Involvement of Facilities Management Specialists in Building Design: United Kingdom Experience

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Abstract: Facilities management (FM) has witnessed a rapid development since its nascence in 1980s. Following its development, the concept of involving FM specialists in building design, simply called early FM involvement, has received an increasing attention from practitioners and researchers in the last decade, which makes it possible to incorporate FM knowledge and experience into the design process. This study investigates the involvement through a series of expert interviews in the United Kingdom. The objective of this study is to get a more thorough understanding of early FM involvement practice. The analysis of interview results shows that it is very important to address a variety of potential problems, such as the lack of operability, maintainability, and serviceability, by applying FM expertise to design decision-making. Early FM involvement in design is found to be particularly useful for the improvement of cost efficiency and effectiveness from a long-term perspective. Although it has received wide recognition today, it still encounters resistance in practice. To ensure its success, there is a need for all the key stakeholders, such as project clients, designers, and FM providers, to continue to make intense efforts. **DOI: 10.1061/(ASCE)CF.1943-5509.0000343.**

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Introduction

Traditionally, design is separated from construction, operation, maintenance, and services provision. The separation of design from the postdesign processes has resulted in many problems, such as the lack of constructability, operability, maintainability, and serviceability, for designed facilities. In the last two decades, it is evident that there has been an increasing integration of design and construction in the U.K. construction industry, which is supported by government reports on industry reform, such as Latham (1994) and Egan (1998, 2002). Generally, there are two ways of integrating design and construction. One is the use of the design-build delivery method (Thomas 2006), and the other is early contractor involvement in design (Mosey 2009). In terms of constructability, design-build practices reduce constructability problems as the interface between contractor and designer in this delivery system is more rigorous than in the traditional design-bid-build system (Arditi et al. 2002). On the other hand, early contractor involvement incorporates construction knowledge and experience into the design process so that constructability can be improved together with the improvement of project performance (Song et al. 2009).

Since the late 1980s, facilities management (FM) has gradually evolved into a new discipline and profession in the construction and property industry (Tay and Ooi 2001). However, FM is usually considered to be a postconstruction service, and the direct involvement of FM specialists as a key aspect of design function has often been absent or minimal at best (Edum-Fotwe et al. 2003).

In this paper, the involvement of FM specialists in design is simply described as early FM involvement. Following the increasing integration of design and construction, various research efforts have been made in the United Kingdom to explore how to integrate design with operation, maintenance, and services provision, which are represented by the FM profession. As a result, the importance of early FM involvement has been gradually recognized by practitioners and researchers. According to Jaunzens et al. (2001), the FM profession has the prime responsibility for managing buildings—both their facilities and services—and therefore there is a need to encourage greater emphasis on applying their expertise to building design. Similarly, Duffy (2000) suggested that facilities managers should learn to work with architects and designers and vice versa so that building systems and working environments can better satisfy clients and end users.

In addition to the United Kingdom, early FM involvement in building design has also attracted an increasing attention from the practitioners and researchers in other countries of the world, e.g., Arditi and Nawakorawit (1999), Dunston and Williamson (1999), Meier and Russell (2000), and Erdener (2003) in the United States, Bröchner (2003) in Sweden, Silva et al. (2004) in Singapore, Jensen (2009) in Denmark, and Mohammed and Hassanain (2010) in Saudi Arabia. Undoubtedly, these research efforts have contributed to the encouragement of early FM involvement throughout the world. However, there are some obvious limitations within previous studies. First of all, many previous studies, such as Arditi and Nawakorawit (1999), Dunston and Williamson (1999), Meier and Russell (2000), Chew et al. (2004), and Silva et al. (2004), are biased toward maintainability. Therefore, operability, serviceability, and other key issues in relation to the whole life cycle have not received enough emphasis. Second, many previous studies have only limited empirical data support. For example, Bröchner (2003) was mainly based on the author's knowledge and experience, Edum-Fotwe et al. (2003) only provided a particular case study to demonstrate early FM involvement in the design process of a hospital project under the private finance initiative (PFI) scheme, and

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Mohammed and Hassanain (2010) established a theoretical framework through a review of the literature. The limitations within previous studies form a barrier to a systematic understanding of how design integrates with FM in today's practice.

Unlike previous studies, this research explores early FM involvement in the design process by interviewing a series of industrial experts in the United Kingdom. The objective of this research is to get a more thorough understanding of early contractor involvement practice. More than 30 industrial experts, such as facilities managers, maintenance managers, architects, and design engineers, are interviewed. This research aims to answer the questions concerning (1) whether early FM involvement in design has significantly increased in today's practice; (2) what are the benefits from early FM involvement; (3) what types of projects are more suitable for early FM involvement; (4) what problems may occur if FM specialists are not involved in design; (5) what are still the barriers to early FM involvement; and (6) how to encourage the wide use of FM expertise during building design. On the basis of the analysis of interview results, a deeper insight is provided for the integration between building design and FM in the United Kingdom, which may also be useful for the relevant practice in other countries of the world.

Importance of Early Project Phases

The life cycle of a project can be broken down into different phases. As seen in Fig. 1, there are seven major phases during a construction project from inception, through briefing and feasibility, design, tender and construction preparation, construction, commission and handover, to occupancy that covers operation, maintenance, and services provision represented by the FM profession (Uher and Loosemore 2004; Pryke and Smyth 2006). Inception, briefing/feasibility, and design are generally regarded as three early phases. A project initiates with the definition of the client's objectives and the identification of possible constraints (Fewings 2005). The inception is followed by briefing/feasibility, during which a project brief is prepared, and the possibilities of achieving the client's objectives are justified (Kamara et al. 2002). On the other hand, design develops from an outline brief to a detailed proposal for the project (Gray and Hughes 2001). According to the Project Management Institute (PMI), compared with a late phase, the level of uncertainty, risk and stakeholder influence during an early phase is much higher, but the cost for change during an early phase is much lower (Project Management Institute 2008). Some construction researchers, such as Kolltveit and Grønhaug (2004), also confirmed the importance of early project phases. For this reason, Mosey (2009) believed that the greatest opportunities for improving the overall project results are at the front end of a project.

During briefing and design, most decisions are made and they have a major influence on later project phases, such as construction and FM (Erdener 2003). Generally, briefing provides strategic decisions, whereas design provides technical decisions (Fewings 2005). In traditional practice, it was not uncommon that these decisions were made without the realization of construction and FM's requirements and the identification of end users' needs (Erdener 2003). The design process is further broken down into outline design, scheme design, and detailed design (Gray and Hughes 2001). Early design links strategic decisions with technical decisions. To avoid inappropriate decisions, construction contractors and FM specialists can be involved from early design (El-Haram and Agapiou 2002; Song et al. 2009). Early contractor involvement and early FM involvement make it possible to incorporate knowledge and experience of construction and FM into the design process, respectively. A main purpose of involving construction contractors and FM specialists early is to address potential problems as early as possible in a proactive manner and allow later project phases to make contributions to early project phases. For example, the FM feedback represents the use of postoccupancy evaluation results (Erdener 2003). Such FM feedback from buildings in use helps to identify any errors and failures within past designs and provide inspiration for the design of more robust buildings (Bröchner 2003). By adopting early contractor and FM involvement, it is also helpful to integrate the whole supply chain.

Research Methods

This research starts with a comprehensive review of the relevant literature. The literature review is followed by a series of expert interviews to collect empirical information about early FM involvement in building design. As mentioned previously, many early studies in this area have only limited empirical data support. For the small number of early studies in which there is sufficient empirical data support, almost all of them have adopted the questionnaire survey. For example, Arditi and Nawakorawit (1999) conducted a questionnaire survey in the United States to investigate the relationship between design practices and maintenance considerations. On the basis of a questionnaire survey, Silva et al. (2004) identified the key aspects that would enable Singapore's construction industry to improve the level of building maintainability. According to many methodology researchers, such as Flick (2009) in general and Knight and Ruddock (2008) in construction, quantitative methods, such as the questionnaire survey, have been the

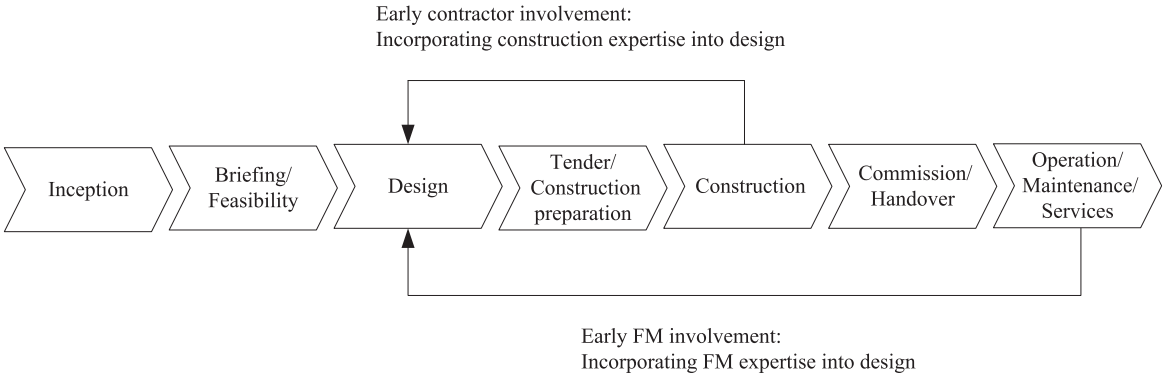

Fig. 1. Project lifecycle and early involvement

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dominant paradigm over the years. Although a questionnaire survey is advantageous of having access to many people, it is very difficult for a questionnaire survey to collect in-depth information from respondents (Gillham 2000). In recent years, qualitative methods, such as the expert interview or case study, have been acknowledged for their contributions to academic research (Bryant and Charmaz 2010). Unlike previous studies, this research adopts the expert interview as a main methodology. The interaction between interviewers and interviewees provides in-depth evidence for early FM involvement. Although the expert interview is generally recognized as a typical qualitative method, to some extent, it is possible to make statistical analysis of interview results. Based on the interviewees' responses in this study, for example, the percentage of the interviewees who have ever experienced early FM involvement can be analyzed in a statistical manner.

In this research, the interviewees are selected from different types of organizations in relation to FM and building design, e.g., FM companies, FM consultancies, FM professional associations, client organizations, and design firms. The interviewees have different backgrounds, such as healthcare, education, local authority, commercial business, and property and estate management. The interviewees from the FM perspective represent both in-house FM and outsourced FM. Most of them hold individual memberships of the British Institute of Facilities Management (BIFM). All interviewees have 5–20 years of working experience in the industry. Almost all of them are in the key positions in relation to FM and building design. The interviewees are selected from different regions of the United Kingdom, including England, Scotland, Northern Ireland, and Wales. As a result, a total of 31 industrial experts are interviewed. The distribution of interviewees' roles is shown in Fig. 2. Among the interviewees participated in this empirical study, 74.2% are FM specialists, such as facilities managers and maintenance managers. In addition, 25.8% of interviewees come from design teams and client organizations, in which their roles include design project manager, architect, structural engineer, mechanical and electrical (M&E) engineer, client representative, and development manager. The purpose of interviewing these experts is to listen to the voices from design and client perspectives about early FM involvement. The interviews are carried out face-to-face or through telephone. All the industrial experts are interviewed individually. Each interview lasts around an hour. The interviews are semistructured, during which the interviewees are allowed to express their views and opinions openly and freely. The sample provides a good representation of the population. The well-prepared interviews ensure the reliability and validity of their results.

Change in Early Facilities Management Involvement Practice

According to early studies, such as Edum-Fotwe et al. (2003), previously there was little incorporation of FM requirements during design, although its importance was highlighted. In this research, 80.6% of the interviewees have experienced early FM involvement in design, whereas 19.4% of them have not had such an experience. Compared with early studies, this research provides more empirical evidence for applying FM expertise to building design in today's practice. Instead of inception, briefing, or feasibility, the interviewees reveal that in practice FM specialists are usually involved from early design. Although it is hard to conclude that early FM involvement becomes widespread, there is no doubt that the use of early FM involvement is increasing. Despite that, most of the interviewees point out that, throughout their career, early FM involvement is still an exception rather than a common practice. This means that, among the projects in which they have participated, the proportion of early FM involved projects is generally not high. For this reason, involving FM specialists in design is found to be twofold. On one hand, the increasing use of early FM involvement is quite inspiring. On the other hand, it is not unusual for FM knowledge and experience not to be considered during design decision-making, and therefore, there is still a long way to go for a radical change in the whole industry in terms of integrating design with FM.

Benefits from Early Facilities Management Involvement

During the interviews, the consensus is that FM specialists, especially facilities managers, should be involved in the design process. This is because of the wide recognition of the benefits from incorporating FM expertise into design. In fact, the benefits have

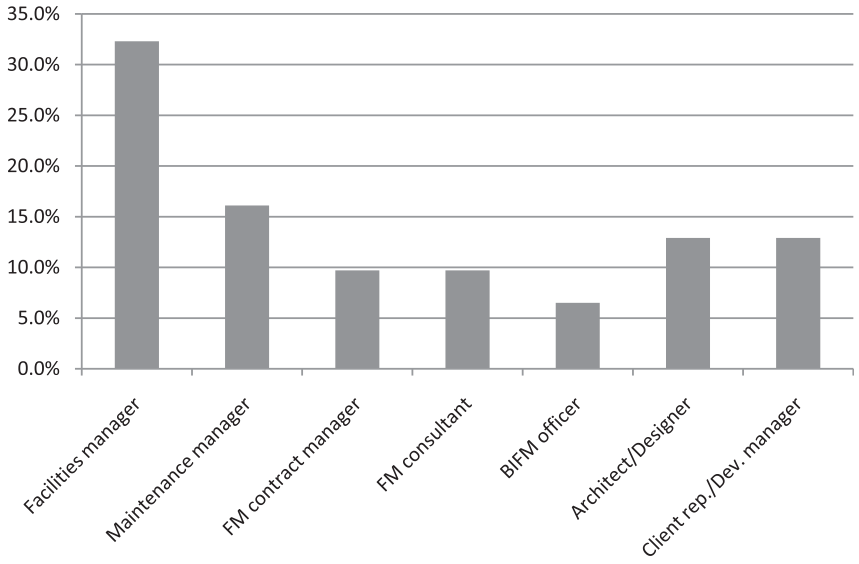

Fig. 2. Distribution of interviewees' roles

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been identified by some previous studies. For example, Jaunzens et al. (2001) stated that involving the facilities manager in the design process and encouraging the design team to take on board the needs of the facilities manager should result in buildings that are as follows:

- Better suited to meet business needs;
- More attractive to clients;
- Easier to commission and maintain;
- Easier to control and manage;
- More cost effective to operate; and
- Better able to respond to the needs of the occupants.

Similar to previous studies, such as Jaunzens et al. (2001), the interviewees in this research agree that early FM involvement benefits all the key stakeholders. Unlike previous studies, this research identifies the benefits from the client, designer, FM provider, and end user perspectives.

The main concern of the client is value for money (Sarshar and Pitt 2009). According to the interviewees in this research, early FM involvement helps to ensure that the completed project is fit for purpose and represents value for money. By adopting early FM involvement, the client mainly benefits from the following:

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

The FM profession plays a leading role in operating and maintaining facilities and providing services in practice (Ventovuori et al. 2007). The interviewees in this research believe that early FM involvement allows FM professionals, such as facilities managers, to attend design meetings in which opportunities are given for their comments to be taken on board. Because FM professionals are in the best position to know the functionality and practicability of a building, their involvement in design benefits all the key stakeholders. From the perspective of FM provider itself, the benefits may include the following:

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

Over the last three decades, there has been an increase in the complexities of building systems and other support services (Mohammed and Hassanain 2010). As a result, building design has to meet changing requirements. According to the interviewees in this research, however, it is often the case that most designers only see their design on paper, although they think that they are the experts in design. This means that they do not see how their design is working on a day-to-day basis. For this reason, the designer will benefit from early FM involvement because it helps to:

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

Previous studies, such as Kaya (2004), have criticized that the needs of end users and occupying organizations are often ignored during briefing and design decision-making and designers do not understand business processes. The interviewees in this research state that, compared with the design team, the FM team better understands users and occupants' needs. For this reason, early FM involvement can benefit users and occupants by:

- Reflecting their concerns and expectations during design;
- Providing a safer, healthier, and more attractive working environment;
- Supporting productivity and improving work efficiency; and
- Providing more flexibility for changing requirements.

Suitability of Early Facilities Management Involvement

In theory, FM specialists can be involved in the design process of any project. In this study, however, the analysis of interview results shows that some types of projects may be more suitable for early FM involvement than other types of projects. By comparison, FM specialists are most likely to get involved in the design process of PFI projects, which is agreed on by 67.7% of the interviewees. This is because PFI is a particular form of public private partnerships (PPPs) used by the U.K. government, in which the private sector led by a project company generally designs, builds, finances, and operates (DBFO) a public project for a specified period of time, e.g., 25–30 years. In a PFI project, the project company takes a single point responsibility of design, construction, and operation, which allows the designer, contractor, and FM provider to integrate together (Fig. 3). As a result, the FM provider becomes an integral member of the whole team, and good communication is practiced between team members. A PFI project is quite long. To achieve the overall success of a PFI project, FM specialists' comments and requirements need to be actively considered.

The finding helps to explain why many previous studies in relation to early FM involvement, such as El-Haram and Agapiou (2002) and Edum-Fotwe et al. (2003), were all based on particular PFI projects in the United Kingdom. According to Edum-Fotwe et al. (2003), for example, the PFI scheme presents opportunities to ensure that the design function addresses the optimum value option for operating facilities through the possible involvement of

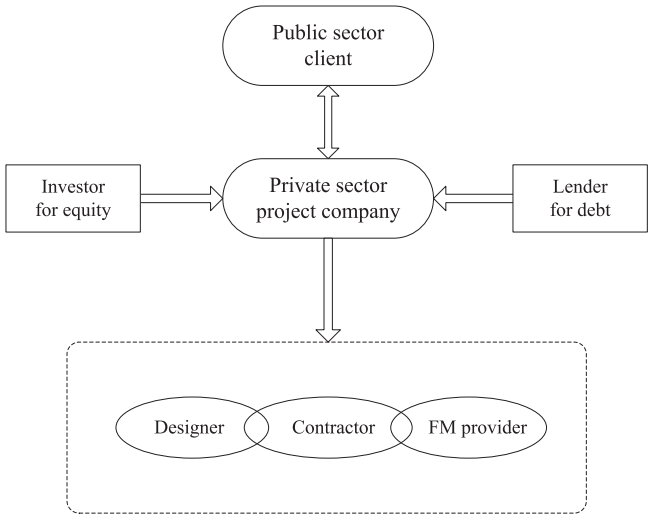

Fig. 3. Integration of design, construction, and FM under a PFI scheme

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the FM team at the design stage. On the other hand, El-Haram and Agapiou (2002) summarized that the responsibilities of a facility manager during the design process of a PFI project include (1) reviewing and assessing the design from operability, maintainability, and serviceability points of view; (2) identification and selection of the optimum operation scenario; (3) identification and selection of the optimum maintenance and replacement strategies; and (4) liaison with the design and construction teams to select the cost-effective design option, which will optimize whole life costing.

Although the role and process of early FM involvement in a new build project should be the same as in a refurbishment project, a new building project is found by 35.5% of the interviewees in this study to less practice early FM involvement compared with a refurbishment project. According to these interviewees, a new build project is a blank canvas, and the design team has enough freedom to do what they like. For a refurbishment project, the design is constrained with existing facilities, and the design team has to work with the FM team. This is the main reason why FM specialists are more involved in a refurbishment project than in a new build project. In a new build project, previous experience of similar types of projects is helpful, whereas in a refurbishment project, historical data of existing equipments and systems become more important.

In this research, 25.8% of the interviewees perceive that the influence of FM on design is also dependent on whether FM is retained in-house or outsourced. An important finding during the interviews is that the comments of in-house FM are often taken into account during design decision making compared with outsourced FM not being considered. This means that, if FM is outsourced, the comments of FM specialists may not be considered important because they are external. According to 19.4% of the interviewees, on the other hand, FM specialists are more likely to be involved in design if a client is the end client. They believe that completed projects that do not match users and occupants' requirements are difficult and expensive to operate, maintain, and manage. For this reason, the end client is more interested in early FM involvement and whole life costing than the client who does not occupy and use the building. Compared with the end client, the client who is not an occupant and a user is more concerned with completing a project as early as possible and spending as little money as possible. As a result, such clients have little or no motivation of incorporating FM expertise into the design process.

In addition, large projects are considered by 16.1% of the interviewees to be more likely to adopt early FM involvement, in which it is possible to generate enough benefits if FM professionals get involved in the design process. Similar to large projects, complex projects are considered by these interviewees to make FM professionals working closely with designers, and this is perhaps more evident in hospital projects. In large and complex projects, clients would like to pay for the cost of involving the FM team early because it makes the design more robust, and meanwhile, savings during operation, maintenance, and services provision will be much greater than the cost paid for early FM involvement. For a small and simple project, on the other hand, the client normally does not appoint the facilities manager until the construction is near completion and it is not necessary for the client to consume the FM resource at the early stage. The finding helps to explain why the identification of benefits is the driver and initiator of involving FM knowledge and experience in the design process. If there are not enough benefits from early FM involvement, it is easy for the client to ignore the FM team during the design process. Based on the discussion and comparison provided previously in this section, the suitability of early FM involvement is summarized in Table 1.

Table 1. Summary of Early FM Involvement Suitability

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

Problems because of Lack of Early Facilities Management Involvement

When identifying the benefits of early FM involvement in design, it is viewed from a positive perspective. All interviewees in this research agree that it can also be viewed from the negative perspective, indicating that various problems may come out if FM specialists are not involved in design. The identification of problems enhances the awareness of the risks for ignoring FM, which are not only related to facilities managers and maintenance managers but also associated with clients, designers, and end users. According to the interviewees in this research, the lack of early FM involvement may cause problems in all aspects of a building from inappropriate use of materials and equipment to poor space layout, all of which are complicated and more costly to rectify once the building is completed. Without early FM involvement, there will be no feedback on proposed design elements. As a result, problems are less likely to be identified in advance and not possible to be solved as early as possible. The occurrence of problems will make the designed facilities difficult and expensive to operate, maintain, and manage after the project is put into use. Rather than the analysis of design flaws, quite often the FM team gets blamed for the problems.

In addition to the expression of the previous viewpoints, some examples are provided by the interviewees to illustrate the problems caused by ignoring early FM involvement. For example, a facilities manager interviewed in this study has encountered a design problem when they were brought in to carry out the maintenance of a refurbished building. The wrong choice about M&E equipment during design left them to fill in the gap. As a result, they had to redesign certain elements. If FM specialists were consulted during the design process, they would be able to identify and prevent such a problem in advance. On the other hand, another facilities manager has participated in the design of a new building, in which a design flaw was that the designers did not plan for any fire escape doors on the higher floors. Fortunately, he identified the problem when he was consulted by the design team. As he has mentioned, it could be highly problematic if he did not identify this flaw before the design was finished.

As for whether a lack of early FM involvement will definitely cause problems or not, the opinions of the interviewees from the FM perspective are something different from those from the design perspective. The interviewees from the FM perspective believe that, without early FM involvement, there is no doubt that problems will occur during operation, maintenance, and services provision. The common understanding of these interviewees is that a project is not simply just constructing the shell of a building. In addition to aesthetic appearance, the design of a building should ensure functionality and practicability, e.g., operability, maintainability, and

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serviceability. Although M&E engineers involved in the design team may be experienced in equipment, on the whole, the design team has not as much experience as the FM team in terms of operating and maintaining facilities and providing services. If FM expertise is forgot, design flaws will be inevitable, which are not clear during design but become apparent after occupancy.

On the other hand, not all the interviewees from the design perspective agree with the views and opinions mentioned previously. Approximately half of the design experts interviewed in this study comprehend that early FM involvement only enhances the design, but they do not think that a design delivered by the design team without early FM involvement is not of a high quality. Their viewpoint is that obvious and major problems do not really occur if FM specialists are not involved in the design because other members of the design team will generally identify the flaws. Although these design professionals do not oppose early FM involvement, their expression indicates that they may have a skeptical attitude toward the FM input. It means at least that they are not active for involving the FM team. An explanation of this issue provided by the interviewees from the FM perspective is that some architects and designers still look at the FM profession as a postoccupancy role rather than a preoccupancy role and as a reactive role rather than a proactive role. More clearly, they do not intend to fully embrace the concept of early FM involvement. In addition to a misunderstanding the FM role, design experts are concerned about the communication with FM practitioners. For example, several interviewees from the design perspective state that sometimes there are conflicts between the design team and the FM team. They argue that it may be more expensive and time consuming in such a case. Obviously, this becomes a barrier to early FM involvement practice.

How to Overcome Barriers

As discussed previously, it is not unusual for FM expertise to be ignored during design decision making, although the importance of early FM involvement has been generally recognized by practitioners and researchers. On the basis of the interviews in this study, it is found that some barriers to the wide use of early FM involvement still exist in today's practice. The main barrier caused by client organizations is that most clients are cost constrained, capital cost driven, and short-term focused. The interviewees express that the FM role in design is redundant if the client's goal is to get a project completed with as little financial outlay as possible. This is perhaps more obvious when a client is not the end user. Generally, there is a lack of awareness of whole life concept for the clients who do not occupy and use the buildings. As a result, they do not want to pay a little more on materials and equipment at the design and construction stages to generate much more cost savings during operation, maintenance, and services provision. A common understanding of the interviewees is that the enhancement of the client's awareness of whole life costing is extremely important to overcome this barrier, which is shown in Fig. 4. To have a greater input, the FM team must be able to demonstrate that their involvement can benefit the client in terms of long-term value.

Similar to the client, the design team often does not recognize the long-term benefits from early FM involvement. The interviewees from the FM perspective criticize that designers often only consider the present situation without a long-term plan, partly because of their misconception and partly because they are subject to clients' pressure on capital cost saving. Therefore, there is a need to place a greater emphasis on whole life costing in the industry. Another barrier caused by designers is that they often look down on the FM role as an afterthought. According to the interviewees, it is not appropriate to design a building at two distinct stages, like build the building and then install the facilities. On the contrary, it is appropriate to merge these two processes into one process, whereby the design and FM teams work together, sometimes compromising to seek the best solution so that a quality product can be delivered to the client. The interviews help to identify that the ignorance of early FM involvement is also because of the design team's low priority to functionality and practicability. Therefore, it is important for architects and designers to better understand how to keep an appropriate balance between different quality features of a building, such as aesthetics, reliability, durability, conformance, functionality, and practicability. A design team is influenced by the client. This means that whether FM specialists can be involved and whether their comments can be considered very much depend on the client's attitude. If early FM involvement is not required by the client, the design team often only is concerned with getting the job done and moving on to the next job. For this reason, the enhancement of the client's awareness shown in Fig. 4 also helps to overcome the barriers from the design perspective.

FM is still in its infancy. As seen in Fig. 4, many FM practitioners are not knowledgeable and experienced enough, which becomes a barrier to their involvement in the design process. If more FM practitioners become well educated and professionally qualified, according to the interviewees, it may increasingly influence the design team to include the FM input. The interviewees believe that FM knowledge and experience can be achieved by (1) establishing educational standards; (2) developing practical standards; (3) having professional qualification training; (4) learning from occupant feedback; and (5) making continuous self-assessment. In addition to FM professional training, the interviewees from the design perspective think that FM practitioners need to have design training to be effective at the design stage. This means that the FM profession may play a more important role if they have more knowledge and experience in design and construction. For example, knowledge and experience in design and construction should be diffused through university education and professional training in the FM discipline, in which case studies can be provided for a better understanding of design and construction practice. Early FM involvement in design can be explained as an interaction between the design team and the FM team. The interviewees believe that the highlight of the importance of early FM involvement does not indicate that FM specialists lead architects and designers. On the contrary, the interaction between the design team and the FM team is often an exercise in compromise. They should learn from each other and they should know how to have a good dialogue. From the FM perspective, they must realize that their involvement means constructive comments and suggestions rather than blame allocation. To ensure the success of their involvement, FM specialists need to develop their communication skills.

On the basis of the previous analysis and discussion, a model is developed in Fig. 4 to categorize the barriers to early FM involvement in design and illustrate how to overcome these barriers. The model exhibits a hierarchical structure. First of all, barriers are identified from three different sources: client, design, and FM organizations. The detailed barriers from each source are described at the second level. For example, the detailed barriers caused by design organizations mainly include the underestimation of FM, separation of facilities design from building design, and low priority to functionality and practicability. At the third level, a measure is created accordingly to overcome each individual barrier. To overcome the barrier Separation of facilities design from building design, for example, integrated processes should be emphasized in design practice. The model can be considered as a contribution of this research to knowledge of design and FM. It provides different

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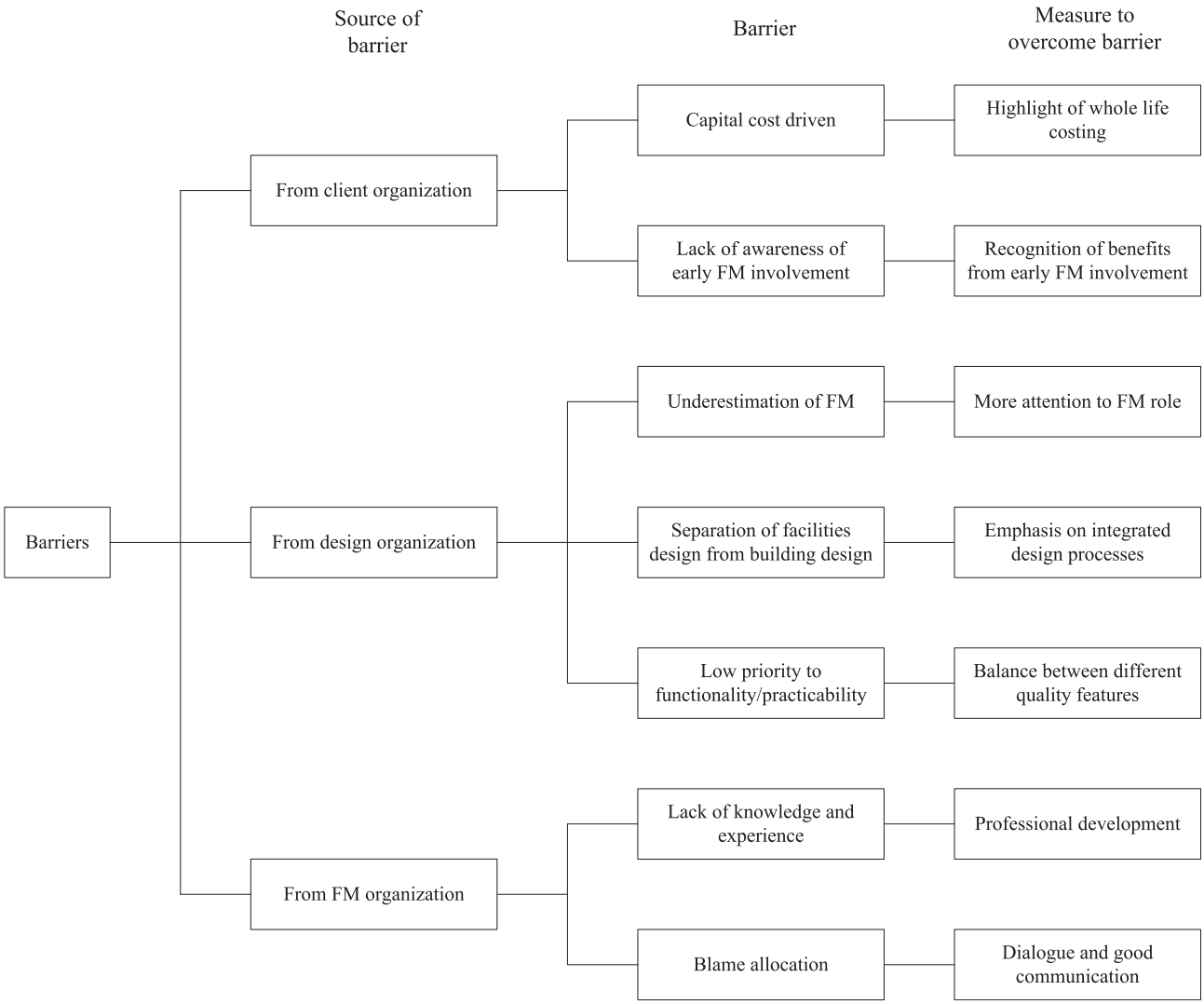

Fig. 4. Model for how to overcome the barriers to early FM involvement in design

stakeholders with a systematic framework for the improvement of their practice in terms of integrating design with FM. This model is a general template, based on which the key stakeholders can customize it by identifying any further barriers and taking appropriate actions in their own organizations.

Conclusions

On the basis of a series of interviews with industrial practitioners in the United Kingdom, this empirical study explores early FM involvement in the design process. It is found that there is an increasing recognition of the importance of early FM involvement and an increasing use of early FM involvement in today's practice. Early FM involvement not only benefits FM providers but also benefits other key stakeholders, such as clients, designers, and end users. By comparison, incorporating FM expertise into design is most suitable for the PFI scheme, in which design, construction, and FM are integrated together. If FM specialists do not get involved in design, various problems may occur during operation, maintenance, and services provision, which demonstrates the importance of early FM involvement from the opposite side. Although early FM involvement in design has been widely recognized by practitioners and researchers in the United Kingdom, there are still some barriers to its wide application. To overcome the barriers, more efforts need to be made for enhancing the awareness of client and design organizations and developing the knowledge and skills of FM practitioners.

The knowledge and experience of both construction and FM can be incorporated into design decision making. The increasing use of early contractor and FM involvement establishes a link between design stage and later stages of a construction project. It also helps to address the problems for the lack of constructability, operability, maintainability, and serviceability during early design. On the other hand, it can be considered as a strategy of developing an integrated project team. Before involving the FM team in design, it is important for the client to select knowledgeable and experienced FM specialists. Obviously, the appropriate selection of FM specialists is a prerequisite for the success of early FM involvement practice. For this reason, a recommendation for further research is to identify which method is most suitable for the selection of FM specialists whose comments are crucial to design decision-making. As a result of involving the FM team in design, the effect of early FM involvement can be seen from the avoidance of design defects. In this respect, some examples have been provided in this study. Further research can be outlined to collect more empirical information and analyze the real effect of early FM involvement on performance

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improvement during operation, maintenance, and services provision, which will help to better understand the value of incorporating FM expertise into design.

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