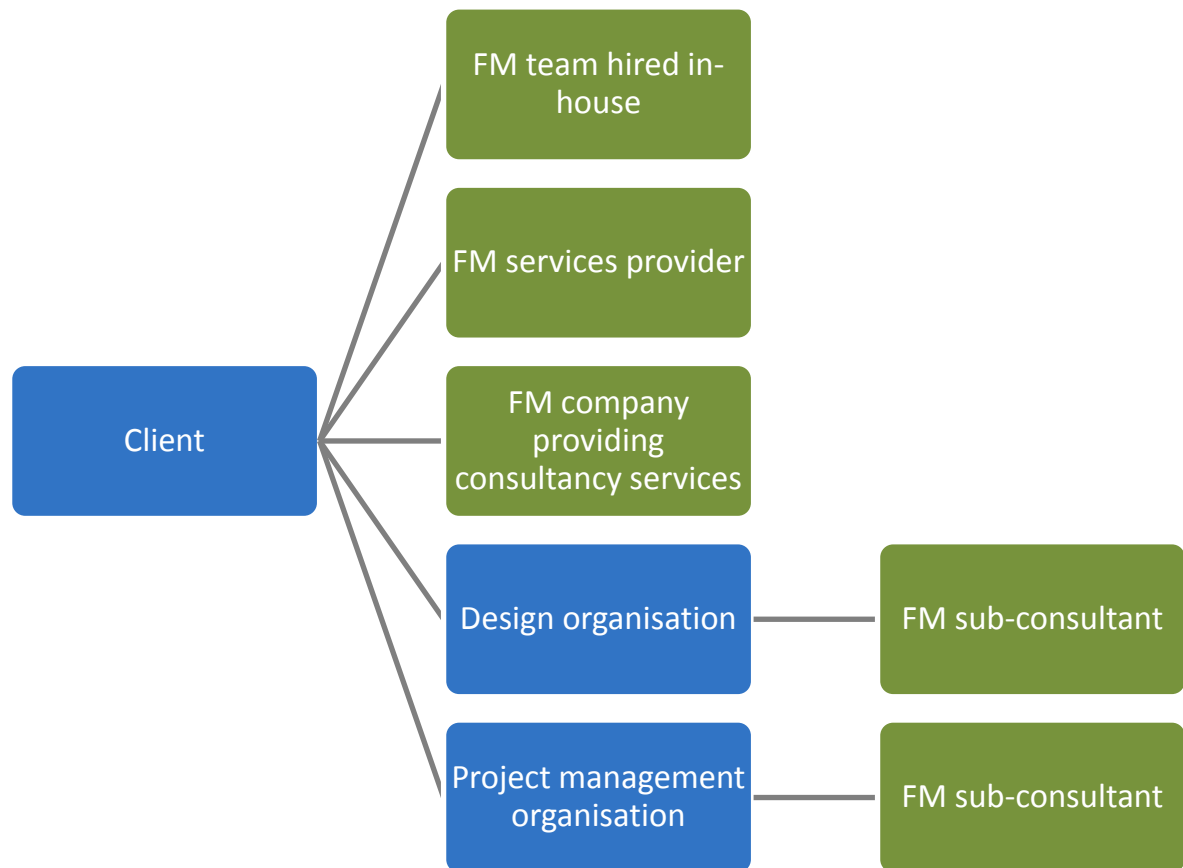


Figure 11 Various contractual models of FM participation

The first two scenarios represent FM personnel hired to carry out the provisions of the FM service contract during occupancy phase; while the third scenario represents FM personnel acting as consultants during project delivery, but are not involved in the actual future operation of the facility under construction.

In order to discuss the mechanism of FM participation during design stage, the timing of such participation as well as the various roles and responsibilities of FM personnel during the various design stages need to be presented in what follows.

5.4.3.1 Timing of FM Participation during Design Stage

Participant responses concerning the FM participation in design varied between programming/brief preparation, planning stage, concept, schematic, and design development. The main issue noticed was to engage FM as soon as possible to provide input when preparing the project program and participate in the selection of different design alternatives. This early involvement is essential for introducing changes on paper without affecting the detailed design and causing any abortive works. The role of FM should extend all the way from programming into design development, when FM people review drawings and sign off before these drawings are issued for construction.

“Whether its concept, feasibility, or detailed design. Throughout the process, no drawing should be signed off without the FM’s approval”

Some participants also suggested that it is essential for FM to get engaged from scratch to finish or in other words, during all design stages.

“FM should be integrated at all design stages” “From construction to finishing... so from the scratch to finish”

Therefore, the role of FM is not restricted to one specific design stage but instead, FM personnel should (in chronological order):

1. Be interviewed by designers as part of the end user groups
2. Participate in the preparation of the design brief
3. Check if FM requirements are incorporated in concept design
4. Review the detailed design submitted by designers
5. Review design drawings (Issued for Construction) prior to sign off and transmittal to contractor

When analysing participant responses, it was found that concept design was the most suggested stage where FM involvement during design should occur, or start to occur. Nearly 44% of all participants argued that during concept design stage, FM involvement would be most effective. The other 56% suggested participation during one of the stages of planning and brief preparation, schematic design or design development.

Participants were asked about the reason for the timing of FM participation they suggested. One major explanation was the fact that it would be more difficult to introduce changes at later stages during the design, resulting in abortive works and cost issues. The reduction of abortive works and the resulting cost savings are achieved due to the fact that as the design progresses, the level of detail increases; therefore getting involved at an earlier stage will result in lesser changes and a smaller amount of work and money required. Various other reasons were also stated by participants as presented in what follows:

- a. It is better to convey the FM recommendations to designers before the design starts. It is not anymore a matter of whether designers know about these requirements or not but instead, they have the recommendations and should take them into consideration as soon as they start designing.
- b. The sooner the FM requirements are stated, the higher the chances that these requirements will influence design. When the design is halfway complete, a lot of decisions that have already been taken can't be reversed and then FM requirements will not be considered.
- c. FM will not be able to affect major change during design development, as opposed to concept stage. Changes during design development are only simple things like direction of door openings, offices layouts or sufficient storage space, and the impact is minor. Whereas at the design concept

stage, changes to the location of a loading bay, lift shafts or service corridors are huge steps that can then be achieved based on FM recommendations.

- d. FM managers are less exposed to the effects of changes during design stage. Changes due to FM requirements could result in large impacts on systems integration, ducts and shafts alignment, etc... Therefore FM managers should be brought in as early as concept stage in order for their views to be incorporated in the design.
- e. “We as designers are very much annoyed if any participation comes at a late stage.”

Observing the various reasons stated above, it is found that in addition to the higher cost impact resulting from abortive work and the greater amount of effort required for introducing changes, it is nearly impossible for certain changes to take place at later design stages depending on the type of change required and its impact on the overall design.

Despite the fact that involvement during concept design is considered to be most effective, FM participation could take place throughout the entire project delivery and the role of FM would then vary according to obligations set by each stage.

5.4.3.2 Brief Preparation

FM participation during preparation of the design brief is translated in performing the following tasks:

- a. Document FM requirements and set operational parameters to be used for measurement against the design

- b. Prepare checklists for space, access and all other documented FM requirements
- c. FM descriptions should show measurable parameters for designers' use
- d. Provide guidance on equipment selection, requirements for access and operation
- e. Provide information on specific operation issues related to multi-use facilities
- f. Input on sustainability issues and determine the project's sustainability category (LEED Rating, for example)
- g. Participate in workshops usually held in the form of breakup sessions. Designers meet with their FM counterparts to take decisions related to all design areas
- h. Answer questions prompted by designers. Information is then recorded and included in the brief
- i. Coordinate with clients and users to make sure that all their requirements are included in the brief. Technical information should also be generated for designers to make decisions and be able to include those requirements in their designs
- j. Prepare a quantitative tangible brief containing performance criteria in relation to FM elements. For example, dB rating of walls should be scientifically stated

- k. Finalize the brief for client sign off

It is important that the FM team provides information that is detailed and technical enough for designers to be able to generate favourable outcomes. It is shown from the aforementioned FM tasks, that the information provided has to be scientific, quantitative and measurable against the design. This technical information would then serve as a common tool that takes FM and users requirements into consideration and can at the same time be utilized by designers to reflect those requirements on to the design.

In addition, designers argue that users of buildings, including FM, should not only state what they require but the reasons for their requirements as well. This would enhance the description of needs and consequently allows designers to propose the solutions that best address those needs.

“Not everything users say is used in the design, but they should tell us (designers) what the concerns are. Maybe we can identify a better system. Maybe they say we want split air conditioning, so that every room can have its own individual control. We can then say we can give you a more efficient system, for example, but you can still have the individual control. They should say what the concern is, what control they want.”

5.4.3.3 Concept Design

Following the preparation and transmittal of the brief to the designer, the designer presents the various design alternatives leading to the development of the concept design. The role of FM during this stage includes the following tasks:

- a. Ensure that FM requirements stated in the brief are actually reflected in concept design

- b. Participate in evaluating the various options and alternatives for different design schemes
- c. Check for feasibility, cost effectiveness and accessibility
- d. Provide input into the concept design report prepared by designers, on the various structural, electrical and mechanical systems to be utilized later in the design of the facility

5.4.3.4 Detailed Design and Construction Documentation

As part of the design review task during design development stage, facilities managers would get involved in the following:

- a. Review the generated design drawings using checklists created in previous stages and provide initials on every drawing. Design drawings related, but not limited, to the following systems should be reviewed by FM:
 - i. Architectural Layouts
 - ii. Finishes Drawings and Schedules
 - iii. Furniture Layouts
 - iv. MEP Systems
 - v. BMS System
 - vi. Lighting Layouts
 - vii. Water Distribution Layouts
 - viii. Elevator and other Conveying Systems
 - ix. Access Control Systems
 - x. Security Systems
 - xi. Fire Alarm Systems
 - xii. Soft and Hard Landscaping
 - xiii. Waste Management Systems

- b. Check for appropriateness of material, equipment, sustainability aspects, energy saving, power and water consumption, utility services, etc...
- c. Participate in design brainstorming sessions and workshops occurring as the design progresses, to give feedback on different design alternatives
- d. Participate in value engineering exercises
- e. Discuss design submittals with the designer; Design agreed and submitted for employer's approval
- f. Give preferences on the selection of options for new products introduced and discuss their suitability for the facility being developed
- g. Participate in the selection of lighting fixtures and materials based on FM capability to maintain such materials
- h. Comment on finishings, floor and wall tiles to check for durability and cleaning depending on the type of use and traffic within a certain area

Facilities managers should also take part in the preparation of the construction documents, and their role during this stage includes:

- a. Reviewing the "Issued for Construction" (IFC) drawings before these are transmitted to the contractor who is getting on board
- b. Assisting in the preparation of the project specifications to ensure the incorporation of all necessary FM requirements

Following the completion of the design, the FM has the role of producing policies, operational procedures and processes which should suit the design produced. These operational documents should be prepared for use by the FM service provider during occupancy phase, after construction is completed and the facility is handed over to the client.

5.4.3.5 Construction Works

The collected research data reveals that FM inclusion during construction phase can also add value to the construction process. During this stage, FM personnel should attend construction progress meetings held between the design consultant, contractor and project manager to help in resolving challenges and problems.

5.4.3.6 Testing, Commissioning and Handing Over

A number of participants emphasized the role of FM during handing over of the project to the client. Before the construction phase is finished, FM could get involved in the testing and commissioning process. The knowledge of how the building is performing would then be known to the FM team enabling it to maintain more efficiently and effectively. The FM involvement during testing and commissioning leaves the FM more aware of the actual performance of facilities and prepares the ground for a smooth handing over.

At this stage, facilities managers should also

- a. Facilitate the listing of assets and equipment and provide the proper format of the data to be included in O&M manuals for it to be compatible with the FM software used during operation
- b. Check equipment operation and whether this equipment is fit for purpose against the design intent
- c. Ensure proper delivery of O&M manuals and as-built drawings

- d. Ensure that legality issues are addressed and met before the facility starts operation

In case the FM entity involved during design stage happens to be different from the FM team that will run the facility when construction is completed, the FM team participating in design should then coordinate with the client's FM service providing team to ensure proper and smooth handing over.

5.4.3.7 FM and Design Integration across the Project Timeline

Following the discussion on the timing of FM participation during design stage, and the various tasks that should be carried out in order to achieve integration, the entire process is summarised in Figure 12 to illustrate the FM intervention during the entire course of project delivery and prior to the commencement of occupancy phase. Figure 12 is developed according to the data collected in this research and refers to tasks included in Sub-sections 2.4.3.2 till 2.4.3.6. The diagram represents a visual capturing that emerged from the data and summarizes the main FM tasks required during brief preparation and all the way through till occupancy stage.

The nature of FM participation changes as the project progresses depending on the requirements set by each phase, and the research shows that the role of FM is not limited to design stage only. The process commences with identifying FM, client and user requirements and documenting the same for transmission to designers. Collaborating with designers to ensure that the requirements are incorporated comes next, followed by the review of relevant drawings. During construction phase, facilities managers could also participate in construction progress meetings as well as testing and commissioning exercises to ensure proper building operation and the submission of appropriate documentation associated with handing over to the client.

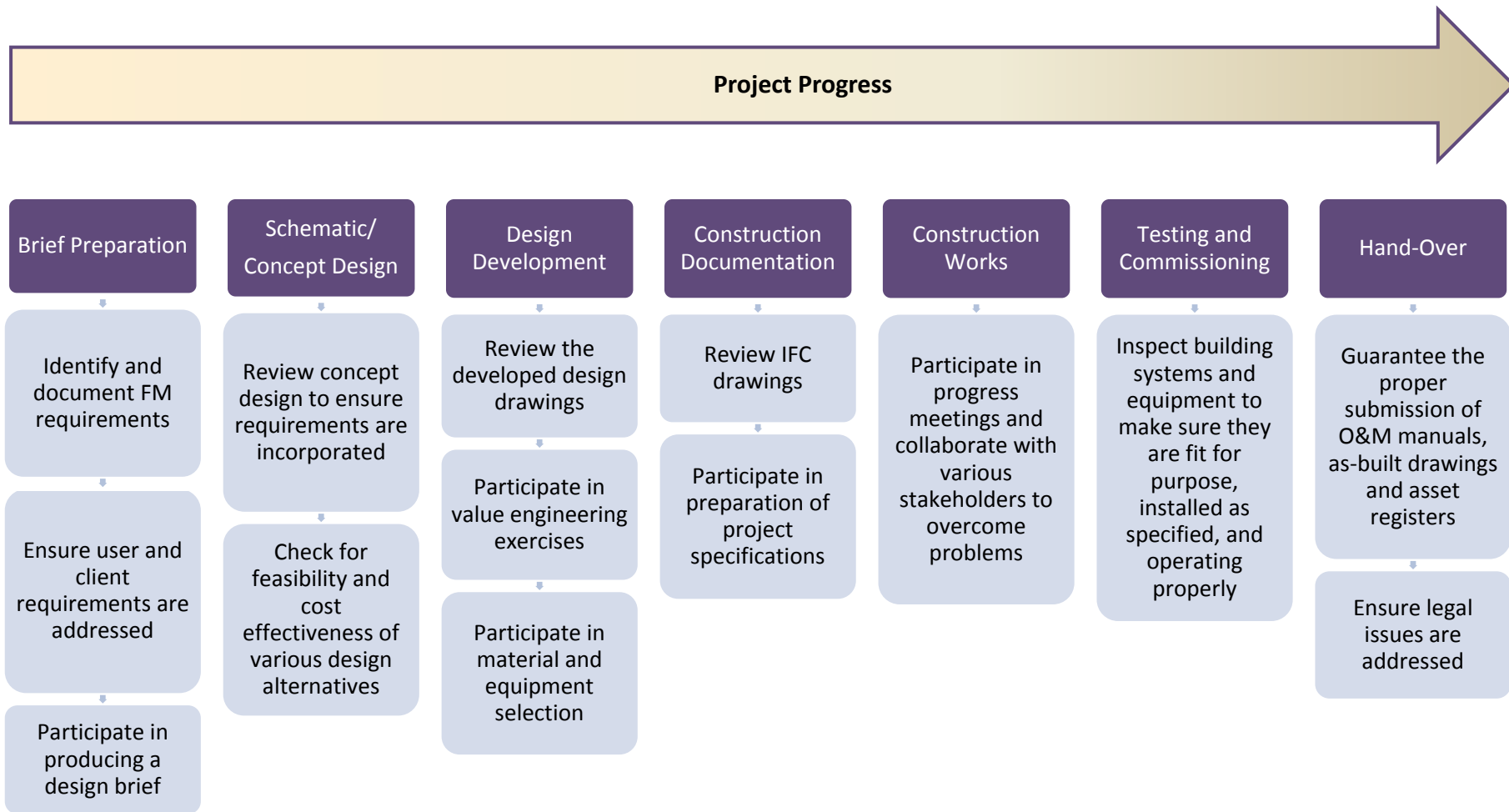


Figure 12 Role of FM during various phases of project delivery

5.4.4 Capacity of FM Participation

As presented earlier in Section 5.4.3 on mechanisms of FM participation, the FM team participating in design could be employed by different stakeholders such as the client, designer or project management firm. In all these cases, FM personnel participating in design are considered to represent an entity that is responsible for advising the design. Members of such an entity have to have certain experiences, qualifications and technical backgrounds that would render them capable of coordinating with designers, clients, users, project management firms and other stakeholders involved on construction projects.

Facilities managers participating during design stage should be able to understand the relationships between different FM activities and know how various systems such as fire alarm and lifts are integrated within a facility. This understanding of how things are done in practice helps in putting the knowledge into theory and transferring it to designers later on.

For design FM input in particular, FM team members have to have a consultancy experience alongside their technical experience, because the interface between FM, the designer and the client is very important to get the message across. This is important in the consultancy profession because it is not only necessarily what you say, but how you say it.

It is also important for those professionals to know how to contribute without impacting the designers' professional responsibility to design and the designers' own ideas and views of what the design outcome would be. The FM/Design collaboration would be negatively affected if the FM team simply comes along and requests changes without understanding what impact these changes are having on the other facets of the building. The combination of technical and consulting experiences would enable FM personnel to understand the various

interconnections between all building components, to effectively interfere in the design process and compromise without creating conflicts.

“On this project for example, one of the fundamental objectives of the design is to retain as much of the culture as possible, which is sometimes in conflict with a pure FM delivery solutions. You can make it look as nice as you want but if I can’t clean it, if I can’t operate it, it’s no good. But by the same token, I have to understand that this is an objective that has been set by the developer on the designer and we have to integrate and work together to achieve that objective. His objective and mine...”

5.4.4.1 The FM Participating Team

Participants mentioned various FM qualifications and job titles for personnel who should be part of the participation during the design process. The FM participation should be represented by a team that is experienced in various FM service types, and includes team members of different technical backgrounds and qualifications.

“FM participation during design has to do with MEP, architecture, interior fit-out, operational aspects and to reduce costs... it is a very large spectrum and you will not find so many people on this planet who are capable of doing this alone... they need also to be supported and be a team to cover all different areas of the consultancy scope.”

More than one research participant considered the FM manager to be *“a jack of all trades”* and *“the master of none”*. He/she has got to have a little bit of knowledge on the building design and engineering, building services systems, an appreciation of the aesthetics and the visual looks that the architects try to achieve, in order to influence all that in the best way possible.

Analysing participant responses revealed various FM team formations that could participate during design stage, as shown in what follows:

- a. All FM department heads
- b. FM consultants with 5 or more years of practical experience or who are at a senior level
- c. Team of soft and hard services specialists. Soft service specialists in charge of cleaning, storage areas, security, waste management, landscaping and pest control. Hard service specialists mainly in charge of operation and maintenance
- d. Generalists looking after cleaning, catering, mailroom and office supplies
- e. Fire specialists and elevator experts
- f. FM cleaning and a maintenance management team
- g. MEP specialists/engineers
- h. MEP, civil and specialists covering all aspects of engineering. Chemical Engineers to look after waste management systems
- i. Team comprising specialists for MEP, fabric, health and safety and FM soft services
- j. Team of engineers (HVAC, electrical and civil disciplines) and general maintenance specialists

- k. Team comprising one lead technical advisor (from an engineering background), one soft services specialist (to look for access points and storage areas, etc...) and one senior FM manager (site manager, from a workflow and operational perspective)
- l. FM building systems specialists to interact with IT designers, as well as electronics and media specialists

The above represent various configurations of FM teams that could participate during design stage. It all depends on the type and size of a project as well as on the client and how specific he wants the FM requirements to be. The type and size of projects as well as the nature of clients' requirements would then determine the size of the FM team and the necessary qualifications and specialties of all team members.

5.5 Achieving Integration outside Facility Boundaries

Numerous suggestions were provided by participants on measures that could be taken to promote knowledge exchange between FM and design and consequently achieve integration.

Arranging conferences to get FM and designer professionals together was one of the most suggested measures.

“Any opportunity for people to come together and share views, to debate and discuss, that’s really useful because we (FM people) are very much in isolation... because we’re now using our personal relationships rather than anything professional... rather than professional ones.”

Another equally significant measure is the need for university training and continuous education, to update knowledge and skills of both design and facilities managers.

The issue of producing FM codified knowledge was significantly addressed by research participants in suggesting ways to document the knowledge and share it with other industry-related professionals. FM codified knowledge could be created through:

- a. Producing standard national performance data related to the national market. This data developed by facilities management could be used by designers to benchmark the design performance
- b. Preparing data sheets, references or guidelines on general FM issues to be considered in design and issuing them to architects through engineering societies and on-line media
- c. Creating universal FM requirement documents for different types of facilities
- d. Preparing do's and don'ts for designers and clients
- e. Writing books, magazines and journal articles on FM issues that should be considered in design
- f. Establishing an effective knowledge management system within FM firms to promote the creation and flow of information between the different strands of business. Lessons learnt when managing the FM service provision should be transferred to consultancy services and vice versa, and the information should also be passed on to other arms of the business such as

the home owners association where FM represent home owners during operation and make sure they are getting value from money

Other suggested measures to achieve integration provided by participants were as follows:

- a. Establish FM and design joint ventures and partnerships that promote knowledge exchange and collaboration
- b. Associations such as RICS, IFMA, MEFMA as well as LEED to promote FM, in an endeavour to increase the ability of delivering clients' end needs
- c. Arrange seminars and workshops that would get facilities managers, designers and even clients together
- d. Open communication channels among designers and FM managers to create exchange programs via emails and the internet or by forming interest groups to attract professionals
- e. Open knowledge exchange channels between the private and public sectors on FM issues and experiences
- f. FM industry bodies to educate clients on the importance and value of FM. FM associations should also approach clients to sell the FM service and highlight the benefits of engaging FM during design stage
- g. FM to approach civil defence and improve and increase laws and regulations to enforce FM participation during design stage

- h. Clients to get the FM involved during testing and commissioning of newly constructed facilities, allowing communication with designers and helping FM to understand the design criteria
- i. FM to arrange de-briefs with designers during occupancy phase to transfer FM concerns
- j. Engineers to practice FM at early stage in career
- k. FM to approach designers and inform them about FM and participation during design
- l. FM to get A-class certifications to be able to provide consultancy services
- m. Utilize Private Finance Initiative (PFI) strategies which require that the construction contractor provides FM services when construction is completed. Similar strategies would force design and construction firms to plan for operation early on and communicate more with facilities managers
- n. Designers and facilities managers to seek training on the differences between various professions and the relevant inter-relationships taking place between representative teams
- o. Investors planning for future developments to keep designers on board the FM team during operation phase to gather occupancy-related information for future use
- p. FM societies to target and involve key clients and people who have the right influence in society; a matter which could help the FM profession to progress faster

5.5.1 Some Already Implemented Measures

A number of measures are already being implemented in the Middle East to address the awareness issue. Based on participant responses, these measures include the following:

- a. Focus groups in collaboration with MEFMA are already established involving a number of FM companies. Action plans are being prepared to educate the clients in general about the FM culture and to show the benefits of FM and the advantages of hiring an FM.
- b. Qatar Sustainability Assessment System (QSAS) and Qatar Green Council are both initiatives towards creating sustainable environments and energy savings.
- c. MEFMA in Dubai is lobbying the government in order to introduce FM. Actions are also taken in terms of Strata Law.
- d. An AM radio station for facilities management, providing questions and answers about tenant complaints is broadcasting in United Arab Emirates (Dubai).
- e. Formation of workgroups on energy conservation and the average operational cost/m² to maintain facilities is also currently facilitated by MEFMA.
- f. The Real Estate Regulatory Agency (RERA) in Dubai is currently interacting with MEFMA in checking the buildings' designs and future maintenance. RERA has in-house facilities managers who are consulted when checking the designs before they are issued for approval by the municipality.

CHAPTER 6 | **DISCUSSION**

This chapter mainly provides a discussion of the research findings against the knowledge available in the literature. Interpretations are made by the researcher and new information that the findings suggest are also presented. Interpretations are included here rather than in the findings chapter to avoid any researcher subjectivity when documenting those findings.

6.1 Distant FM and Design Relationship

Research participants, whether designers or facilities managers, mainly agree with the views presented in the literature (Ercoskun and Kanoglu, 2003; Hien et al., 2003) regarding the unidirectional construction process resulting in poor integration among various stakeholders and causing FM and design to be seen as two different process occurring at different stages.

“I think there is a huge disconnect. Facilities management deals with clients. Most of FM, they don’t get involved in the design stage early on. If the facilities management needs some kind of a system, the designer was never informed about it. So there’s actually disconnect.”

Designers reveal that the FM team would still be unknown during design stage.

“There is hardly any communication between the facilities management and the designer in the Middle East. There are very few requirements and communication as to who is going to manage the facility in the future.”

Facilities managers confirm that designers would do their job and move on before the FM service provider gets appointed and enter the finished facility. Participants also agree that the two entities, FM and design are independent and that their relationship is distant and nearly non-existent.

The increase in popularity of user involvement though, mentioned in the literature (Stappers et al., 2009), is also confirmed by respondents when discussing the signs of increased FM/design communication through increased client awareness, sustainability input and the rise of FM communities in the Middle East that are starting to initiate discussions.

“...But clients are starting to wake up to the fact that the facilities team needs to be part of the client team at the design stage. You know briefing, understanding client needs, etc...”

6.1.1 Facilities Management Role

It is noticed that some designers, and although they say that FM participation in design is uncommon, are serious about the need for FM engagement in design and willing to consider facilities management when designing.

“We take FM seriously but I don’t think we integrate it enough in our design work.”

On the other hand, many FM responses are actually complaints that FM is not being involved.

“...what I see is that when it comes to a new building, we have never been invited at a design stage to add any comment or feedback on the design.”

FM not being seen participating in the production of design solutions and the FM role being neglected during design stage are observed in the literature (Jaunzens et al., 2001; Martin and Guerin, 2006). Research participants agree with these views when designers state that it is common to develop the design without any FM participation. Facilities managers add that the FM role during design stage is rather neglected.

“I’m not aware about any particular FM involvement in design. I hadn’t been aware of anything in the Middle East. My personal gut feeling would be that I don’t think there’s any consideration for FM in the design stage.”

The communication gaps between users, clients and owners presented in the literature (Tzortzopoulos et al., 2006) are also reflected in participants’ responses when stating that there is a disconnect resulting in designers not being informed about FM requirements.

“At the time when we are designing, we do not deal with FM... and the FM procedures would not be in place during this design stage.”

Another issue affecting the definition of FM requirements as part of the overall client requirements depends on the type of clients involved. Literature (Darlington and Culley, 2004) discusses various clients’ levels of clarity with respect to requirement definition and that sometimes clients haven’t got a clue about detailed requirements. Research participants illustrate this matter when discussing the involvement of first-time clients who are new to the business and the low chances of them engaging any FM participation.

“Unless I’m mature enough to bring all those teams together, this will not happen. I will then employ a designer and then a contractor to construct it, and then a few people who will attend to the complaints from the users and tenants... depending upon the maturity of the investor...”

6.2 Follow-up on Design Outcomes

Nearly 50% of all designers interviewed had no previous involvement during occupancy phase. The other 50% are involved at least once, at various levels, but

mainly following project completion at a time when the facility has not been fully occupied.

FM responses in turn, showed that evaluating building performance from a design perspective was an uncommon task to carry out. This shows either an absence or an incomplete evaluation of design-related project outcomes carried out by both FM and design professionals and reflects Fianchini's (2007) observation that the reasons for having facilities not fit for purpose are not only the absence of user-participated design decision making, but also the limited follow-up and evaluation of project outcomes.

Designers declared that they do not follow up enough on design outcomes of projects while facilities managers stated that evaluating buildings from a design perspective was something uncommon to do.

Literature also reveals that post occupancy evaluation is often considered a low priority concern for facilities professionals (McDougall et al., 2002); an issue that was confirmed by FM respondents who affirmed that facility evaluation is a task that needs to be performed more.

“This sort of work is something that we need to do more of... To monitor and record the performance of various types of equipment.”

The issue of the lack of financing for performance measurement observed in the literature (Eley, 2001), is also discussed by facilities managers who stated that clients are not formally involved in post occupancy evaluation. The lack of interest of clients in evaluating building outcome in relation to design directly affects the fees paid to FM service providers who would not get paid if they carried out evaluation exercises of this sort.

“Post occupancy, from my point of view, clients in general terms don’t really get involved in a formal basis.”

6.2.1 Building Evaluation Tools Used

KPIs, as the literature states regarding tools used during post occupancy evaluation (O’Neill and Duvall, 2004), were suggested by FM and design respondents as being tools to evaluate building performance.

Designers also mention the use of questionnaires and client satisfaction surveys which are also discussed by McDougall et al. (2002), while facilities managers suggest the use of occupancy analyses to evaluate the outcomes from an FM point of view.

It is also worth mentioning that preventive and corrective maintenance procedures constitute the main response provided by facilities managers when asked about building evaluation; although such procedures are done on a regular basis and regarded as part of the FM service provided rather than used to evaluate design outcomes.

“We do not have a system of evaluation at this point in time. We take what is given to us, and we use it; planned preventive maintenance and regular corrective maintenance.”

Facilities managers also provide tools to evaluate the FM service itself and the performance of the FM team, such as audits and service level assessments, rather than the performance of the building.

Although several FM and design professionals mention the sustainability related term “LEED” during the interviews, none did clearly suggest their involvement in environmental assessment and the use of tools such as BREEAM, discussed by

McDougall et al. (2002). The outcomes from energy and asset management systems are only “suggested” by facilities managers as tools that could provide information on building performance in relation to design.

The Soft Landings approach described in the literature (Way, 2005) is found to be nearly unknown to research participants who are unaware of the term and its application in the Middle East. The approach that gets the designers in contact with FM during occupancy phase and opens communication channels for knowledge exchange is only suggested by one respondent as a tool for collecting occupancy-related information; although not personally experienced or applied by the aforesaid respondent in the Middle East.

6.2.2 Future Designs

When designers are asked about the future utilisation of any information gathered about occupancy phase, they all agree with the literature (Ellis, 1987) that the information gathered should be stored as lessons learned and used on future projects where applicable. Literature observes that occupancy evaluation exercises have a planning aspect directed to the future rather than the present, through accumulating information for undetermined future designs.

Designer responses reveal a barrier to the generation and storage of lessons learned, specifically in relation to the Gulf area. Design firms face difficulties in maintaining their staff which results in the loss of design know-how related to problems and mistakes encountered after a facility is occupied.

“The know-how in design companies is not easily maintained. You can maintain drawings or standards... but the know-how itself and lessons learned is very unlikely to be saved. The turnover in staff is very high... in the personnel.”

As examined previously when discussing the target population for this study, around 60% of the top 200 international design firms operate inside the Middle East. The high number of design firms operating outside their home land, as well as the high construction activity which continuously creates new job opportunities in the Middle East could also be preventing design firms from maintaining their staff.

The views of FM respondents are different from those of designers, in relation to future utilisation of gathered information. Facilities managers focus on enhancing their current practices during the course of service delivery through developing maintenance plans, monitoring energy consumption, benchmarking, responding to clients' inquiries or preparing tenders for future FM service contracts. None of the facilities managers had previously gathered any building performance information for the purpose of inputting the same into future facility designs, although some regard this as a good concept for enhancing future designs.

“It is a good concept to get these information to the designers so that they know the consequences of the systems they are about to use in a particular building. These are the consequences of this system and they know what will happen to the system they are designing for.”

6.3 Facilities Management Knowledge

FM-related issues that should be considered during design stage, in order to overcome problems during occupancy phase, are obtained from all research participants. These FM issues are comparable to a list of common operational problems obtained from a study found in the literature (Jaunzens et al., 2001) that was carried out to identify the problems which could be overcome if dealt with during design stage.

These problems addressed by the literature mainly list electrical and mechanical services and equipment, fabrics maintenance, delivery of goods, waste management, landscaping, public health services, finishes, layout, fire safety and the procurement process. Problems generally deal with operation and maintenance, space layout, health and safety, and project procurement. Table 13 shows the topics addressed by both this research and the study found in the literature.

FM Issues to be Considered during Design Stage	
Literature	Research Findings
	Customer Satisfaction
Problems with mechanical services	Operation and Maintenance
Problems with electrical services and equipment	
Problems with fixtures and fittings	
Problems with the building fabric	
Problems with public health services	
Problems with deliveries and waste management	
Problems with landscaping	
Problems with layout	Space Layout and Flexibility
Problems with the procurement process	
Problems with fire safety systems	1 issue only
	Energy Efficiency
	Sustainability
	Ergonomics

Table 13 FM-related Issues: Comparing literature views to research findings

When comparing the two lists, it is deduced that operation and maintenance issues as well as space layout are covered in both lists. Operation and maintenance is covered in more detail in the literature as the relevant list mainly presents “operational” problems that could be avoided during design stage. Issues

related to customer satisfaction, sustainability, energy efficiency and ergonomics considered in this research as main FM-related concerns are almost absent from what the literature lists as operational problems to be dealt with during design stage. Literature on the other hand expands on fire safety issues which are only addressed by respondents through the issue of fire and emergency exit locations and escape routes.

The differences portrayed above are also related to the fact that the issues meant to be addressed during design stage as discussed in the literature, deal more with the problems faced by facilities managers as a result of operational issues inadequately addressed during design. Conversely, this study inquires about design issues that relate to or could affect the FM service delivery as proposed by both facilities managers and designers who participated in the research. Problems faced by FM managers throughout the procurement process are also mentioned in the literature; however such problems are not FM-related aspects of facilities that should be considered during design stage.

6.3.1 Taking Facilities Management into Consideration

Incorporating FM-related data into design processes highly depends on who clients are and the level of requirements they wish to put forward. Respondents assert that issues such as external facade cleaning and access to air conditioning systems are not specifically required by clients. This again confirms the observation done by Darlington and Culley (2004) concerning the influence of client types on the design requirement process.

Clients have different levels of clarity in relation to the design they require and if clients are not clear about aspects of façade cleaning or access to air-conditioning, then these aspects will not be part of the client requirements constituting the design brief. Conversely, when the brief is properly prepared by clients and clearly states the requirements, then these are often integrated in

design decisions. This reflects how stringent and aware the client is regarding what is required, and the various issues that need to be communicated to designers at early stages of design.

“With one of our clients we do this most of the time, and their brief is very stringent.”

Over and above Darlington and Culley’s (2004) client types affecting design requirements, both FM and design professionals emphasized the difficulty in implementing sustainability measures. As participants describe this matter to be Middle East-specific, clients do not seem to be interested in sustainability implementation for the purpose of receiving benefits, but instead to create an image that the facility is sustainably certified. One of the main factors contributing to this reality, more common in oil-rich Gulf countries is the low energy prices that hinder the implementation of energy efficiency and sustainability matters.

“In the Middle East, you know because the cost of utilities is not seen to be excessive, the desire for sustainability and energy efficiency is not great.”

Practical solutions such as LED lighting, facade insulation, reduced use of glass facades are still not seen to be very widely addressed.

Facilities managers argue that the current consideration of FM-related issues is also obstructed due to the fact that designers sometimes rely on previous designs and the process would then be repetitive, not allowing for any external input. The requirement definition process in this case is affected because of problems in stakeholder relationships (Darlington and Culley; 2004), leading to poor involvement of all project related parties, FM in this case, as Kamara, Anumba and Evbuomwan (2000) discuss.

6.3.2 Knowledge Sources

FM and design professionals agree on the issue of designers' own experience and knowledge as the most important source of information related to incorporating FM into design decisions. This also confirms Martin and Guerin's (2006) views who mentioned that FM personnel are not seen interfering in the production of design solutions and are relying on designers to take action in benefiting from research practices in design.

It is currently up to the designer to introduce any FM-related information that would be stored in the brain as knowledge and experience in tacit form, or explicitly stored in design databases. Although respondents do refer back to international standards, sustainability requirements and various building codes and regulations, FM requirements are still not separately presented within building standards and regulations to address the concerns of facilities managers during occupancy phase.

“Designers design according to what is available. Once there is a new trend of LEED for example, they have to stick to it. But LEED does not address certain O&M and management issues. They only address architectural and environmental issues.”

When only one designer states that information on operation and maintenance is obtained from FM operators, this reflects the weak communication between facilities management personnel and designers and their nearly non-existent collaboration during the design stage of a facility.

“We do get information from FM operators on O&M and other information from the client on the space layout and flexibility when he is a hotel expert.”

Design participants blame the FM community that the absence of information related to FM operation is somewhat due to a lack of FM references available for designers to use; the reason being that FM people are not doing their homework and advertising their know-how.

“FM knowledge is the know-how of each company... and they will not advertise it... I don't want to say sell it... but they do not want to expose it.”

6.3.3 Barriers to the FM Knowledge Transfer

6.3.3.1 FM Related Barriers

Literature's view on the FM loss of identity (Yiu, 2008) affecting the FM and design integration is verified by FM respondents. FM companies provide services ranging from cleaning or catering only, to services of an integrated nature covering the management of an entire facility including mechanical, electrical and plumbing (MEP), cleaning, security, parking management, etc... The various definitions of what an FM company provides affect the type of input that these companies are able to offer and the overall database of FM requirements in relation to design.

“FM are not cleaners, are not security people, and are not two guys with a bucket and a mop calling themselves facilities managers. It's not maintenance, facilities management is an integrated science, an integrated discipline that actually looks after an asset and extends the life of an asset through maintenance, through cleaning and through all sorts of things... asset management and planning, preventive maintenance, revenue generation, all of these things that actually define what a facilities management company does, it's not a cleaning company.”

FM's incompetence is observed by clients and this creates a problem in the recognition of FM value whereby FM is then regarded as an added cost that clients do not need. This also confirms McLennan's (2000) examination of the absence of a feedback loop (from operation back into design) mainly caused by

the fact that FM is not viewed as a core activity but instead, an activity having cost implications.

Facilities management is also seen as a second or poor cousin to design, as respondents reveal, a matter discussed in the literature through Malatras et al. (2008) who argue that building services are traditionally considered to have limited scope and provisions for advancement.

Moreover, the post-occupancy and building performance evaluation which FM respondents admit they need to do more of concurs with Fleming's (2004) observation that facilities management often focuses on the building's technical performance rather than the observation carried out by the facility occupiers. The main concern of FM respondents regarding evaluation relates to the parameters affecting the FM service provided and not design aspects affecting the operational ability of buildings in meeting client and user expectations.

In addition to the barriers presented in the literature, respondents discuss barriers such as the infancy of FM industry in the Middle East. FM and designer participants agree that FM market is still premature, affecting the performance of facilities managers.

"I think FM is a new idea in the Middle East and the design people have to get used to the fact that companies are getting FM to maintain their assets and they have to start to realise that they should listen to these people (FM), because they are the end users of their designs."

There is still a lack of knowledge on practical application and experience which in many cases negatively affects how clients see facilities management and prevents them from hiring FM to advise on design-related issues. The premature market can also be linked to the fact that in the Middle East, clients are still hiring building

contractors to carry out operational-related services for buildings they have just finished constructing. This also prevents FM firms from being involved in any phase of the entire facility life cycle.

Furthermore, designer participants are seen accusing facilities managers of keeping their information to themselves because FM managers think that if they document the knowledge then they will not be asked for their expertise anymore. The absence of an FM knowledge base affects the FM performance (Nutt, 2000; Yiu, 2008) and hinders the management of knowledge and the transfer from FM to design.

6.3.3.2 Design Related Barriers

Besides the barriers correlated with the FM side, literature discloses barriers linked to the design side as well.

Way's (2005) observation that designers are not usually interested in gaining any knowledge of building performance at occupancy stage is reflected in research participants' responses. Both facilities managers and designers mention that designers do not see benefits for themselves in engaging FM during design stage, and that the main concern is the design itself rather than operation.

“There have been some great designs and as a design it works great but as an operational tool it failed. I think that is the biggest problem... that designers need to have more appreciation of the challenges in using the space, just purely using the space.”

It is unclear whether research participants, when asserting that designers mainly concentrate on producing a building that looks fancy and satisfies the client, are specifically referring to clients in the Middle East.

Designer participants stress on the fact that they are not willing to incur extra cost for retrieving FM and operational information, especially if their fees do not allow for such efforts. As a result, FM participation then becomes an additional workload that designers do not wish to take. FM participants on the other hand mention that quite often designers leave the project even before snagging starts, at a time when the FM service provider has not yet been appointed. Such cost and time issues are in line with Smith et al.'s (2004) discussion that the act of bridging the gap between designers and user needs is obstructed due to time and budget constraints.

In addition, designers do not in many cases meet with all relevant stakeholders when producing designs, participants say. Ignoring the FM presence during design stage directly affects any FM participation, same as Erdener (2003) sees the FM position within the whole process still being ignored.

Another barrier discussed by research participants which confirms what literature presents, is the designers' perception of what the requirements for building usage and operation actually mean. Tzortzopoulos et al. (2006) emphasise that the reason behind gaps in communication between facilities managers, designers and clients is due to the absence of a common language leading to the designers being criticised for not being able to interpret business needs of clients. Designer participants provided examples during interviews on this absence, when FM managers for example, might have requirements for durable equipment which could be interpreted by designers as equipment with the highest cost and the longest warranty.

Facilities managers agree with designers on the above mentioned variance in the interpretation of needs.

“The rating of each filter is maybe 4 or 5 times more than what we need here. And on top of that, we have the maintenance of 8 filters instead of only having 2. So why are we having 8 filters to maintain? This is the question.”

One of the barriers not clearly stated in the literature but presented by research participants, is the issue of designer education. Design students in the Middle East do not seem to be educated on the importance of FM services, and FM issues are not something that design students would ever think of.

6.3.3.3 Client Related Barriers

Almost all respondents when asked about the barriers to FM and design integration discussed the issue of clients' lack of knowledge and awareness on the importance and value of facilities management as whole, and its role during design stage specifically.

“Convincing the owner to have FM on board once the design is still being evolved... That's the hurdle number one and it's a principle hurdle to be honest.”

Among all barriers that research participants provided, client determination to get the FM involved during design stage, seems to be the most serious issue. If the client has no intention to involve FM at early stages during project development, then no integration will most probably happen. After all, the client is the one to pay the fees of all participating parties. If the client does not push FM involvement then designers, and due to the highly competitive market, will not raise their fees to allow for any FM involvement. This explains the observation found in the literature (Jensen, 2009) that highlights the importance of clients' role in using power to ensure that the requirements of facilities management are seriously considered by design teams.

Various reasons discussed by research participants shift clients' attention away from FM and design integration, apart from the lack of knowledge. Culture and the attitude towards construction in the Middle East are also considered barriers that respondents agree on. Due to the high budgets available, there is the ability to construct facilities which would not last more than 25 years, and demolish and replace them after this period.

“Frankly in this part of the world if a building doesn't work they demolish and build another one. I think you can tell that by the style of the design, especially the integration between facades and electromechanical installations. Here we just pump in tons of cooling into a building and not necessarily consider how you can design the facade to make it more efficient for example.”

This matter consequently affects the attitude towards maintenance and the diminished attention given to life cycle planning. Attitude though, depends on whether the client is the owner and occupier of the facility being built. The chances of realizing FM and design integration are higher when the client is the owner as well as the occupier of the facility, as this increases interest in long term operation especially the cost of operation.

“If he's a developer occupier for a 25 year period for example, he would be more aware of the considerations required for what it is to make a building as economic as possible.”

FM and design professionals both agree that clients in the Middle East are highly interested in aesthetics, especially facades. The implementation of glass facades, highly requested by clients, negatively affects FM aspects such as sustainability and energy efficiency.

6.3.4 Consequences of Insufficient FM Knowledge Integration

Problems in operation and maintenance of mechanical and electrical systems, fabrics, material selection, space layout, landscaping, safety, etc. are all issues provided by research participants and also discussed in the literature (Al-Hammad, Assaf and Al-Shihah, 1997; Jaunzens et al., 2001; Cullen, 2007; Afacan and Erbug, 2009).

Asking participants specifically about the most serious and frequent consequences following the inquiry about consequences in general, provides the chance to cross check and confirm the ones that are most significant. When cross-referencing between consequences provided by FM and design professionals mentioned in the findings, it is found that some issues make the list almost every time.

Interrupted/dissatisfied users, unavailability of spare parts, improper consideration of FM requirements, system operation problems and inefficiency and difficulty in access for cleaning and maintenance appear whether through analysing participant responses to identify the most significant consequences, or when directly asking participants about the consequences they consider most significant.

“It would be good for me to know how they (designers) thought we are going to clean those windows on the second floor.”

In addition to consequences related to the FM service itself as presented by Jaunzens et al. (2001), respondents also provided consequences disturbing users and clients. Interruption caused to users and their dissatisfaction due to an affected FM service, the loss of profit facing clients due to a lower asset value or tenancy rate are also consequences resulting from lack of FM and design integration.

“When the tenant comes inside he has a lot of complaints. Tenants cancel their tenancy contract because the FM is not able to attend anymore to all the problems, too much load and complaints... and the client loses in the profit.”

6.4 Why Promote FM Inclusion in Design?

Designers participating in this study mostly agree that addressing client requirements and attending to building sophistication to reduce complexity are main benefits to the FM and design integration. This confirms Martin and Guerin's (2006) observation that standard design processes are insufficient nowadays in resolving complex issues and requirements and shows that designers currently face these problems in practice.

Moreover, participants agree with Jaunzens et al. (2001) and Heywood and Smith (2006) that integration results in meeting client and FM requirements and expectations. Cost savings are emphasised by both FM and designer participants and which could be achieved through increasing building and equipment efficiency and reducing abortive work and retrofitting. Simultaneously, clients will benefit from increase in profit, better reputation and a higher asset value and FM managers will benefit from a more efficient building operation and maintenance.

The thought of cost savings is presented by McDougall et al. (2002) who discussed the 1:5:200 ratios developed by the Royal Academy of Engineers. Costs incurred when running the facility are 5 times the costs of design and construction. Therefore, cost saving initiatives occurring during project development will result in greater savings during occupancy in both FM and business operations. Research findings reveal a 20% design and construction cost versus 80% maintenance and building operating costs. The ratio provided by research participants is very similar to that in the literature, and is regarded as a main purpose for achieving FM and design integration.

Adding on to the benefits discussed in the literature, this research reveals that integration also benefits designers involved. Both designers and facilities managers discuss benefits such as better designer reputation, creating a design selling point (having FM on design teams), better design coordination and eliminating negative responses to designer questionnaires.

“...Because at the end of the day a lot of negative responses come because we [designers] don’t have the proper input, we don’t have the interaction of the FM during the design phase so surely when the building is handed over, we discover that many areas are not dealt with. So the involvement of specialists at the early stages is critical.”

Therefore, FM and design integration should not only occur to benefit facilities managers and building occupiers, but also designers through achieving better overall design outputs.

6.4.1 Measures to Achieve FM Inclusion

Participants’ responses to the issue of promoting FM inclusion in design and the participation of FM during design stage reveal that clients’ awareness, education, and responsibility of getting the FM on board appear to be the most significant. The responsibility seems to rest almost entirely on clients who are generally not knowledgeable enough to decide on employing an FM at early design stages, rather than after the construction is completed.

It is also noticeable that in terms of accountability, the responses mainly reflected actions that need to be taken by either clients or the FM community in dealing with the situation, with no major blame put on designers. On top of the increased effort that clients need to put, FM bodies and professional organisations are also required to effectively demonstrate the FM value to clients, document requirements for designers’ use, and push FM standards in an endeavour to

incorporate the FM point of view in building designs. Respondents do not see that designers would have much to do in this case, other than employ an FM consultant on their team to provide the FM input. As discussed previously and due to losing the competitive edge, incurring extra costs due to additional fees charged by such an FM consultant on board the design team is not likely to happen, if designers are not compensated by clients who do not recognise the extra effort put in by those designers.

Respondents agree with the literature observations (Nutt, 2000; Jaunzens et al., 2001; Erdener, 2003; Smith, Love and Heywood, 2005; Bogers, Meel and Van der Voordt, 2008; Jensen, 2009) that facilities managers should be present during design stage and engage in the preparation of the design brief in order to inform designers about FM considerations and constraints and overcome the design limitations and consequences on facilities management operations during occupancy phase.

Conversely, respondents' views vary when the topic of combining FM and project management is presented. The majority (around 70%) of respondents agree with Brown, Hinks and Sneddon (2001) who proposed enhancing the project management process through making use of FM competence and combining FM and PM key elements or teams. Research participants consider that PM can promote FM participation in different ways such as being the link between FM and design, enforcing the FM participation, incorporating FM expertise within PM teams or recommending FM participation to clients.

“As a project manager, my role is to make sure that the right people are involved, and that if they’re not engaged we need to inform the client that we need this. It’s our role to direct the client and advise the client that these are the elements and these are the risks associated with NOT employing somebody.”

The remaining participants disagree with the literature on the basis that budget and schedule are main concerns of project management and are jeopardized when FM is introduced into the design stage. FM participation will most probably increase the construction cost and extend the time of project completion, acting against PM objectives which are usually set to ensure that projects are delivered according to budget and on time.

“Project management usually comes after the design, to make sure that the project is delivered on time and within budget. Whether the project has X Y Z features is not really their concern.”

However, PM objectives are negatively affected only if FM participation is not allowed for in the initial budget and project duration. When facilities managers participate during project planning and briefing prior to the commencement of actual design and construction, and when their participation is accounted for in terms of cost and duration, this becomes part of the overall budget and schedule that PM is responsible for maintaining.

Respondents also suggested promoting FM participation and input into design through pushing the use of Building Information Modelling under Integrated Project Delivery, a method developed by McGraw-Hill Construction and the American Institute of Architects (Integrated Project Delivery, 2007). This integrated approach allows construction professionals as well as buildings users to input into the design process.

“One of the greatest ways to promote that is through the building information modelling because it provides a common platform... this is leading edge operations. All our projects are now designed using REVIT one of the BIM products if you will. The contractor has access to the model as well as the client and the FM should have access to this model as well.”

Literature does not provide clear views on the form of FM participation during design stage, except the participation of FM managers within client organisations and the input they provide on FM operations (Jaunzens et al., 2001; Jensen, 2009). Involving FM managers who are already part of a client organisation is possible when development of new buildings for the same client, relocation, refurbishment or any other construction-related activities involving design, are considered. In cases of first-time clients, respondents suggested that clients should involve the FM service provider, the same entity that shall be hired to carry out FM services following construction completion, during design stage.

Respondents also suggested the involvement of an FM consultant acting on behalf of the client in matters related to occupancy phase. In this case, the FM team involved in design might not be a team that carries out services during occupancy phase, but rather an advisor acting in the interest of the client and recommending FM-related considerations in design.

“There should be some sort of specialised consultants to educate the client and help them understand that if you have all the information you can make informed decisions.”

Another form of participation could be an FM team working on board the design team during design stage. As discussed earlier, even though such participation is unlikely to happen if designers are not compensated for offering it, FM participation still takes place through the involvement of FM expertise internally within design organisations.

“Every designer company, they should have a consultant from the FM to review the design; if it is acceptable for the future use of the building or property.”

6.4.2 Involvement during the Entire Delivery Process

Literature provides analyses on the role of FM during design stage and the various tasks required from facilities managers when participating in design (Janzens, 2001; Jensen, 2009). Table 14 provides a summarized comparison between these views and the outcome of this research combining all respondents' input. Research findings concur with the literature that the involvement of FM is not limited to one particular design stage but could spread over the entire project development process. Apart from their natural role during occupancy stage, the role of facilities managers could stretch from pre-design through to construction completion and handing over with specific tasks required by each stage. The representations used for each stage and sub-stage differ from one study to the other, but the tasks largely resemble one another and this is mainly driven by the particulars characterising each phase within the overall development process.

It is crucial for the FM participating team to identify and document requirements early on during briefing stage and ensure that the requirements of the client and relevant users are also taken into consideration. Despite the fact that FM participation should occur during the entire design stage as presented in the literature, research findings also reveal that FM participation has the most beneficial effect during concept design stage. The main reasons leading to this conclusion is the higher probability that FM requirements would be reflected on design drawings, at a time when decisions are still reversible and changes have minimum effect on the overall design outcome.

Project Phase	As Viewed by Jaunzens et al. (2001)		As Viewed by Jensen (2009)		Based on the Research Findings	
	Project Stage	Activities to be Undertaken	Building Project Phase	FM-Specific Tasks	Project Stage	Role of Facilities Management
Pre-Design	Inception	-Contributing to pre-briefing discussions	Decision	-Incorporating real estate strategies	Brief Preparation	<ul style="list-style-type: none"> -Document FM requirements and set operational parameters -Prepare checklists for space, access and all other documented FM requirements. FM descriptions should show measurable parameters for designers' use -Provide guidance on equipment selection, requirements for access and operation -Provide information on specific operation issues related to multi-use facilities -Input on sustainability issues and determine the project's sustainability category -Participate in workshops -Answer questions prompted by designers -Coordinate with client to ensure that all user and owner requirements are included in the brief -Prepare a quantitative tangible brief containing performance criteria in relation to FM elements -Finalize the brief for client sign off
	Feasibility	-Inputting to strategic requirements relating to operational issues		-Information on space needs etc...		
		<ul style="list-style-type: none"> -Giving advice on the requirements setting within the brief -Ensuring that end users' needs are incorporated into the planning process 		<ul style="list-style-type: none"> -Estimation of impacts on cost of FM 		
Schematic Design	Outline proposal and scheme design	<ul style="list-style-type: none"> -Ensuring that any strategic facilities requirements have been incorporated into the design -Contributing to assessment of design -Checking that the cost plan considers operational costs where this is required 	Design	<ul style="list-style-type: none"> -Incorporation of considerations for operation, sustainability and user needs -Formulation of operational concept -Formulation of requirements for building automation system 	Concept Design	<ul style="list-style-type: none"> -Ensure that FM requirements stated in the brief are actually reflected in concept design -Participate in evaluating the various options and alternatives for different design schemes -Check for feasibility, cost effectiveness and accessibility -Provide input into the concept design report prepared by designers, on the various structural, electrical and mechanical systems
		<ul style="list-style-type: none"> -Reviewing the design and ensuring that functionality has not been compromised -Reviewing the design and ensuring that operating costs meet financial criteria -Checking design limitations 				
Construction Documents	N/A			Construction Documentation	<ul style="list-style-type: none"> -Review the "Issued for Construction" (IFC) drawings before transmittal to the contractor -Assist in the preparation of the project specifications to ensure the incorporation of all necessary FM requirements 	
Construction	Project planning	-Ensuring that the chosen tenders comply with key requirements	Construction	-Interior Planning	Construction	<ul style="list-style-type: none"> -Attend construction progress meetings held between the design consultant, contractor and project manager to help in resolving challenges and problems
	Operations on site	<ul style="list-style-type: none"> -Ensuring that the commissioning procedures are appropriate -Witnessing that commissioning has been properly carried out 		<ul style="list-style-type: none"> -Prepare commissioning -Contracting-out operational tasks 		
Handing Over	Completion	<ul style="list-style-type: none"> -Ensuring that handover documentation is adequate and complete -Ensuring that facilities staff and end users have been instructed in using facilities 	N/A		Handing Over	<ul style="list-style-type: none"> -Participate in Testing and Commissioning Phase -Facilitate the listing of assets and equipment and provide the proper format of the data to be included in O&M manuals -Check equipment operation and whether this equipment is fit for purpose against the design intent -Ensure proper delivery of O&M manuals and as-built drawings
Occupancy	Feedback	<ul style="list-style-type: none"> -Ensuring that post-handover services are in place (eg post-handover commissioning) -Obtaining information on building performance; ensuring that feedback is given to the design team and appropriate follow-up action is taken 	Occupation	<ul style="list-style-type: none"> -Move -Handling former building (s) -Implementation of operational procedures 	Occupancy	<ul style="list-style-type: none"> -Coordinate with the client's FM service providing team to ensure proper and smooth handing over

Table 14 Literature vs. Research Findings

As Table 14 shows, the main task of facilities managers during design development is to review the design deliverables. Facilities managers should check the design drawings for material and equipment suitability, sustainability and energy efficiency, functionality, and all other design aspects affecting FM operations. Jensen's (2009) representation combines both schematic and detailed design into one stage. Ensuring incorporation of FM requirements still shows but is not specifically listed under schematic design stage. It also mentions managing the move of the organisation to a newly built facility after construction is completed, although this should only mean the case of company relocation. The other two representations focus more on the general procedure of handing over from the contractor to the FM service provider, and the preparation of all the required documents associated with this process.

6.4.3 The Qualified FM Participant

Research findings indicate the need for an additional function within the design process which should be responsible for all FM-related considerations. Irrespective of what form the FM participation takes in representing this function, there should be a team comprising facilities managers responsible for carrying out the required tasks.

“FM has different disciplines and is not one man show. They have different expertise and requirements for every discipline. So normally there should be staff and not one man, you need a team for the relevant disciplines.”

Respondents concur with the literature (Jaunzens, 2002; Jensen, 2009) that FM team members need to have skills and capabilities enabling them to work alongside designers. Team members should be experienced in FM operations and it is insufficient to involve individuals who only have theoretical knowledge such as fresh or inexperienced university graduates. In addition, FM personnel involved in design should also be qualified to handle the job of giving advice to designers.

“FM have to have both types of experience, the consultancy and the operational experience and exposure. But the most important thing is the ability to get the message across. Because you have to contribute without impacting... at the end of the day the designer has the professional responsibility to design the systems and secondly has his own ideas in his mind that go into the design so the aesthetics and what he as a designer wants to achieve has to be welded together. It’s not good for the FM to come along and say I want this and that without understanding what impact that is having on the other facets of the building, and that understanding actually comes from experience.”

It is as well insufficient to involve personnel who only possess the operational experience but lack the managerial and consulting experience that enables them to effectively participate in design. The FM participating team should be capable of influencing the design process and modifying design decisions while maintaining a conflict-free environment.

6.5 Integration beyond Facility Borders

Facilities management and design integration occurs through the participation of FM experienced professionals during design stage; however, there are as well other means to achieving this integration. Respondents agree with Jensen (2009) that integration can be accomplished through raising the awareness of designers about FM-related considerations. FM requirement documents could serve as a valuable source of knowledge used by designers when making decisions and producing drawings and specifications.

Conferences, seminars and other networking events could also get the designers as well as clients in more contact with facilities managers and promote knowledge exchange between these three entities. Training and university education also

provide designers with information related to facilities management and raise their awareness about operation activities. Moreover, extending the service duration of designers on projects allows for increased FM and design collaboration during occupancy phase and provides designers with valuable information on design outcomes.

The role of FM associations and societies was also suggested by participants to be important and influential in sharing expertise related to different aspects of FM with clients and designers.

“Our focus is to teach the client. We are now taking part in a focus group in collaboration with MEFMA, and our aim is to teach the client about FM in general. Starting by the design aspect and that FM should be there from the beginning. Clients should involve FM from the beginning. We are preparing an action plan to educate the clients in general, not our clients as a company only, about the FM culture.”

In addition to raising designers’ awareness, research findings also reveal that governmental institutions could also introduce FM review of design drawings prior to approval and transmittal to building contractors. Performing this sort of design checking occurs at a late stage when the design drawings are already developed, but would also provide an FM input where possible.

**CHAPTER 7 | VALIDITY AND RELIABILITY OF THE
RESEARCH**

A test is considered reliable, according to Gillham (2005), if upon re-testing would lead to consistent results. In the case of interview data, the research has to take a surface approach (using simple descriptive categories, for example) while analysing the data, in order not to end up interpretively constructing what the interviewee said. Following this surface approach in analysing the data would serve the reliability of the data and the consistency of the results, if the data is to be reanalysed.

McNeill and Chapman (2005) also discuss reliability when stating that a method is considered reliable whenever other researchers use it or the same researcher uses it again, and the obtained results turn out to be the same. The authors give an example on participant observation, whereby the risks are always high that this technique is considered unreliable and cannot be repeated. Involving participants' input through observation, confirms what Gillham (2005) mentioned above regarding the researcher's own interpretation that should be absent in order to achieve reliability.

According to Cohen, Manion and Morrison (2000), validity on the other hand is one major issue in research due to the fact that a research exercise is rendered useless if invalid, and therefore, researchers should always endeavour to increase validity and decrease invalidity. The authors assert that validation is required by both qualitative and quantitative approaches but in different forms depending on the type of research; in qualitative research, aspects such as honesty, richness of data, depth of the research, triangulation and objectivity are addressed, while in quantitative research, measures of error, statistics, sampling and proper instrumentation are the basis for measuring validity. The issue of objectivity, as opposed to the researcher's subjective interpretation of the data collected, is shown to be required in qualitative research in order to achieve validity.

Finlay (2006) argues that the concepts of reliability, validity and generalisability mainly serve as a framework for evaluating quantitative research, while qualitative researchers challenge and refuse such concepts. The author states that achieving consistency of data collection methods (reliability), in qualitative research, is mostly irrelevant due to the fact that qualitative research aims to obtain participant responses within a certain context instead of achieving consistent results. The same applies for validity which calls for the objective investigation of an undoubted reality in quantitative research, whereas qualitative research engages researchers' or research participants' subjectivity that contradicts with the existence of one definite reality representing all research findings.

Generalisability, another evaluation concept used in quantitative research, looks for the ability to extrapolate the research findings from a sample to a larger population.

Conversely, qualitative research seeks to reveal that the findings have the ability to be transferred and may be relevant when applied to other people. The richness and depth of data are more relevant to qualitative research than the selection of a random representative sample (Finlay, 2006).

7.1 Criteria for Evaluating Qualitative Inquiry

Even though qualitative research disagrees with the evaluation concepts linked to quantitative research, Willig (2001) mentions that qualitative researchers generally agree that it is important to critically evaluate the findings through the use of certain criteria. Researchers commonly agree that qualitative research findings have to be trustworthy, meaning that they should be capable of demonstrating a rigorous process and a relevant end product (Finlay, 2006). Creswell and Miller (2000) also state, that as a general consensus, qualitative researchers are required to show that their work is credible.

Research evaluation criteria used in qualitative research, as proposed by Lincoln and Guba (1985), are **credibility** and **transferability** (both corresponding to validity in quantitative research), **dependability** (corresponding to reliability), and **confirmability** (corresponding to objectivity).

According to Lincoln and Guba (1985), the four criteria are explained as follows:

1. **Credibility:** Reflects the extent to which the findings make sense. In quantitative research, internal validity is used instead, whereby researchers have to be confident that their research findings are true.
2. **Transferability:** Requires detailed description of the setting involving the research which provides readers with sufficient information to decide whether findings can be applied to other settings. External validity is used in quantitative research, involving the establishment of a random sample representing a wider population.
3. **Dependability:** Corresponds to reliability used for quantitative research evaluation, and promotes the documentation of methods, decisions, and gathered data which can be presented for external enquiry. The use of audit trails is encouraged to achieve dependability.
4. **Confirmability:** Replaces objectivity used in quantitative research, and involves the use of auditing to reflect on the quality of the research output. Self-critically reflexive analysis or different types of triangulation can be used to attain confirmability.

Various approaches are found in the literature for addressing the credibility, transferability, dependability and confirmability in qualitative research.

Creswell (2003) recommends several strategies, one or more of which should be identified and implemented in order to check the accuracy of the research results. Among the strategies that Creswell (2003) presents are *member checking*, *use of rich descriptions* and *presenting negative or discrepant information*. Moreover, Shenton (2004) presents potential provisions that could be made by a qualitative researcher to address credibility. Besides member checking and the use of rich descriptions, Shenton (2004) handled *triangulation via use of different types of informants*, in addition, the *examination of previous research to frame findings*, and the use of *in-depth methodological descriptions*. Lincoln and Guba (1985) and Onwuegbuzie and Leech (2007), discuss peer debriefing as a tool used to expose the research to criticism by external readers.

According to Creswell and Miller (2000), researchers usually engage in one or more of these approaches and the results obtained are reported within their investigations. However, the discussions on validity rarely handle the selection of these procedures and why one procedure should be selected over others. The authors believe that the selection of criteria is guided by the researcher's lens used for validation as well as the paradigm assumptions associated with the research. They also provide a framework that shows how different approaches to validation are linked to the aforementioned lens and assumptions (Table 15).

As the aforementioned table shows, the lenses used for establishing validity are related to the researcher, participants or external reviewers. Creswell and Miller (2000) assert that the lens used in qualitative research is different from that of quantitative inquiry which involves instruments, scores or research designs. Nine approaches for evaluating qualitative research are presented by the authors, who state that the most important matter is to be able to achieve validity and credibility while acknowledging the lens and assumptions behind the selection of each approach.

Paradigm Assumptions/Lens	Systematic Paradigm	Constructive Paradigm	Critical Paradigm
Lens of the Researcher	Triangulation	Disconfirming Evidence	Research Reflexivity
Lens of Study Participants	Member Checking	Prolonged Engagement in the field	Collaboration
Lens of People External to the Study	Audit Trail	Thick and Rich Descriptions	Peer Debriefing

Table 15 Validity Procedures Within Qualitative Lens and Paradigm Assumptions (Creswell and Miller, 2000)

While the above tabulated approaches could be used to address validity according to Creswell and Miller (2000), Shenton (2004) tabulates the various provisions that can be made to address all four criteria presented by Lincoln and Guba (1985) earlier in this chapter; however, most provisions presented by Shenton address credibility.

Shenton (2004) considers that triangulation, for example, addresses both credibility and confirmability, while transferability can be realized through the use of background data to establish context. Dependability on the other hand can be addressed through an in-depth description of the methodology, allowing the research to be done again.

Being of qualitative nature, this research follows several approaches to achieve trustworthiness. The various approaches used are defined and evidence is provided on how this research meets the various qualitative research evaluation criteria.

7.2 Detailed Description of Context and Phenomenon

Lincoln and Guba (1985) and Shenton (2004) consider the use of background data to describe the settings and context of the research, in addition to the detailed description of phenomena under study both contribute to the **transferability** of the research.

This research includes a detailed description of the research context and the reasons behind the decisions taken to choose the settings and location of the research. Procurement strategies guiding project development were explained and analysed to decide on the situations related to this research. The location where this research applies was studied to reveal the various cultural, social and economical aspects along with other factors affecting FM and design practice in this specific location.

The subjects of facilities management and design were researched in detail to arrive to the process of FM/design integration and provide a clear explanation for readers to understand this phenomenon under study.

7.3 Member Checking

Member checking, according to Creswell (2003), is used to verify qualitative findings through sending the final report on findings to research participants, for them to determine whether they believe that these findings are accurate. Lincoln and Guba (1985), Creswell and Miller (2000) and Shenton (2004) consider member checks, performed on the collected data and the interpretations or theories generated by the research, a quality criterion used to achieve **credibility**.

Lietz and Zayas (2010) state that the researcher could select a subset of the research sample and provide them with the research findings in order to get feedback on whether they agree with these findings. Findings of this research

were sent to 19 out of the 30 professionals who were interviewed. The choice was made based on the availability of email addresses and therefore no selection criteria were used. The other 11 participants originally contacted to participate in the research could not be reached via email for participating in validation.

Out of the 19 participants who received the research findings, 6 participants never replied despite sending out several reminders, 10 participants provided responses, and the email addresses of 3 other participants were no longer valid. All 13 emails received (10 replies + 3 delivery fails) are presented in Appendix B of this thesis.

Considering these 19 participants to be a subset of the overall research sample, the following was observed:

- a) 32% of participants never replied
- b) 52% of participants replied
- c) 15% of participants (2 designers + 1 FM professional) had their email addresses changed and were no longer valid

In view of the above, more than half the number of participants who received the research findings responded to the email they received. Among these who replied:

- a) 30% felt that the findings are correct
- b) 20% felt that the findings are correct and commented on the contents
- c) 50% apologised for not being able to provide any feedback
- d) None of the participants showed any disagreement with the findings

It is also worth noting that participants who effectively read and commented on the content of the findings were only facilities managers; and all participants who apologised were in fact designers. This fact could reveal that facilities managers in

general, were more interested than designers in the topic of FM and design integration. Facilities managers put more effort to run through the findings and agree with them, or go beyond confirmation to comment on the contents.

Comments that the researcher received on the content of the findings were mainly of two types:

1. Confirmations and/or additions to what was already included.

a) On the “FM Participation in Design”:

“You have described the situation very well at each stage. The reality is that design has a big impact on the long term operational costs. Over the life cycle of a building the operational costs will be ~80% of the total building cost, 20% for construction. Your summary of the stage of impact of the FM in practice is after the structure is built. There are many reasons for this though you have captured the main points. One of the issues in the FM business there is no clear definition of what FM is about. If you refer to any FM organization there are different interpretations.”

b) On the “Clients’ Willingness to attend to Integration”:

“I think this premise is correct. I find there is a lot of talk the talk but not walk the talk. Having said that the designing of many of the FM issues can be sold to Owners at little cost, the Owner’s interest will be determined by his particular interest in the use of the facility. Facilities where the owner resides or his main office is located will have a higher level of interest.”

- c) On the “Infancy of the FM Profession in the Middle East”:

“FM is not so young in more advanced countries, where FM is a normal part of a structure’s management. Very young in the Middle East though.”

- d) On the “Perception of What FM is”:

“This lack of clarity of a FM professional company is holding back the acceptance of the FM management of facilities. The industry attains a bad name due to, in part, the lack of true professionalism.”

2. Clarifications and/or recommendations to further elaborate for clarity

- a) On the “FM being part of the Client Organisation”:

“Does this mean that the Client is an end user?”

- b) On the “Building Evaluation Tools used by FM during Post Occupancy”:

“Maybe divide between a tool i.e. Infor and reports/KPI/SLA.

Softlanding and occupany analysis I do not understand as described herein.

- c) On the “Designers’ Interpretation of what Durable Equipment means”:

“Correct, but need to be explained a little further.”

The above examples along with the rest of the comments provided were addressed and modifications were made to the research findings, to enhance the content and increase clarity.

7.4 In-Depth Methodological Descriptions

Research methodology was researched in detail in Chapter 3 of this report. An analysis of the various research methodologies was carried out prior to the selection of the most appropriate method that should be applied to this research. In addition, the description of the work carried out was also provided following a certain research design that included pilot work, the preparation and use of standardised interviews and the analysis of results. Work related to all these steps was documented and included in Chapter 4 of this thesis. In addition, the gathered data was recorded and transcribed (i.e. available in audio and word formats) making it available for any external scrutiny, as recommended by Lincoln and Guba (1985) to achieve **confirmability**.

According to Shenton (2004), the provision of in-depth methodological descriptions allows the research to be repeated, thus achieving **dependability**. Methodological descriptions also allow for checking the integrity of the research findings, thus achieving **confirmability**.

7.5 Triangulation

Not being a data collection technique by itself, Scandura and Williams (2000) discuss triangulation as a process involving the use of more than one method for assessment and validation.

Shenton (2004) discusses two forms of triangulation to achieve credibility. The first involves using different data collection techniques particularly observation, focus groups and individual interviews. The author considers these three methods to be the main data collection approaches used in a great deal of qualitative research.

The second form involves a range of research participants, an approach considered one of the methods of triangulation through data sources. In the case of involving different data sources, the experiences and opinions of individuals can therefore be compared to others resulting in a rich illustration of different needs and behaviours (Shenton, 2004). Denzin (2009) also tackles the issue of data triangulation which requires the use of different data sources such as different participant groups, times or settings.

One example provided by Shanon (2004) is to engage both the users of an information service as well as the professionals delivering it, to help check and explain the attitudes and behaviours as well as improve the contextual data.

Applying the second form of triangulation, as described above, to the subject of FM and design integration, the researcher approached facilities managers as well as designers to identify a range of viewpoints and needs and achieve corroboration through comparison. The analysis of interview data was distinctly presented in the research findings so as to reveal the information provided by both research participant categories.

According to Creswell and Miller (2000) and Shenton (2004), triangulation addresses **credibility** and **confirmability**. In addition, providing different viewpoints to improve contextual data also touches on the issue of **dependability**.

7.6 Examination of Previous Research to Frame Findings

Silverman (2000) considers that the capability of a researcher to relate findings to previous knowledge is a key measure for the evaluation of qualitative research output.

According to Shenton (2004), examining previous research findings is carried out to assess the similarity between the research findings and the results of past studies. Information from previous studies that address issues comparable to research findings might be valuable sources and is used to address **credibility**.

The literature review done for this research reveals several previous works carried out to address FM and design integration. These were examined in the literature review section and were discussed and compared to the research findings. Moreover, an entire chapter of this thesis (Chapter 6) is dedicated for the discussion of research findings and existing literature. Discussion enables the researcher to confirm the findings with the knowledge that already exists and identify the differences and new knowledge that has emerged.

7.7 Use of Rich Descriptions

Creswell (2003) recommends using rich and thick descriptions when documenting the research findings, a strategy which will result in communicating a holistic representation of participants' experiences. This could also provide readers with a lens to view the research settings and relate to any shared experiences. Shenton (2004) considers that the provision of using rich descriptions adds to the **credibility** of the research findings and addresses trustworthiness.

Throughout the findings section of this research, participants' input is portrayed in detail, and the use of quotations to convey what interviewees exactly said adds to the truthfulness of the rich descriptions.

7.8 Presenting Negative or Discrepant Information

Due to the fact that there are different perspectives in real life which do not always come together, Creswell (2003) argues that presenting the opposite information increases the credibility of findings for readers. Creswell and Miller (2000) and

Shenton (2004) agree that the use of negative cases or disconfirming evidence can be implemented to attain **credibility**.

The findings of this research were developed using data as provided by the research interviews. Facilities managers and designers had varying opinions regarding many issues discussed, which were all presented as stated by the participants. In addition, participants in some cases had contradicting statements in relation to certain subjects; one example is the FM/design collaboration during design stage. In more than one instance, participants declared that they feel there is no relationship between facilities management and design, while on the other hand their previous experiences reflected some sort of relationship or collaboration. This contradicting information was all included in the research findings as provided by research participants.

7.9 Peer Debriefing

Lincoln and Guba (1985, p. 308) define peer debriefing as a "process of exposing oneself to a disinterested peer in a manner paralleling an analytic session and for the purpose of exploring aspects of the inquiry that might otherwise remain only implicit within the inquirer's mind". Hail, Hurst and Camp (2011) define a disinterested peer as someone who is not involved in the research and its outcome, but is knowledgeable about the research topic.

Daymon and Holloway (2011) mention that peer debriefing or peer review requires the involvement of colleagues to re-analyse the data and the researcher then discusses the concerns arising from their interpretation. Another approach to peer de-briefing would be that the researcher could send the draft report to peers at the end of the research.

According to Onwuegbuzie and Leech (2007), peer de-briefing has several benefits such as detecting bias and improper subjectivity, providing explanations different from those of the researcher, and preserving the honesty of interpretations provided by the researcher concerning participants' quotations.

The initial step carried out by the researcher in debriefing, is to identify the de-briefer (Spall, 1998). As Erlandson et al. (1993) mention, the de-briefer should be a professional outside the context of the research carried out, but should have an understanding of the research topic necessary for discussion. A de-briefer helps the researcher in uncovering biases, perspectives and various assumptions made. The de-briefer also checks if the results are reasonable and credible from his/her point of view (Cohen and Crabtree, 2006).

Spall (1998) asserts that researcher should state who the de-briefer is and the reason behind choosing this person in particular. A study carried out by the author revealed that students chose de-briefers whom they highly trust and interacted with in several situations. De-briefers were classmates, professional colleagues, friends, office mate, etc... The feeling of trust according to Spall (1998) was found to promote an open dialogue for discussions about ideas and concerns. Schwandt (2007) also considers that de-briefers should be knowledgeable colleagues whom the researcher trusts.

The researcher's personal experience also adds to what the literature reveals concerning trust that should exist between researcher and de-briefer. Prior to choosing the de-briefer for reviewing the research findings, the researcher was becoming increasingly convinced that there needs to be a certain level of previous interaction, experiences and a comfortable connection with the de-briefer.

The understanding that the researcher had built was due to the several apologies received from participants during member checking. A number of participants

were not able or willing to provide any feedback, due to the time and effort that were required for reviewing the large volume of information included in the research findings. In case the researcher knew the de-briefer and both had connected previously with each other, the researcher can then trust that the de-briefer would be willing to offer an acceptable amount of effort and commitment to review the research in depth, and provide meaningful and useful feedback.

Based on what has preceded, the researcher chose an experienced professional who is also a colleague, to act as the de-briefer for this research. The de-briefer works in the field of construction, and is mainly involved in project management and cost consultancy/planning. The fact that the de-briefer is neither a design nor an FM professional makes him a disinterested peer who is not involved in the research and its outcome, but is knowledgeable about the research topic.

Several reasons led the researcher to take this particular decision in choosing the de-briefer for this research. The selected de-briefer:

- a) Has 32 years of overall experience, of which 30 years in the Middle East and North Africa region including the countries of Saudi Arabia, Qatar, UAE, Bahrain and Iraq.
- b) Has specialized working mainly in the consultancy field advising and guiding clients in all facets of the construction industry.
- c) Has had key senior managerial experience involving pre-contract consultancy (during planning and design), post-contract consultancy (during construction) and acting as client representative responsible for various types of facilities during different project phases including occupancy.

These skills and experiences enable the de-briefer to have a clear understanding of the entire project delivery process and use of facilities. Working in countries within the Middle East for a long period of time also offered the de-briefer chances to coordinate with different stakeholders including many design and FM firms operating in the aforementioned region.

7.10 De-briefer's Review: Comments and Contribution

The draft thesis was handed to the de-briefer for review and comments. The de-briefer carried out a thorough review of the document and provided comments on presentation, wording and content. Following the review process, several sessions were held between the researcher and the de-briefer for discussion. The outcome of the de-briefing was analysed by the researcher, documented and comments provided by the de-briefer were addressed and incorporated in this thesis.

7.10.1 Comments on Presentation

The de-briefer agrees with the overall outcome of the research findings, and feels that these findings are correct.

The main advice the de-briefer provided was to include some sort of an executive summary as part of the research findings chapter, for several reasons. One reason is that the executive summary grounds the findings and puts them into context for readers to expect what they are about to read.

"I think what you have in here is fine, but you need to put it more into context... as the Middle East... you need to ground it more. You have it already in the main thesis, but you can summarise it and write in here so that you put all what is written here into context, so that the reader can relate to what you are talking about. This is the main advice I would give you for this, put all your findings in

here but put something in the beginning so that anyone who is reading this needs to say... oh yes, yes... and it places your findings into a matrix of an idea.”

Another reason for adding an executive summary at the very beginning of the findings chapter would also show the readers that the researcher has a clear idea of where he is going with the research and what the purpose of it all is.

The de-briefer also stressed on the aspect of portraying the clear idea of what FM is. Facilities management should be introduced clearly in the literature review and the various components carefully explained to show that FM comprises various tasks and covers several services. FM should be clearly defined and its components and various functions presented, as this has to be transmitted to the reader in a comprehensive manner, due to the complicated process of FM and all what it includes.

“To me there are many things involved in FM. There’s engineering, housekeeping and security. These are the three big ones, and I’ve put down here the operator. Hotels have catering equipment and these have different requirements from the main building. And you’ll need a specialist maintenance team for these things, apart from the building’s air handling units, FCUs and plumbing and thermostats, etc... and I’d like somehow for that to be dealt with more clearly here. Because this is a very complicated subject, FM, because it has so many things involved in it and my feeling is that you need to transmit to the reader that you have a very clear understanding of how these things fit together. They are all part of the FM of the building and all these guys have to work together.”

The researcher, and based on the above comments, made sure that the FM section within the literature review chapter contained separate headings handling definition, roles and responsibilities, components, and the relation of FM and the core business within a facility (distinction between operational and strategic FM).

The de-briefer also advised minor changes to the wording used in order to better express the ideas presented. The proposed changes were discussed with the de-briefer, agreed and incorporated in the final thesis.

7.10.2 Contribution to Research Findings

The de-briefer's comments on the research findings were mainly to provide additional information on issues that, in his opinion, needed to be emphasized more through further elaboration. The de-briefer made contributions to various topics presented in what follows.

7.10.2.1 Marketing FM Consultancy in the Middle East

The de-briefer agrees with the research findings that FM is still in its infancy in the Middle East, and that the FM and design relationship is generally non-existent. He also argues that the change will happen regarding this relationship and the overall integration process, which will only take place when large consultancy firms (mainly designers) start to see the benefit for themselves. When this point is reached, these large firms will then begin to market this integration process through introducing an FM consultancy service to be sold to clients. The de-briefer used the example of the rise of project management services in the Gulf, and considered that the same should happen in case of FM.

“One of my other notes up here is that 20 years ago, in the Gulf in general, nobody used project managers. They had the consultant and his job was to design and then supervise the construction, they didn't have project managers. And it's only when project management started being marketed by these big design companies, that's only when project management started appearing. In the same way that that happened 20 years ago, maybe FM if it gets the right kind of profile and they employ lots of people, then the consultancies will see that it is necessary over a long period of time. And for now in the Middle East, there is only one consultancy firm that is aware of this. Nobody is still paying attention to it here,

because nobody is marketing it. When they start to market it as it surfaces, they start to think: instead of employing 50 people for 2 years on this project, we can have 5 people for 10 years on this project, making them more income. When they wake up to that idea, then FM will start to be taken seriously.”

In the case of project management, design firms started thinking that they can employ more people for an additional 2 or 3 years beyond design stage and keep themselves in business. The de-briefer believes that when the same idea gets into designers' heads to provide 10 people for 10 years and include FM as a consultancy service, then design firms would start to think of marketing it.

“Over time things will change when the big consultants start thinking that we can have a steady stream of income not just a project hit for 3 years with 50 team members, we can have a 20 year hit with 5 or 10 guys instead.”

In addition, the de-briefer considers that this change will happen because buildings are getting more complicated and clients need a central point of responsibility, one person to be blamed for everything; project management during project development and the facilities management during occupancy. The need for integration also depends on the scale of the project. If it's only one building for example, then it tends more to be only a contractor (an FM service provider). While if there are a series of buildings or a project of a larger scale, then consultancy might then be more probable.

7.10.2.2 The 20/80 Ratio: A Significant Factor

Research findings reveal that the construction cost (capital cost prior to occupancy) constitutes 20% of the entire facility lifecycle cost, and the other 80% are incurred during building use.

The de-briefer regards this information as very important and could serve as a starting point for big consultants when trying to market FM and design integration.

“If the big consultants in the region go with one of your statistics here that only 20% of the overall cost goes into construction, and another 80% goes into operation over a 25 year period, then they start to think well, we’re spending the money at the front end to try to get it right... and they don’t get it right... there could be another set of people that could help us optimise our spending and minimize the cost over the whole lifespan of the building.”

The de-briefer also wonders how come when the life of the building is 25, 30 or even 40 years, nothing is yet spent on analysing and optimising how the running costs are controlled during the 40 years of the building’s life.

“No one thinks about it... It’s because the savings are not tangible, you don’t see them. And it’s not only about savings; it’s also about quality and customer service, the user satisfaction.”

The above comment confirms the role of FM in delivering a quality service to achieve customer satisfaction, one of the main FM concerns discussed in this thesis.

7.10.2.3 The Importance of Having a Consultancy Service

The de-briefer argues that in order to promote and achieve FM and design integration, a consultant is required and not an FM service provider.

“I think big FM service providers, they wouldn’t be very much help during design stage; mainly because they don’t think like consultants. They think as contractors who want to make money, offering the lowest possible service at the highest

possible cost... while you expect a consultant to be a little more enlightened on that, providing a good product that does the job as defined by the employer.”

The de-briefer also concurs with what the research findings reveal concerning the need for having an “FM team”, including team members of different technical backgrounds and qualifications, to participate in design. Due to the large spectrum of services covering different building trades, a supporting team is needed to cover all areas during participation.

7.10.2.4 Absence of Required Skills

The de-briefer believes that the FM skills required to carry out consultancy services and consequently achieve FM and design integration, are non-existent in the Middle Eastern market in general. He also considers that the western market might be more developed in this regard. The issue of insufficient skills goes in line with what the research findings present concerning the FM-related barriers to integration. Findings reveal that FM is still a young profession and the FM market is not mature enough, a matter which affects FM's own practical performance and contribution.

“You might find that there’s a paradox here overall. That those developments that would most benefit from FM... hotels, hospitals and to a lesser degree shopping centres, the skill sets and knowledge to carry out FM consultancies do not exist in the market, because it’s not a sophisticated market. I’m sure in Germany you’ll have people specialised in operational consultancy or building operations consultancy on things like hospitals. In the Middle East I’m pretty sure it isn’t happening.”

Even though many European consultancy firms for example do operate in the Middle East, the use of buildings in the Middle East is different from that in

Europe. This prevents the knowledge and skills from being properly applied and integration from effectively taking place.

“Hotels in the Middle East for example are driven by revenue from their food and beverage sales. While in Europe, they’re driven by the revenue from beds and the organised stays. So there’ll be different thinking between FM in hotels in Europe and FM in the Middle East. There is a kind of paradox that the services you want actually do not exist. So how can you sell them? To convince a client that he needs such and such a service, you need someone knowledgeable to come and sell to him.”

7.10.2.5 Employer’s Education

The de-briefer agrees with what the research findings present regarding the lack of awareness and knowledge of clients in relation to FM. He adds that designers as well need to be aware of the meaning of FM and what FM does.

“Something else I need to comment on is the client or employer education and awareness. That needs to be aroused in the employers... a better awareness. Client awareness and also designer’s awareness I’ve got here. Designer’s awareness of what FM is? One of my questions is it clear that designers know what FM is? Some of them will confuse FM with the organisation’s operation.”

7.10.2.6 The Role of FM during the Handing-over Process

The de-briefer stresses the importance of the FM role during handing-over of the building from the construction contractor to the client. FM should be responsible for ensuring that “legality” has been achieved before the building goes into operation.

“Another big and stumbling issue for me in all the countries in the region is the issue of legality. A lot of times, owners would take a building into operation without

it being properly finished. So for example, the sprinklers are not yet properly tested. The fire prevention systems are not properly checked by the authorities yet. And where I've been working, this went on this way for 1 year after we took operation."

FM should also ensure that all O&M manuals, as built-drawings and all the different contracts with operators and maintainers of sliding doors, elevators, etc... are in place before occupancy phase begins.

"That to me is an issue that the FM should make sure that they're fully aware of the minimum requirements that should be in place, before the employer takes over."

7.10.2.7 FM Participation during Value Engineering

The issue of FM participation during value engineering sessions is mentioned in the research findings, and the de-briefer made a point to stress this issue more due to its importance during design stage.

"There is another detail in here that maybe I only saw once. FM participation in value engineering workshops? I think this is a missed opportunity at the moment. Value engineering is a very good point, but unfortunately in the Middle East, value engineering is misunderstood. It's only seen as a cost reduction exercise, but it's not that."

The way value engineering is perceived in the Middle East, might not reveal a relevant role for FM to participate in. Due to it being regarded as a cost saving measure during design stage rather than an exercise to add value, FM's role during value engineering might be considered irrelevant by clients in the Middle East; especially that FM measures would require an increase in the capital cost to achieve a saving in the long term.

7.10.2.8 Middle Eastern Countries Involved in FM

Research findings show that the United Arab Emirates (Dubai in particular) is the country with the most active FM operations in the region.

Based on his personal experience, the de-briefer was able to compare the FM activity occurring in different places within the Middle East, and confirms that Dubai is actually the catalyser when it comes to FM.

“In Dubai the construction industry is much more sophisticated than in the rest of the Gulf, actually the rest of the Arab world. Because in Dubai, you have already all the specialist sub-contractors, all the specialist suppliers and all the big consultants they have usually started their business in Dubai. And they then spread out to the rest of the region.”

It is also worth noting that Dubai is not an oil-generating economy, it is in itself the market and is rather geared towards money and investments. This fact has resulted in more thinking towards preserving buildings and developing facilities that are not “whimsical”, as the case is in other oil-rich surrounding countries.

“Dubai is in itself the market. The projects are not whimsical projects like in Qatar for example. Sometimes you just don’t need projects that big, you can just extend old ones. But they (oil-rich countries) have the money and they can build them.”

In summary, the aim of the researcher was to achieve validity and reliability in the best possible way, utilizing various approaches provided by the literature that could be applied to this research. The use of all approaches described in this chapter resulted in addressing credibility, transferability, dependability and confirmability through validity perspectives of the researcher, research participants and an external reviewer.

CHAPTER 8 | **CONCLUSION**

This research provided a detailed insight into the professions of facilities management and building design and revealed the need for their integration on construction projects. Integrating FM knowledge in design was found to be vital for maintaining an efficient long term running of facilities, ensuring effectiveness of FM services and safeguarding the success of organisational core businesses.

The process of integrating FM and design was revealed showing that this integration is still limited in many regions of the world. Whilst there were no studies addressing limited integration on construction projects within the Middle Eastern market, this research was able to provide an analysis of the current status of integration, reflecting on the relationship between designers and facilities managers working for organisations involved in the aforementioned market.

8.1 Summary of the Key Findings

Through addressing the various objectives, the researcher was able to accomplish the aims and answer the established research questions. Following the same numbering scheme as the one used for listing the research objectives, the research outcome is presented as follows:

1. Literature review was carried out to introduce facilities management and design, reveal the need for their integration and disclose the fact that this integration is still limited.
2. A detailed investigation of the integration process was achieved by this research, through revealing the nature of the relationship between FM and design and the degree of involvement of FM during design stage. The findings revealed that the relationship between FM and design professionals in the Middle East is nearly non-existent and the degree of collaboration between those two groups of professionals is nearly absent.

This is resulting in a poor integration process. Facilities managers are not seen involved during design stage, but are rather kept off the radar when it comes to project delivery processes. The United Arab Emirates, Dubai in particular, was found to be the region with the most active FM operations within the Middle East region, and the place where FM integration is most likely to happen.

3. The evaluation of design outcomes for facilities in use carried out by FM and design professionals was determined and showed the extent of contribution of both parties in gathering design-related information during the occupancy phase. Both the FM and design professions demonstrated insufficient work done regarding the evaluation of the design outcome.

The findings revealed that it is not a common task for designers to go back and evaluate their designs, as it is also uncommon for facilities managers to evaluate the building performance in relation to design. Inadequate evaluation exercises reveal that problems occurring during occupancy phase are inappropriately identified and documented for use in the development of future facilities.

4. A number of facilities management related issues arising during the occupancy phase were identified by research participants. FM and design professionals agreed most on operation and maintenance requirements, while sustainability concerns were the least in common. The incorporation of FM considerations was found to greatly rely on the client. The knowledge that clients possess about the importance of including FM and the amount of details they wish to include when stating requirements both affect the statement of FM requirements before design commences.

Requirements related to sustainability were found to be hard to include in design within the Middle East region, especially in oil-rich countries where energy prices are low hindering the implementation of sustainability and energy efficiency measures.

Currently, designers are mostly relying on lessons learned from previous projects, which might include FM-related issues that were addressed in the past. In the absence of FM references providing knowledge on FM experiences during occupancy phase, it is still up to the designers to address any FM concerns. These concerns or requirements would be found in the form of architectural and engineering international standards, sustainability assessment measures or certification requirements or included in various building codes and regulations.

5. Apart from the segregated nature of procurement systems, which naturally create a separation between FM and design processes, the research revealed several barriers to integrating FM knowledge in design. These barriers are client, design or FM-related issues that are resulting in limited FM integration on construction projects in the Middle East.

The loss of identity of FM companies and the various definitions given to FM-related services was found to be one of the major barriers preventing FM from being competent enough to provide advice to clients during design stage.

The lack of interest of designers in occupancy phase and their unwillingness to incur extra costs to integrate FM related knowledge in their design solutions was also regarded a significant barrier to integration. In addition, findings showed that design students in the Middle East are not being made aware of the operation side of design solution.

The lack of knowledge and awareness of construction clients about the importance of FM constitutes a main hurdle resulting in a lack of FM and design integration. There is a lack of determination from the client side to get the FM involved at early stages during project delivery. In addition, culture and the attitude towards construction and maintenance in the Middle East also contribute to clients' lack of determination.

All barriers influencing integration result in consequences that negatively affect built facilities, clients, users, FM operators as well as designers. Interrupted/dissatisfied users, unavailability of spare parts, improper consideration of FM requirements, system operation problems and inefficiency and difficulty in access for cleaning and maintenance were found to be among the most significant problems encountered during occupancy phase, as a result of limited integration.

6. Achieving integration and promoting the inclusion of FM knowledge in design are essential for eliminating the negative consequences resulting from lack of integration. However, the findings also revealed that integration could also benefit designers. Attaining better designer reputation, creating a design selling point (having FM on design teams), achieving better design coordination and eliminating negative responses to designer questionnaires were all benefits revealed by this research.

Discussions on promoting FM inclusion and participation during design stage revealed that clients' awareness, education, and responsibility of getting the FM on board appear to be the most significant factors affecting inclusion. Several approaches for promoting FM inclusion were suggesting such as pushing FM standards, producing an FM-compliant design contract, documenting FM requirements for designers' use, promoting the use of BIM, and the involvement of FM throughout the project delivery

process. The various roles and responsibilities of the FM participating team were revealed and presented according to the various stages occurring across the project timeline.

The research identified various contractual models that could be implemented in order to get FM involved during design stage. The FM participating team could be (1) the in-house FM team responsible for carrying out FM services as part of the client organisation's operations, (2) a team working for an external FM services provider hired by the client to carry out outsourced FM services, (3) an FM consulting team hired by the client solely to provide advice during project delivery phases i.e. not involved in carrying out actual FM services during occupancy phase, (4) an FM team hired by the designer or (5) an FM team hired by the project management firm.

This FM participating team should include team members of different technical backgrounds and qualifications; due to the large spectrum of services covered by FM. FM team members should also have a consultancy experience alongside their technical experience, because the interface between FM, the designer and the client is very important to get the message across.

Integrating FM and design, as the research showed, could also be achieved outside the premises of a given facility under construction. Promoting conferences to get facilities managers, designers, clients and other relevant stakeholders was found to be one of the most significant measures that could be taken. Another significant measure would be to continuously update FM and design professionals' knowledge and skills through trainings and continuous education. Documenting FM knowledge for designers' use was also found to be an important task that should be performed by

facilities managers to achieve integration. Creating codified knowledge can be done through producing national performance standards to be used as benchmarks, preparing guidelines and universal FM requirement documents or establishing an effective knowledge management system within FM firms to promote the creation of information.

8.2 Contribution to Knowledge

In view of the key findings presented in Section 8.1, this research contributes to the knowledge through:

8.2.1 Theory

- a. Providing a new dimension to the research on facilities management characterised by a substantive study of the FM industry in the Middle East; before this study very little research had been carried out into facilities management in the Middle East. This research uncovers the importance of facilities management within the Middle Eastern construction context through presenting the numerous benefits gained as a result of engaging FM at early stages of project development.

- b. Introducing an analysis of the relationship between FM managers and designers. None of the research undertaken so far has approached these two distinct professional groups in the Middle East, to investigate their relationship and inquire about the mechanisms of considering FM aspects in design. The findings are presented based on primary data gathered on professional experiences and reflect how FM is perceived by a range of construction professionals and where FM stands within the entire building industry.

- c. Broadening the comprehension of building design and FM integration. This research presents the various factors affecting integration, illustrates the different resulting consequences on facilities and people, and highlights the important role of FM managers extending from brief preparation up till the stage of steady facility operation.

8.2.2 Practice

- d. Suggesting an interaction between facilities managers and designers that could take place during different stages of project delivery, extend outside the boundaries of a facility under development, or occur during occupancy phase. These different types of professional interaction are provided by this research to facilitate the transfer of FM knowledge to designers and consequently improve integration.
- e. Proposing different contractual models for getting the FM team on board during early stages of design. This study shows that the FM participating team can provide the required input through acting on behalf of the client, designer or project manager. In the absence of an established FM department within client organisations at project inception, this research provides alternative means of engaging an FM team that can ensure effective integration.
- f. Raising the awareness of clients, through the highlighted importance of the role of FM and the benefits of FM and design integration. Using the information provided by this research, client organisations are able to appreciate the significance of FM inclusion in design. They are also provided with the knowledge that makes them capable of implementing integration in practice in order to achieve enhanced

facility designs, a more efficient FM service, improved user satisfaction and a longer facility lifetime.

8.3 Future Research

Inspired by the research itself, and the limitations discussed in the introduction to this thesis, potential measures for future research have appeared and are presented in what follows.

- 1- Test the findings on a project under construction, as applicable, and measure the outcome and contribution made by FM participation.
- 2- Consider the contractual implications on designers due to the FM involvement (changes to contract conditions, programme of works, sequence of tasks to allow for FM input, and any resulting cost implications).
- 3- Research findings revealed the subject of friction between FM and designers if participation takes place. In addition, a master-slave relationship is exposed depending on who employs the FM participating party. As a result, research could be further performed to understand the behaviour and attitudes of both FM and design professionals throughout the integration process.
- 4- Culture and attitude towards construction and operation were seen to significantly affect FM and design integration in the Middle East. Further research could also be carried to identify the effect on the overall quality of buildings and the FM service provided.

5- As advised by the peer de-briefer who reviewed this research, further research could also be carried out to involve project owners, clients or developers. This category of stakeholders, even if not directly involved in the technicalities of the FM and design integration process, is one of the major factors which affect the occurrence of any integration attempts that could take place during the development of construction projects, as revealed by this research.

APPENDIX A | **THE STANDARDISED INTERVIEW**

Research Interview Form

Question 1

How would you describe the relationship between designers and facilities managers in the Middle East?

Prompt: Does this apply to all countries where your firm operates?

Question 2

What can you say about facilities managers' participation in design?

Question 3

Based on your previous experience, can you provide me with examples on good or bad practice related to the following situations?

- a- FM expertise was present during design stage, its role and influence on the overall outcome

- b- FM expertise was absent during design stage and the resulting outcome

Question 4

Were you previously involved in facility evaluation during occupancy phase?

Prompt: What was your role?

Prompt: Were there any evaluation tools used?

Prompt: Did this involvement have an effect on later facility designs?

How?

Prompt: What can you tell me about the Soft Landings Approach?

Question 5 (if answer to Question 1 was “uncommon” or “any other similar term”)

What in your opinion are the barriers to FM knowledge and expertise integration in design?

Question 6

What are the consequences resulting from lack of integration?

Prompt: Would the building be affected? In what ways?

Prompt: What about the various stakeholders? Which ones will be affected and how?

Prompt: Which consequence do you consider the most serious?

Most frequent?

Question 7

What in your opinion are the FM-related issues that designers should attend to when designing?

Question 8

According to the literature, FM-related concerns during occupancy phase fall under the following main headings:

- Client and User Satisfaction
- Operation and Maintenance
- Space Layout and Flexibility
- Sustainability
- Energy Efficiency
- Ergonomics

Can you provide me with one or more examples related to each topic?

Prompt: Are all the examples you provided currently being considered by designers? Which ones are not?

Question 9

What/who are the current sources providing information on those topics?

Prompt: How does the knowledge reach designers from each source?

Prompt: Does this vary for different building types? How?

Question 10

Do you believe increased FM participation in design should be achieved in the future?

Prompt: Why?

Question 11

What do you think should be done to promote increased FM participation in design?

Prompt: Would you suggest anything in relation to contractual agreements?

Prompt: What about the involvement of a third party?

Prompt: How would project management facilitate such participation?

Question 12

To create a mechanism for an effective FM participation during design stage, what should the resulting FM and designer roles be?

Prompt: On what levels would facilities managers and designers interact? In what capacity?

Question 13

During which design stages should FM participation occur?

Prompt: Why?

Prompt: What should the FM role be during preparation of the design brief?

Question 14

What would the benefits of increased FM participation in design be?

Prompt: Who would benefit and why?

Prompt: What are the facility-related benefits?

Prompt: In what ways do you think project complexity will be resolved?

Question 15

What in your opinion are the measures that should be taken to enhance knowledge exchange between FM and design disciplines?

Prompt: How do you see the FM knowledge push and the design knowledge pull taking place?

Question 16

Is there anything else you would like to add to what we've previously discussed?

APPENDIX B | **MEMBER CHECK E-MAILS**

Type-1 Response: Opinion Received and Comments Provided

FW: Interview

[REDACTED], Thomas [REDACTED] [Thomas.[REDACTED]@[REDACTED]-middle-east.com]

Sent: Sunday, December 02, 2012 4:32 PM

To: Bu Jawdeh, Habib Milhem (PG)

Dear Habib

First of all. Well done! I went through your narrative and I have to admit that you did an comprehensive analysis of the as-it-is situation.

I have just some minor suggestions for you.

My comments and questions are stipulated in the docs as word-comments.

In general I recommend to link the different documents closer to each other.

That would transfer your work more into a an 'identified issue' – 'related mitigation strategy/recommended action' type of documentation.

What about a kind of an 'summary' at the beginning and an industry otlook at the end.

Best Regards,

Thomas [REDACTED]

Head of Facility Management

[REDACTED] SOLUTIONS MIDDLE EAST [REDACTED] W.L.L.

Mobile: [REDACTED]

Type-1 Response: Opinion Received and Comments Provided

FW: Facilities Management

Bob [Redacted] [Bob. [Redacted]@ [Redacted]]

Sent: Wednesday, December 05, 2012 6:13 PM

To: Bu Jawdeh, Habib Milhem (PG)

Hi Habib

I have read your summarise with interest and am pleased to say you have captured the reality for FM industry in the ME. In fact I think your paper would stand scrutiny in most parts of the developed world.

I have made some comments in some of the documents and hope these are helpful. I think the long term future of effective integration of design and FM lies with awareness of graduates in both disciplines at training institutions.

I wish you all the best for the future and hope your work will benefit you personally and the FM industry as a whole.

Cheers

Bob [Redacted]

Manager - Mep Technical Advisor [Redacted]

[Redacted] **Facilities Management Services WLL**

Type-2 Response: Opinion Received. No Comments Provided.

RE: PhD Research - Attn. Mr. Sivasubramanian [REDACTED]

[REDACTED] [mailto:[REDACTED].net]

Sent: Sunday, November 25, 2012 11:59 AM

To: Bu Jawdeh, Habib Milhem (PG)

Dear Habib,

Thank you for sending me the short report on your research findings of FM/Design related PhD topic.

The research findings are recorded by you are correct and are in conformity with my experiences with various projects.

Wishing you the best.

Sincerely

[REDACTED] Sivasubramanian

Type-2 Response: Opinion Received. No Comments Provided.

RE: Facilities Management Research

Clare [redacted] [cb [redacted] @ [redacted]]

Sent: Thursday, December 20, 2012 10:31 AM

To: Bu Jawdeh, Habib Milhem (PG)

Habib

My apologies for not getting back to you earlier, I have now had a chance to review your document and it looks great, congratulations.

Regards

Clare [redacted]

Director of Facilities Management

Type-2 Response: Opinion Received. No Comments Provided.

RE: PhD Research

Brad [redacted] [brad.[redacted]@[redacted].com]

Sent: Saturday, December 15, 2012 5:06 PM

To: Bu Jawdeh, Habib Milhem (PG)

Sorry Habib,

I overlooked this, I am happy with what has been provided, good luck with it all

Brad [redacted]

General Manager

[redacted] Facilities Management [redacted]

Website: [www.\[redacted\].com](http://www.[redacted].com) Email: [helpdesk@\[redacted\].com](mailto:helpdesk@[redacted].com)

Type-3 Response: Apology Given. No Opinion/Feedback Provided.

RE: PhD Study

Imad [redacted] [Imad.[redacted]@redacted.com]

Sent: Sunday, December 09, 2012 10:29 AM

To: Bu Jawdeh, Habib Milhem (PG)

Sorry, I cannot help.

Regards,

Imad [redacted]

Type-3 Response: Apology Given. No Opinion/Feedback Provided.

RE: PhD Research

Hani [Hani@[REDACTED].com]

Sent: Tuesday, December 25, 2012 2:00 PM

To: Bu Jawdeh, Habib Milhem (PG)

Dear Habib,

Please accept my apology for not being able to dedicate time to give my feed back to you.

Appreciate you accept my apology for the time being

Regards,

Hani [REDACTED] LEED AP, QSAS CGP

General Manager- Pre-Contract Services

Type-3 Response: Apology Given. No Opinion/Feedback Provided.

RE: Interview for PhD Study

Christian [redacted] [cfn@[redacted].com]

Sent: Thursday, November 29, 2012 11:20 AM

To: Bu Jawdeh, Habib Milhem (PG)

Dear Habib

I have only briefly scanned the findings, but found nothing to comment on. Sorry but I will not have time to do more at the moment due to other commitments.

BR

Christian

Type-4 Response: Promise Given to Provide Feedback. No Opinion/Feedback Provided.

1/24/13

Re: PhD Research

Re: PhD Research

Samantha ([REDACTED]@[REDACTED].design[REDACTED].org)

Sent: Tuesday, January 22, 2013 12:16 PM

To: Bu Jawdeh, Habib Milhem (PG)

I'm really sorry but I do not seem to have the time to read the material.

If it is important for you to receive feedback then kindly highlight areas for me to read so that I may lessen the load.

Thank you for your understanding.

Best Regards,

Samantha

Type-4 Response: Promise Given to Provide Feedback. No Opinion/Feedback Provided.

RE: PhD Research Findings

Rick [REDACTED] [RickS@[REDACTED].com]

Sent: Sunday, December 09, 2012 8:15 AM

To: Bu Jawdeh, Habib Milhem (PG)

Dear Habib,

Thanks for the reminder and I will hope to have any comments to you this week.

Best regards,

Rick

Rick [REDACTED] MPM, ARAIA

Senior Project Manager

Type-5 Response: Delivery Fail Received. E-mail Address No Longer in Use.

Undeliverable: RE: PhD Research

postmaster@[REDACTED].com
Sent: Monday, November 19, 2012 2:49 PM
To: Bu Jawdeh, Habib Milhem (PG)

Delivery has failed to these recipients or groups:

[GrantSL@\[REDACTED\].com](mailto:GrantSL@[REDACTED].com)

There is a problem with the recipient's e-mail system. More than one person has this e-mail address. The recipient's system administrator will have to fix this problem.

Diagnostic information for administrators:

Generating server: [REDACTED].com

GrantSL@[REDACTED].com
#< #5.1.4 smtp;550 5.1.4 RESOLVER.ADR.Ambiguous; ambiguous address> #SMTP#

Original message headers:

From: "Bu Jawdeh, Habib Milhem (PG)" <H.M.BuJawdeh@edu.salford.ac.uk>
To: [REDACTED] Stewart" <Hays@[REDACTED].com>, "GrantSL@[REDACTED].com"

Subject: RE: PhD Research
Thread-Topic: PhD Research
Thread-Index: Ac0rWi4+rpgoySmTFiQ1qGUu+GFOQAha6zAABhd2oAAti6QAACjk8FACadv+Amj3xOKw==
Date: Mon, 19 Nov 2012 11:49:10 +0000
Message-ID: <D3466DA4B1B8B946A558156B6C212A2910D11310@AMSPRD0104MB102.eurprd01.prod.exchangelabs.com>
References: <D3466DA4B1B8B946A558156B6C212A2903B24772@AMSPRD0104MB102.eurprd01.prod.exchangelabs.com>

Content-Type: multipart/mixed;
 boundary="_008_D3466DA4B1B8B946A558156B6C212A2910D11310@AMSPRD0104MB102_"
MIME-Version: 1.0
Return-Path: H.M.BuJawdeh@edu.salford.ac.uk
X-OriginatorOrg: edu.salford.ac.uk

Type-5 Response: Delivery Fail Received. E-mail Address No Longer in Use.

Undeliverable: PhD Research

Postmaster@ [REDACTED]

Sent: Thursday, January 24, 2013 10:48 AM

To: Bu Jawdeh, Habib Milhem (PG)

Delivery has failed to these recipients or groups:

[Arindam.\[REDACTED\]@\[REDACTED\].com](mailto:Arindam.[REDACTED]@[REDACTED].com)

The e-mail address you entered couldn't be found. Please check the recipient's e-mail address and try to resend the message. If the problem continues, please contact your helpdesk.

Diagnostic information for administrators:

Generating server: MSC08DOM.ghdnet.internal

Arindam.[REDACTED]@[REDACTED].com

#< #5.1.1 X-Notes; User Arindam.Bose (Arindam.[REDACTED]@[REDACTED].com) not listed in Domino Directory> #SMTP#

Original message headers:

From: "Bu Jawdeh, Habib Milhem (PG)" <H.M.BuJawdeh@edu.salford.ac.uk>
To: "Arindam.[REDACTED]@[REDACTED].com" <Arindam.[REDACTED]@[REDACTED].com>
Subject: PhD Research
Thread-Topic: PhD Research
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MIME-Version: 1.0
X-OriginatorOrg: edu.salford.ac.uk

Type-5 Response: Delivery Fail Received. E-mail Address No Longer in Use.

Undeliverable: FW: Research - Facilities Management

Undeliverable: FW: Research - Facilities Management

MAILER-DAEMON@MAILER-DAEMON

Sent: Thursday, January 31, 2013 7:51 PM

To: Bu Jawdeh, Habib Milhem (PG)

Delivery has failed to these recipients or groups:

[rayc@](#)

Your message couldn't be delivered. Try to send it again later. If the problem continues, please contact your helpdesk.

The following organization rejected your message: q-mx3.

Original message headers:

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From: "Bu Jawdeh, Habib Milhem (PG)" <H.M.BuJawdeh@edu.salford.ac.uk>
To: "rayc@" <rayc@>
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Thread-Topic: Research - Facilities Management
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