TOWARD AN EFFECTIVE DESIGN PROCESS: ENHANCING BUILDING PERFORMANCE THROUGH BETTER INTEGRATION OF FACILITY MANAGEMENT PERSPECTIVES IN THE DESIGN PROCESS

A Dissertation

by

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ABSTRACT

In today's architecture and construction industry, there is a growing agreement that the input of facility management professionals (FMs) can be a vital resource during the architectural design process. FMs are responsible for the everyday operation of buildings, and are therefore aware of many practical details of maintenance and efficiency that designers may overlook. In this study, the current state of the facility management industry and the extent of FMs' collaborations with designers were examined in the United States, the United Kingdom, and the Middle East. The objective was to understand the challenges and concerns faced by FMs in these diverse regions, and to determine how the process of collaboration could be improved so that the accumulated knowledge of FMs can better inform design. The study included a comprehensive literature review of previous work on this topic, in-depth interviews with prominent facility management professionals, and a broad quantitative survey of FMs in the three study regions. An analysis of the interview and survey data revealed the nature of existing collaborations and their benefits, as well as barriers against collaboration and suggestions for overcoming those barriers. Difficulties in communication between the two fields were found to be the most pervasive obstacles, closely followed by a perceived lack of interest on the part of designers. The study data also allowed for a comparative analysis of FM–designer collaborations in the U.K., the U.S., and Middle East, and led to suggestions about the most effective times during a project's life cycle for FMs to provide input to designers. The study results indicate that interventions to

improve training and awareness in both fields may be particularly effective in increasing the benefits of collaboration. A process model for more effectively integrating the knowledge of FMs into the design process is also provided based on the study results.

DEDICATION

I dedicate my dissertation to my loving parents, Ali and Mahin Kalantari, whose endless love, support, and encouragement ring in my ears.

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TABLE OF CONTENTS

Page

ABSTRACT ii

DEDICATION iv

ACKNOWLEDGEMENTS v

TABLE OF CONTENTS vii

LIST OF FIGURES xii

LIST OF TABLES xvi

CHAPTER I INTRODUCTION 1

1.1. Problem and Setting 1
1.2. Significance of the Project 3
1.3. Research Aims and Objectives 5
1.3.1. Aim One: Understand International Facility Management Challenges and Their Potential Impact on Building Performance 5
1.3.2. Aim Two: Provide Recommendations for Effective Communication between Facility Managers and Designers with the Goal of Enhancing the Quality of Design 6
1.4. Conceptual Framework 7
1.5. Research Questions 9
1.5.1. Research Questions Related to Aim One 9
1.5.2. Research Questions Related to Aim Two 9
1.6. Overview of the Dissertation 10

CHAPTER II LITERATURE REVIEW 12

2.1. Introduction 12
2.2. Scope and Method of Review 13
2.3. Building Performance and Post Occupancy Evaluation (POE) 14
2.3.1. POE Definition 14
2.3.2. POE Benefits and Barriers 15
2.3.3. Theoretical Approaches 18
2.3.4. Post-Occupancy Evaluation and Facility Management 21
2.4. High Performance Design Process 23

2.4.1. Design Process 23
2.4.2. Performance-Based Design Process 29
2.4.3. Design Process and Post-Occupancy Evaluation 30
2.4.4. Lean Thinking in Design Process 31
2.5. Facility Management Involvement in Design Process 39
2.5.1. Facility Management 39
2.5.2. History of Facility Management Integration in Building Design Process 40
2.5.3. The Benefits of Facility Managers' Involvement in the Design 41
2.5.4. Problems that Arise When Facility Managers Are Not Involved in the Design Process 44
2.5.5. At What Point in the Design Process Should Facility Managers Become Involved? 45
2.5.6. Models of Collaboration 46
2.5.7. Barriers Against Facility Managers' Involvement in the Design 49
2.5.8. Knowledge Management in the Design Process 52
2.5.9. Use of BIM and Integration of Facility Managers in Design Process 53

CHAPTER III RESEARCH DESIGN AND METHODOLOGY 55

3.1. Introduction 55
3.2. Multi-Methodology Approach 55
3.3. Qualitative Method 56
3.3.1. Theoretical Paradigm 56
3.3.2. Interviews 57
3.3.3. Sampling 62
3.4. Quantitative Method 62
3.4.1. Developing the Survey Questionnaire 62
3.4.2. Participant Recruitment and Data Collection Procedure 63
3.5. Research Validity 64
3.6. Research with Human Subjects 65
3.7. Summary of Methodology 65

CHAPTER IV INTERVIEW ANALYSIS 66

4.1. Introduction 66
4.2. Data Analysis Procedure 66
4.2.1. Unitizing Information 66
4.2.2. Categorization 68
4.2.3. Classifying Themes 68
4.3. Theme I: Context 70
4.4. Theme II: The Current State of Facility Management in the United Kingdom, the United States, and the Middle East 75
4.4.1. Facility Management in the United Kingdom 76

4.4.2. Facility Management in the United States 79
4.4.3. Facility Management in the Middle East 79
4.4.4. Comparison of Facility Management Cultures: The United Kingdom vs. the United States 81
4.4.5. Comparison of Facility Management Cultures: The United Kingdom and the United States vs. the Middle East 82
4.5. Theme III: Communication Within Facility Management Firms 83
4.5.1. Facility Management Meetings 83
4.5.2. Feedback Loops Within Facility Management Firms 85
4.5.3. Facility Managers' Vision of Their Industry 86
4.5.4. Facility Managers' Vision of Designers 87
4.6. Theme IV: Relationships between Designers and Facility Managers 88
4.6.1. Communication Issues 88
4.6.2. Relationships between Designers and Facility Managers after Building Occupancy 90
4.6.3. The Need for Better Training 91
4.6.4. Knowledge Management 92
4.7. Theme V: Facility Managers' Involvement in the Design Process 93
4.7.1. Motivators and De-Motivators of Facility Managers for Collaboration in Design 93
4.7.2. Other Factors Affecting the Likelihood of Collaboration 94
4.7.3. The Benefits of Collaboration 95
4.7.4. When Should Collaboration Begin? 97
4.7.5. Solutions for Integrating Facility Managers into the Design Process 98

CHAPTER V SURVEY ANALYSIS 100

5.1. Introduction 100
5.2. Procedure 100
5.3. Data Analysis Method 103
5.3.1. Tool 103
5.3.2. Descriptive Statistics 103
5.3.3. Analysis of Variance (ANOVA) and Chi-Square tests 104
5.4. Demographic Information 104
5.4.1. Job Title 104
5.4.2. Training 105
5.4.3. Work Experience 106
5.4.4. Location 107
5.4.5. Specialization 109
5.5. General Results 110
5.5.1. Organizational Protocol 110
5.5.2. Lean Principles in Facilities Management 115
5.5.3. Current Challenges in the Facility Management Industry 116
5.5.4. Experience in Working with Designers 118

5.5.5. FMs' Early Involvement in Design Process....121
5.5.6. Communication Between FMs and Designers....123
5.5.7. Suggestions for Integrating FMs into the Design Process....126
5.6. Hypotheses Testing....128
5.6.1. The Impact of Training and Role in the Company....129
5.6.2. Country of Origin....132
5.6.3. Confidence in Sharing Opinions....138
5.6.4. Respondents' View of Designers....141
5.6.5. Impact of Occupants....143
5.6.6. Lean Principles....144
5.6.7. Number of People Supervised....145
5.6.8. Rates of Collaboration....147
5.6.9. Training....150
5.7. Summary....151

CHAPTER VI DISCUSSION....152

6.1. Collaboration Between Facility Managers and Designers: Comparing the United Kingdom, the United States, and the Middle East....152
6.2. The Early Involvement of Facility Managers in the Design Process....157
6.3. Communication between FMs and Designers....164
6.4. How to Better Integrate FMs into the Design Process....169

Chapter VII CONCLUSION....177

7.1. Summary....177
7.2. Discussion of Limitations....180
7.3. Recommendation for Future Research....181
7.4. Closing....183

REFERENCES....184

APPENDIX A IRB LETTER....196

APPENDIX B INTERVIEW RECRUITMENT LETTER....198

APPENDIX C INTERVIEW INFORMATION SHEET....199

APPENDIX D SURVEY RECRUITMENT LETTER....201

APPENDIX E SURVEY INFORMATION SHEET....202

APPENDIX F WAIVER OF DOCUMENTATION OF CONSENT....204

APPENDIX G INTERVIEW QUESTIONS....205

APPENDIX H SURVEY QUESTIONS 208

LIST OF FIGURES

Page

Figure 1. Conceptual Framework 8

Figure 2. POE as Facility Management Tool 23

Figure 3. Design Development Spiral with Additional Respect to the Sustainability 25

Figure 4. The Map of Managing the Building Design Process and 14 Toyota Way Principles 38

Figure 5. Project Lifecycle and Early Involvement 44

Figure 6. Present Framework 47

Figure 7. Modified Framework 47

Figure 8. The Role of the Facility Management Team within the Integrated Design Team 48

Figure 9. The Detailed Flow of the Design Modification Loop 49

Figure 10. Model for How to Overcome the Barriers to Early FM Involvement in Design 51

Figure 11. General Knowledge Database for Maintenance Issues 54

Figure 12. Example of a Unit Card 67

Figure 13. Demographic Information of Participants: Gender 73

Figure 14. Demographic Information of Participants: Level of Education 73

Figure 15. Distribution of Interviewees' Roles 75

Figure 16. A Common Hierarchy of Management Levels in Facility Management Companies in the Middle East 81

Figure 17. Survey Completion Rate (Percentage of Survey Questions Answered by Number of Individuals) 102

Figure 18. Survey Duration (Amount of Time Individuals Spent Completing the Survey) 102

Figure 19. Respondents' Job Titles (Partial List) 105

Figure 20. Level of Training 106

Figure 21. Work Experience 107

Figure 22. Distribution of Locations Where Respondents Have Worked in the Facility Management Industry 108

Figure 23. Map of Locations Where Respondents Have Worked in the Facility Management Industry 108

Figure 24. Areas of Specialization 109

Figure 25. Meeting Regularity 110

Figure 26. Participants in the Management Meetings 111

Figure 27. Sharing Opinions in Management Meetings 112

Figure 28. Facility Management Companies' Success in Enhancing Building Performance, as Perceived by Respondents 113

Figure 29. Number of Respondents by Amount of People They Supervise 114

Figure 30. Regularity of Receiving Complaints from Building Occupants 115

Figure 31. The Use of Lean Principles in Facility Management 116

Figure 32. FM's Experience in Working with Designers 119

Figure 33. Post-Occupancy Relationships between FMs and Designers 120

Figure 34. FMs' View of the Importance of Having a Relationship with Designers 120

Figure 35. Early Involvement of Facility Managers in the Design Process 121

Figure 36. FM's Most Commonly Referenced Consultants 122

Figure 37. Fields That FMs Believe Have the Most Shared Understanding with Facility Management 123

Figure 38. FMs' Beliefs about the Value of Their Feedback in the Design Process, and Their Beliefs about the Likelihood of that Feedback Being Heard 124

Figure 39. Positivity of Designers about Collaboration with FMs in the Design Process 125

Figure 40. Efficiency of Designers' Proposals in Solving Building Maintenance Problems 126

Figure 41. Respondent's Perceptions of the Best Time to Initiate Collaboration 128

Figure 42. ANOVA Analysis: Impact of Length of Work Experience on Sharing Opinion in the Company Meetings (*p-value*=0.0043) 129

Figure 43. ANOVA and Chi-Square Analysis: Impact of Length of Work Experience on the Believe of Relationship with Designers as a Necessary Step to Achieve a High-Performance Building (*p-value*=0.0118 and 0.0195) 130

Figure 44. Using LEAN Principles in the Facility Management Industry: The U.S., the U.K., and the Middle East 133

Figure 45. FMs' Early Involvement in the Design Process: The U.S., the U.K., and the Middle East 134

Figure 46. Rate of Collaboration with Designers for Solving Problem after Occupancy: The U.S., the U.K., and the Middle East 135

Figure 47. Rate of Collaboration in the Design Process (Number of Projects): The U.S., the U.K., and the Middle East 136

Figure 48. Perceived Positivity of Designers about Collaborating with FMs: The U.S., the U.K., and the Middle East 137

Figure 49. Respondents' Confidence in Sharing Their Opinions in Meetings vs. Their Feeling about Their Ability to Affect Decision-Making in the Design Process 139

Figure 50. Respondents' Positive Feelings about Their Ability Influence Decision-Making in the Design Process vs. Their Rate of Collaboration 140

Figure 51. Positive Perceptions toward Designers vs. Collaboration with Designers 141

Figure 52. Belief in the Effectiveness of the Relationship between FMs and Designers vs. the Rate of Collaboration between FMs and Designers 142

Figure 53. Number of Employees Supervised By Respondents vs. the Use of LEAN Principles in the Respondents' Organizations 146

Figure 54. Length of Career Experience vs. Rate of Collaboration in the Design Process 147

Figure 55. Length of Experience in Current Position vs. Rate of Collaboration in the Design Process 148

Figure 56. Degree of Experience with Collaboration in the Design Process vs. Perceptions about the Positivity of Designers 149

Figure 57. Factors Associated with Greater or Lesser Likelihood of Collaboration between FMs and Designers 163

Figure 58. Model for Overcoming Barriers and Better Integrating Facilities Managers into the Design Process 174

Figure 59. The Proposed Model of Collaboration to Better Integrate the Knowledge from Facilities Managers in Design Process 176

LIST OF TABLES

Page

Table 1. Theoretical Approaches for POE Studies 19

Table 2. Identified Categories of the Study 69

Table 3. Themes of the Research 70

Table 4. Age, Gender, Location, Method of Interview, and Educational Level for the Participants 72

Table 5. Positions of Interviewees 74

Table 6. Analysis of Hypotheses 1 to 3 (p-value<0.01 is marked in green; p-value<0.05 is marked in red; p-value<0.10 is marked in purple) 131

Table 7. Analysis of Hypotheses 4 to 13 (p-value<0.01 is marked in green; p-value<0.05 is marked in red; p-value<0.10 is marked in purple) 138

Table 8. Analysis of Hypotheses 14 and 15 (p-value<0.01 is marked in green; p-value<0.05 is marked in red; p-value<0.10 is marked in purple) 140

Table 9. Analysis of Hypotheses 16 to 19 (p-value<0.01 is marked in green; p-value<0.05 is marked in red; p-value<0.10 is marked in purple) 143

Table 10. Analysis of Hypotheses 20 and 21 (p-value<0.01 is marked in green; p-value<0.05 is marked in red; p-value<0.10 is marked in purple) 144

Table 11. Analysis of Hypotheses 22 and 23 (p-value<0.01 is marked in green; p-value<0.05 is marked in red; p-value<0.10 is marked in purple) 145

Table 12. Analysis of Hypotheses 24 and 25 (p-value<0.01 is marked in green; p-value<0.05 is marked in red; p-value<0.10 is marked in purple) 146

Table 13. Analysis of Hypotheses 26 and 27 (p-value<0.01 is marked in green; p-value<0.05 is marked in red; p-value<0.10 is marked in purple) 149

Table 14. Analysis of Hypotheses 28 to 30 (p-value<0.01 is marked in green; p-value<0.05 is marked in red; p-value<0.10 is marked in purple) 151

Table 15. Summary of Findings: The current State of the FM Industry in the United Kingdom, the United States, and the Middle East 156

Table 16. Summary of Benefits from FMs' Early Involvement in Design 159

Table 17. Summary of Identified Barriers against the Involvement of FMs in Design 165

CHAPTER I

INTRODUCTION

1.1.Problem and Setting

Facility management is a growing field of professionals who administrate the operational aspects of large, multi-use buildings. It is critically important for architectural designers to understand the role that facility managers (FMs) play in implementing the designer's intended patterns of building use. The accumulated knowledge and anticipated practices of FMs can provide vital input into the architectural design process. When there is good communication between designers and FMs, the final architectural product will operate to its maximum efficiency (Erdener, 2003). However, when FMs and designers do not communicate well, the result is waste and error, which can lead to higher operating costs as well as decreased building performance and lower levels of satisfaction among building occupants. Buildings do not always perform as their designers intended, and poor communication between the design team, the building occupants, and the facility managers may be one of the central reasons for this problem (Tzortzopoulos, 2007).

One factor that contributes to poor communication among the various stakeholders in architectural projects is the growing use of software and automation in the design process (Meng, 2013). These virtual environments can be extremely useful to architects, but they can also encourage designers to think more individually and esoterically, at times losing touch with the needs and perspectives of the managers who

will be involved in actually maintaining the final architectural product. It is critically important for architects to temper their individual design focus with a commitment to collaboration, in order to maximize the usefulness of their designs (Markus & Arch, 1973). Another cause of communication difficulties between designers and facility managers is simply a lack of mutual interest, which is a result of the parties being so far apart from each other in the building's life cycle. By the time that FMs become involved in managing a building, the designers have almost always moved on to their next project(s). Often these designers are less than excited about returning to discuss the successes and failures of their earlier work. Likewise, FMs often see little point in discussing their problems with a building's designers, because any insights that such discussion might yield would only help to improve the designers' future projects, and would have little benefit for the already-designed-and-constructed building that the FMs are currently in charge of running.

There are different cultures of facility management throughout the world. In some regions, architectural companies and FM providers have begun to seek out ways to establish more effective communication processes. This is particularly true in wealthier regions, where there is a more established culture of facility management providers and more resources available to invest in enhancing design practices. However, for architectural firms that are engaged with work in developing countries, good communication between designers and FMs can still be a serious problem, one that can be complicated by multi-directional cultural and linguistic obstacles. For example, Texas A&M University's campus building in Qatar was designed by a Mexican architect,

developed by a Chinese construction firm, and is now being operated by a Lebanese facility management firm. The context of remote design and international collaboration can present even greater difficulties for the already-problematic communication process between designers and FMs.

1.2.Significance of the Project

In order to address concerns about a lack of effective communication between designers and facility managers, this research assessed the collaboration process in several different countries and institutional settings. The outcome of these different organizational processes, in terms of subjective perception of building performance, was used as a basis for creating recommendations for more effective communication procedures. The research thus provided new knowledge about improving the architectural design process. While previous studies have emphasized the importance of including FMs' knowledge in design, this study went further in its goal of detecting specific problems in the current state of communication between FMs and architectural firms, and using this evaluation to generate specific recommendations for more effective communication practices.

The value of incorporating FMs' knowledge even in the earliest stages of the design process has been confirmed by researchers all over the world, including Arditi and Nawakorawit (1999), Dunston and Williamson (1999), Meier and Russell (2000), and Erdener (2003) in the United States; Bröchner (2003) in Sweden; Silva and colleagues (2004) in Singapore; Jensen (2009) in Denmark; Mohammed and Hassanain

(2010) in Saudi Arabia; Duffy (2000), Jaunzens et al. (2001), and Meng (2013) in the United Kingdom; and Bu Jawdeh (2013) in the Gulf countries. However, this research has seldom led to specific organizational recommendations. Perhaps even more importantly, this research has not been extended to address the difficulties inherent in communication between FMs and designers who reside in different regions of the world.

The increasingly common practices of remote design and international collaboration need to be taken into account in any evaluation of these communication patterns. For this reason, the current study analyzed contexts in which architectural design firms in one country needed to communicate with facility management providers in a different country. The inter-regional communication processes that were studied involved designers and FMs in the United States, the United Kingdom, and Qatar.

In comparing the relative success of communication processes between FMs and designers, the current research made use of post-occupancy evaluations. Many previous researchers have demonstrated the usefulness of such evaluations for identifying gaps between the expectations of a building's designers and the actual performance of the final architectural product. These earlier studies (Preiser, 2001; Zagreus, Huizenga, Arens, & Lehrer, 2004; Nicol & Roaf, 2005; Turpin-Brooks & Viccars, 2006; Muehleisen, 2011) mainly focused on building occupants—the extent to which they were satisfied with the architecture that they inhabited, and the extent to which they engaged in the behaviors and energy-use patterns anticipated by the building's designers. The current research took a slightly different approach to this topic, by evaluating the outlooks and practices of facility managers (rather than occupants). In doing so, it helped

to show how better communication between FMs and designers can contribute to better-performing buildings, greater occupant satisfaction, and fewer negative environmental impacts. Ultimately, the significance of improving the communication process between designers and FMs will be the creation of buildings that function more efficiently, have lower operational costs, and more effectively address the needs of those who use the buildings during the course of their everyday lives.

1.3.Research Aims and Objectives

1.3.1. Aim One: Understand International Facility Management Challenges and Their Potential Impact on Building Performance

The first goal of this study was to identify and analyze the concerns of facility managers in the international context. The methods and procedures of FM firms were researched in order to find common paths, best practices, and potentials for development. This review can enable FM providers to understand any shortcomings in their maintenance procedures, and to see how better communication with designers can help to eliminate these shortcomings. The study made use of interviews of facility managers in the United States, the United Kingdom, and Qatar.

Specific Objective One

To review, understand, and compare technical and theoretical approaches in the facility management process (via literature review).

Specific Objective Two

To identify the most pressing problems encountered by international facility management firms during the course of their operations (via interviews).

1.3.2. Aim Two: Provide Recommendations for Effective Communication between Facility Managers and Designers with the Goal of Enhancing the Quality of Design

Using the knowledge gained in Aim One, the effectiveness of different communication processes was evaluated in regard to how well this communication helped to minimize facility management difficulties. The research compared communication between designers and FMs in the United States, the United Kingdom, and Qatar, and formed practical recommendations on how to best integrate the concerns of FMs into the design process.

Specific Objective

To compare and evaluate the communication practices between designers and FMs in specific international case studies (via interviews).

Specific Objective Two – Written Survey

To gain an understanding of the perspective of architectural firms about the current input of FMs in the design process, and to evaluate designers' opinions regarding what they have learned by communicating with FMs about the results of their previous projects (written survey).

Specific Objective Three – Recommendations

To generate a set of recommendations for keeping track of design principles throughout the different phases of an architectural project by comparing the data from the focus groups, the interviews, and the survey.. These recommendations can help designers and FMs to more effectively communicate their needs, thereby enhancing their collaboration during the design process.

1.4.Conceptual Framework

Figure 1 illustrates the variables in this research. The effects of an early involvement of facility managers in the design process (independent variable) were examined in relation to subjective perception of building performance (dependent variable). The personal attributes of individual FMs were expected to play a role as a mediator variable, as these attributes can affect the relationship between the independent and dependent variables. The effect of FMs' involvement in the design process was also expected to be moderated by other qualitative and quantitative variables, including the personal attributes of the designers, the size and cost of the projects, the location of the projects, the organizational culture of FM firms and architectural firms, language barriers, and so forth.

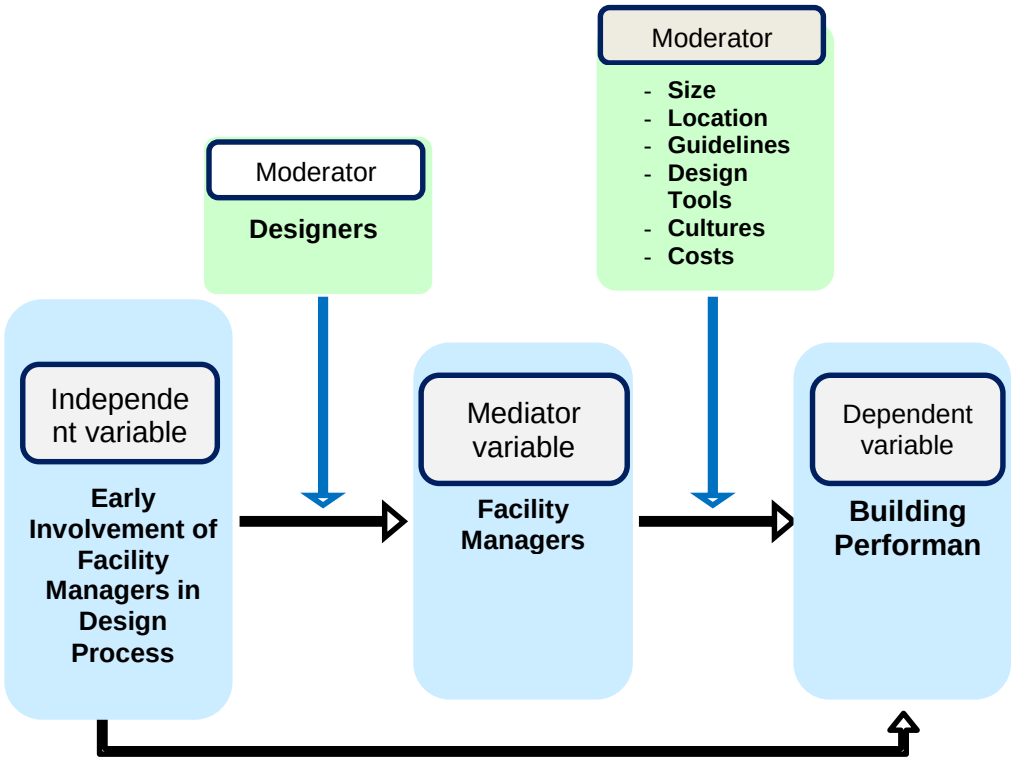


Figure 1. Conceptual Framework

1.5.Research Questions

Research questions are generated based on the “Aim One” and “Aim Two” of the study.

1.5.1. Research Questions Related to Aim One

Question 1 - What are some of the communication processes that are currently in place between FMs and designers?

Question 2 - What are some of the most pressing challenges in facility management in the United States, the United Kingdom, and Qatar?

Question 3 - How do facility management practices affect building performance?

Question 4 - What are some of the benefits of good communication between FMs and designers?

Question 5 - Has the involvement of FMs in the design process significantly increased in recent years?

Questions 6 - How effective is the communication of FMs with designers located in the United Kingdom, as compared to their communication with designers located in the United States?

Question 7 - How effective is the communication of FMs with designers located in Qatar, as compared to their communication with designers located in the United Kingdom and the United States?

1.5.2. Research Questions Related to Aim Two

Question 8 - What factors are important in effective communication between FMs and designers?

Question 9 - How positive are designers about collaborating with FMs during the course of the design process?

Question 10 - What types of architectural projects are more practical for the early involvement of FMs?

Question 11 - What problems can occur if there is poor communication between FMs and designers during the design process?

Question 12 - What factors can encourage designers and FMs to communicate more effectively?

Question 13 - What factors prevent designers and FMs from communicating more effectively?

1.6.Overview of the Dissertation

This next chapter of this dissertation is a systematic literature review on the effects of collaboration between facility managers and designers. The literature review prepares a context for the topic by fully defining terms such as post-occupancy evaluation, building performance, design process, and facility management. In addition to research on the benefits of FMs' involvement in the design process, this section also reviews models of collaboration and knowledge-management presented by different scholars, and explains the obstacles that can prevent FMs from being involved in design. Chapter III then introduces the research and data-collection methods used in the study. This chapter explains how a combination of quantitative and qualitative research methods were used to examine different aspects of the relationship between designers

and FMs. Chapters IV and V present the results from the interview and survey data, respectively. In the qualitative material, the results of interviews are interpreted using the content-analysis method. In the quantitative material, survey results are presented and interpreted. Chapter VI provides a discussion of the research findings, and compares these results against outlooks given in the previous literature. Finally, Chapter VII is a conclusion that highlights the main findings of the study, its contribution to knowledge, the limitations of the research, and suggestion for future studies.

CHAPTER II

LITERATURE REVIEW

2.1.Introduction

This literature review covers the scholarly work associated with facility management, building performance, post-occupancy evaluation, and the role of facility managers (FMs) in the design process. Facility management is a relatively new field of study, and there are a limited number of scholarly publications focused specifically on facility management and architectural design. The rapid development of communication and data-management technologies during the past twenty years has opened new horizons in this area, greatly expanding the possibilities for knowledge-sharing (Jensen, 2009). Thus, it was only in the late 1990s that researchers first began to systematically investigate how the experience of FMs could be integrated into the design process. There are two basic approaches to this knowledge-sharing. First, designers can go back to their earlier projects, once these buildings have been constructed, and they can solicit feedback from the inhabitants and managers of those buildings. This is called post-occupancy evaluation. Second, designers can also ask FMs to be directly involved in collaboration during the design process. This allows the designers to solicit FMs' perspectives on the buildings that the FMs will be managing in the future.

2.2.Scope and Method of Review

The studies reviewed here were selected using the six criteria for scholarly research literature as defined by Hamilton and Shepley (2010)—substantive methodology, peer-reviewed or refereed, problem-focused, objective, repeatable methods, and triangulated outcomes. To locate literature for review, I first conducted exhaustive keyword searches using the terms "post-occupancy evaluation," "high-performance building," "facility management," "design process," and "knowledge management." After weeding out non-scholarly and irrelevant results, I screened the literature to clarify my understanding of post-occupancy evaluation and its use by designers and FMs. I have examined more than 100 scholarly and non-scholarly articles, and I have included more than 40 studies in the review. I then sought to identify materials focused specifically on the current state of communication between FMs and designers. Finally, I reviewed the literature to analyze the role of FMs in different parts of the of architectural design process.

The literature review in this chapter starts with a definition of terms, and a history of attempts to integrate the knowledge of facility managers into the design process. It then describes literature in which the current benefits and barriers to such integration have been analyzed. The concluding sections of the review focus on different models of collaboration and specific uses of technology in information-sharing.

2.3.Building Performance and Post Occupancy Evaluation (POE)

2.3.1. POE Definition

Post occupancy evaluation (POE) is the study of built environment that address the success and failure of design decisions (Shepley, 2010). Post occupancy evaluations (POE) have been defined by Preiser (1995) as an "evaluation of buildings in a systematic and rigorous manner after they have been built and occupied. According to Zimring and Reizenstein (1980), POE 'examine the effectiveness for human users of occupied design environment.' This systematic evaluation measures and monitors the performance of a built environment using data gathered from behavioral, technical, and functional observation. Friedman (1978, p.20) defines POE as "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." The RIBA (Royal Institute of British Architects)'s Research Steering Group described POE from an architectural point of view and 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" (Duffy and Hutton, 2004).

From the POE interpretations cited can understand that POE is a systematic procedure and well-established technique that utilizes research covering building performance, human needs, and facility management. The POE results may range from technical issues to functional and socio-psychological concerns.

Preiser (1995) defined post-occupancy evaluation as the process of systematically comparing actual building performance with explicitly stated

performance criteria. Initially, POE was a response to occupants' problems due to building performance in institutional care facilities, such as nursing homes, mental hospitals, and correctional facilities. An extra advantage of POE rests on its capability to be applied to an extensive variety of building types and building problems.

Preiser (2001) has provided a list of common set of problems in building performance which includes health and safety problems; security problems; leakage; poor signage and wayfinding problems; poor air circulation and temperature control; aesthetic problems; handicapped accessibility problems; lack of privacy; lack of storage; hallway blockage; entry door problems with wind and accumulation of dirt; maintainability of glass surfaces; inadequacy of designing space for equipment (like copiers). According to Preiser (2001) Building performance evaluation (BPE) is more comprehensive than POE, as it includes feedback in different phases of a project from planning to occupancy.

2.3.2. POE Benefits and Barriers

"POE provide an opportunity to produce measured outcomes, generated guidelines, and focus on high-impact questions in an open, unbiased way (Harris, Joseph, Becker, Hamilton, Shepley, Zimring, 2008)." The benefits from POE can be classified in the following categories (Zimmerman and Martin, 2001):

- **Built Environment Improvement.** The results from POEs are used to support the goal of continuous improvement through better understanding the user requirements, which improved fit between users and their built environment.

- **Providing Knowledge for Design Guides and Regulatory Processes.** A successful POE will inform designers about the hypothesis in the design process. The results can help designer to define value metrics more practically based on what occupant want or need. The increased knowledge can benefit design firms by adding value to the next projects and gaining a competitive edge over other companies who have not done POEs.
- **Reduce Operating and Owning Costs.** As the findings from POE can be used to fix the built environment, POEs can result in reducing long-term owning and operating costs, diminishing waste of space and energy, and targeting of refurbishment.
- **Impacting Change.** The assessment of innovation can outcome in changing behavior, guideline and assumption and create a new context for future design development as well as improving competitive advantage in the marketplace. Improving commissioning and management process.

Despite all of the benefits for both designers and designer's firms, why there are few number of POE study in comparison with number of constructions? Vischer (2001, p.23) mentions a number of significant barriers to each level. "Widespread adoption of POE including cost, defending professional integrity, time and skills." Similarly, Zimmerman and Martin (2001) identify following barriers to POE:

Standard Practice. As the idea of continual improvement are not taught traditionally as part of design education, they are not considered as a standard practice in the facility delivery process.

- **Split Incentives.** Two-dozen categories of specialist, with different technical languages, outlook and incentives play role in delivering a building (Lovins, 1992). Different goals and approaches among actors in optimizing the aspect of the building result in failure in applying a POE process, which need integrity of the goal in all phases.
- **Indicators and Benchmarks.** According to the industry fragmentation, different specialists could not agree on what is the constitution of a high performance building. This difference in incentives among all organization involved in the delivery of a building results in the lack of agreed benchmarks and indicators.
- **Owner/ Developer Specific.** Avoiding any delay in the approval, financing, and design process, owner/ developer tend to follow standard guideline and not to innovate (Lovins, 1992). In addition, many building owners are against the activities such as POE that may result in showing the shortcomings in the performance of the building and consequent reduction in revenue.

Additionally, Cooper (2001, p. 159) acknowledge the notion that as POE is not part of the architectural service, clients are reluctant to pay for POE unless the paybacks of the evaluation are both substantial in value and evident." Similarly, Bordass (2001, p.145) indicate the cost of implementing the findings from the POE in addition to carrying out the POE studies as the barrier to adoption of POE.

Hadjri and Crozier (2009) mention the absence of POE in architectural education system and lack of research knowledge among designer as another barriers. Professions need to highlight the role of POE in both education and industry.

2.3.3. Theoretical Approaches

There are different approaches and methods to POE, based on the required outcome and contextual agenda. Shepley (2010, page 11) describes different theoretical approaches listed on the table 1 (Shepley, 2010; Preiser, 2001; Preiser, Rabinowitz, & White, 1988; Preiser & Vischer, 2005; Zimring et al., 2008).

Preiser (1988) defined three levels of rigor for POE studies: indicative, investigative, and diagnostic. In the indicative level, the purpose of study is to primarily pinpointing problems. This level needs low budget, short time, and few resources. The goal of investigative level is to study problems in building deeper, and it requires higher budget, longer time, and more resources. The diagnostic POE level aims at the deepest level of understanding of the problems of built environment, with a specific approach to solve them. The diagnostic requires the highest budget, longest time, highest budget, and resources.

Table 1. Theoretical Approaches for POE Studies

Specialists/ Groups	View to POE	Approach	Goals
Wolfgang Preiser	Define POE as a systematically evaluating the performance of the buildings after they have been built and occupied	Categorize POE to three levels of indicative, investigative, and Diagnostic; Emphasizes a holistic, process oriented approach toward evaluation- not only facilities but also the forces that shape them are taken into account.	Health, safety, and security; Functionality, efficiency, and work flow; Psychological, social, cultural, and aesthetic performance
Craig Zimring	Define facility Performance Evaluation (FPE) as a continuous process of systematically evaluating the performance and/or effectiveness of one or more aspects of buildings in relation to wide range of issues from aesthetic to sustainability	More extensive range of measures, including organizational, economical, and technical effectiveness; Categorize FPE to three levels of quick-response; decision-focused guides; evaluation for design guide; evaluation for knowledge base; evaluation to enhance building delivery management	Support fine-tuning; Support specific decision-focused design issues; Support key decision for repeated building types; Help link facility decisions to business drivers; create communication mechanisms for stakeholders and encourage participation
The Medical Architecture Research Unit (MARU)		Creating a research unit consist of the Faculty of Engineering, Science, and the built environment.	Explore the interface between health service organizational culture and the built environment response
The New Building Institute	Describe POE as a method to respond to market demand	Sustainability evaluation in three levels of (1) user surveys, facility interview, and energy bill analysis; (2) diagnostic tools to response to the results found in Level 1; (3) identify referral to guideline	Improving energy performance in commercial buildings
The PROBE Group	Define POE as a tool to identify obstacle in the building performance	Surveys to investigate occupant perceptions and energy consumption which include: client contact, survey team review of information; first site visit; analysis and descriptive report; second site visit; occupant survey; energy analysis; pressure test; final report	Formation of a group to represent building occupants; To reach design that emphasize satisfying rather than optimizing
New South Wales(NSW) Health Facility Guidelines(HFG)		To create a standard methodology formatted in a kit, and a template for entering information into NSW Health database	(1) Develop a review process that address service model (2) Provide a structure to test current guideline and provide feedback (3) Consistent framework for collecting data (4) Develop a report format

Bill Bordass and Adrian Leaman (2005) discuss how feedback from different phases of project- design to occupancy and post-occupancy, could be developed as a "natural part of project delivery," and how this could result in high-performance building. In the UK, Latham's report (1994) highlighted the role of client in project delivery. In 2001, the Confederation of Construction Clients (CCC) emphasized the significance of client leadership through publishing the Client's Charter, which encourages clients to undertake feedback on the quality of their suppliers, their products, and themselves.

Bill Bordass and Adrian Leaman (2005) listed a portfolio of feedback techniques in five categories which includes:

- **Audit category.** Quantitative technical assessment such as the method such as CIBSE Group Technical Memorandum (TM) 22 method, which was developed as an energy surveys of buildings providing Design Ratings, and Operational Ratings and was used in the Probe studies.
- **Discussion category.** Asking people to discuss about foresight, insight, and hindsight.
- **Questionnaire category.** Rapid survey of occupant satisfaction, which includes BUS Occupant Survey (Bordass, 2001) – a survey to understand what occupant think about a building before starting the construction.
- **Process category.** It focuses on aftercare and feedback in the first few months of occupancy with the goal of adapting procurement process based on

organized feedback system such as the Building Research Establishment Checklists and Soft Landings.

- **Packages category.** Occupant questionnaire to study of the use of space, which includes Probe package (CIBSE TM22, and BUS Occupant Survey) and the AMA Workware package.

In another article, Mark Way and Bill Bordass (2005), define 'Soft Landing' concept with the goal of making follow-through and feedback as the natural parts of a project's life cycle. Designer and builder consist a Soft Landing teach who is resident on site through the move-in period. After that, the resident team monitor the building performance for the first three years to deal with emerging problem more effectively, identify opportunities for fine-tuning, and explore issues for future improvement. In comparison with any other feedback system, Soft Landing, as a 'process career', covers the whole process from design process, construction, building delivery, and occupation. Soft Landing focuses on involvement of designer and builder both before and after handover to achieve a close interaction between the design and expectations of users (Way & Bordass, 2005).

2.3.4. Post-Occupancy Evaluation and Facility Management

The policies and practices of facility managers (FMs) can have a significant effect on whether or not a building meets the performance expectations of its designers. For example, the responsibility for maintaining the building's physical services—air conditioning, heating, lighting, etc.—is an important part of facility management. If FMs and designers do not communicate well in regard to the intended function of this

physical infrastructure, then energy consumption in the building can be much greater than anticipated (Menezes et al, 2011). In order to determine the extent to which a building is performing as its designers intended, architectural firms and facility management providers make use of post-occupancy evaluations (POEs). These instruments are typically designed to measure the behavior and satisfaction of a building's inhabitants. The use of POEs can provide both short-term and long-term benefits. They can yield helpful feedback/suggestions from occupants, information about the practical effectiveness of different designs and materials, data records that allow FMs to fine-tune their practices, and vital documentation for legal purposes (warranty disputes, safety-related disputes, etc.) (Preiser, 1995).

The use of POEs to measure and document building performance is becoming more common, and some scholars have suggested that it is only a matter of time before these evaluations become a universal, legally required practice for facility management providers (Eley, 2001). The consistent use of POEs can be extremely effective when the results are compiled into databases that cover broad scopes of time and multiple facilities. This allows large-scale facility management firms to "close the information loop" so that occupant feedback can be analyzed on a broad level and used systematically to improve facility management practices (Preiser, 1995).

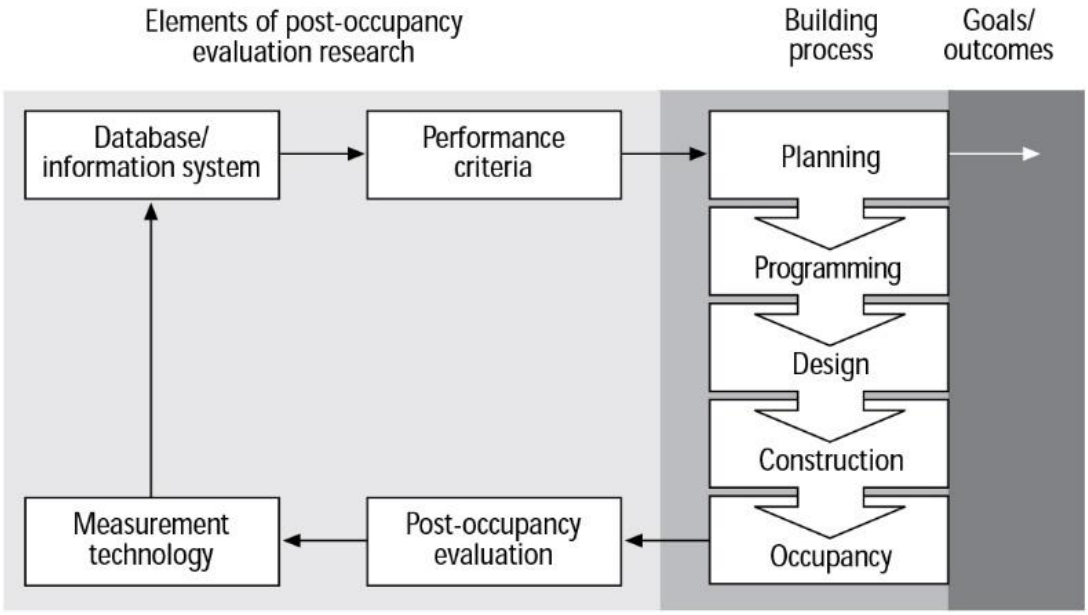


Figure 2. POE as Facility Management Tool (Preiser, 1995, p. 23; With permission from Emerald Group Publishing Limited)

2.4.High Performance Design Process

2.4.1. Design Process

As Markus and Arch (1973) mention, a complete image of the design process requires the consideration of both individual decision-making process as well as the management process. The integration of both views in the building industry can have a great impact on the quality of the final product. The metaphor of design as a spiral

procedure described by John Zeisel (2006) can be used to model how the various design components fit together. A spiral process reveals the following features of design:

- **Backtracking.** A designer returns to the problems to adjust or revise earlier decisions
- **Repeating activities with shifting focus.** Consecutively imaging, presenting, and testing in each cycle of the design process
- **One movement in three.** Adaptation, revision, and conceptual shift during design

In this review, a design development spiral with respect to the sustainable design is presented according to the spiral metaphor demonstrated by Zeisel (2006) (Figure 3). Considering another spiral in order to focus on imaging, presenting, and testing in sustainability can help designers to elaborate the role of sustainable design effectively. Put another way, this concept demonstrates sustainable design as a parallel development process in a project, not as a part of the design process itself.

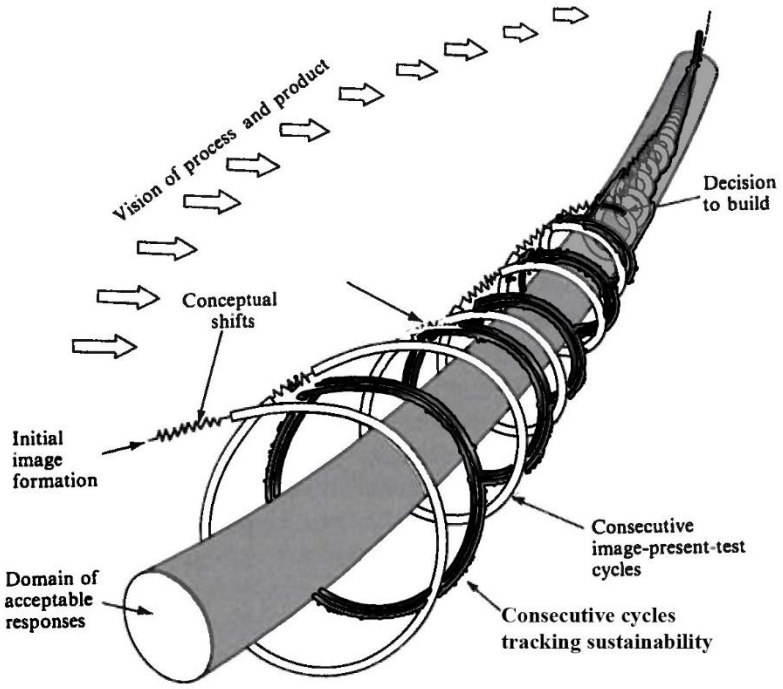


Figure 3. Design Development Spiral with Additional Respect to the Sustainability

Generally speaking, designing is a continual process of identifying the relevant elements, perceiving how they interact, and organizing them in a meaningful way (Tunstall, 2006). Architects conventionally break down the design process into contractually binding stages (Zeisel, 2006): programming, preliminary design, final design, working drawings, and construction supervision. The following is an explanation of these stages with a special focus on the integration of sustainability values to the procedure.

Programming

Pena and Parshall (2001) suggest that programming concern five steps including establishing goals, collecting and analyzing facts, uncovering and testing concepts, determining needs, and stating the problem. The programming phase starts with interviewing the client, gathering information about the specific site and general research regarding the function of the project. Visiting sites, having discussion with the client and users, and studying research in the topic can give architects an upgraded understanding for creating the principles and concepts of the project. Architects can discuss the ideas of sustainability with the client to convince them of the need for increased spending on the project. The result of this negotiation would assist architects to design the program and project goals with a more professional vision toward sustainability. In the next step, architects draw sketches and diagrams to start fleshing out this vision and revise them with the design team and the client. Indeed, oral presentation of the concept can help architects to communicate clearly the design intentions and philosophy more effectively (Zeisel, 2006). Additionally, studying and analyzing the LEED principles for having a sustainable site such as alternative transportation, site development, and storm-water design can play a significant role in the programming phase of the design process.

Preliminary Design

In the first part of this phase, the project board assesses the feasibility of the principles before proceeding. Next, concept diagrams and sketches are completed according to ideas about overall building images, main functions, and the relationship among architectural elements. Architects can test and refine their concepts through

sharing them with the client and the building's eventual users. After an appropriate group discussion and confirmation of the concept with the client, the design team moves towards the building phase via presenting schematic drawings. Meanwhile, the sustainable concepts, such as building orientation, daylight, and views should be integrated to the main concept of the designer. The owner's review and input, as well as landscape, structural and mechanical consultants' initial ideas provide an integral part of this phase. Architects continue to devise schematic designs, making decisions about the space relationships, windows and doors location, and room sizes. In the end, the design team finalizes the schematic drawings by consolidating the agreed-upon concept, the fitness of the building in context, and how the whole building "hangs together" (Zeisel, 2006).

Final Design

Other consulting engineers start injecting their ideas into the design of the building. Any creative idea in energy system design should be applied during this stage. In fact, the outcomes of this phase of the design process will be "presentation drawings", including plans, elevations, sections, and perspective renderings. In terms of sustainability, major LEED concepts including water efficiency, energy and atmosphere, environmental quality, and material and resources should be discussed during this phase. Designers need to ensure that all material and energy inputs and outputs follow the initial sustainable principle of the project. In the next step, the meetings with the client can result in refined suggestions for improvement (Zeisel, 2006). After negotiating with the client, the design team applies changes and finalizes the design to meet the owners'

needs. Lastly, the sustainable spiral metaphor would suggest to double check that the changes do not contradict the main goal of the project regarding sustainability.

Working Drawings

In this phase, architects articulate their ideas from foundation to doorknob in "working drawings" that illustrate the building detail to the contractor. Energy system designers optimize energy performance of the project based on fundamental green goals. Through using energy modeling software, they strive to test different energy systems, based on the successful experience in the same geographical location to achieve optimum energy use. Then, at the same time that the design team checks the criteria and standards, the specialist consultants confirm that their standards have been met. In the last part, the design team prepares the details of the client approval to the working drawing, and provides sufficient information to launch an accurate cost analysis for the subsequent construction phase (Zeisel, 2006).

Construction Supervision

In the last phase, the consulting team continues the process by selecting a contractor through evaluating companies' resumes. As a matter of sustainability, this step should meet the LEED criteria for the selection of a general contractor. The chief goal of this phase requires the flow of information from the design team to the contractor in order to maintain the construction program. A solid communication between contractor and design team can result in protecting the design principles until the end of construction. Specifically, tracking all changes to the sustainable design details can make the actual energy consumption of the building closer to the energy optimization goals. In

conclusion, the architect should keep working closely with the contractor until the completion of the standards as described in the contract documents, and to the satisfaction of the client (Zeisel, 2006).

2.4.2. Performance-Based Design Process

Design process is a procedure of defining problems, generating alternatives and evaluating the options (Cross and Roozenburg, 1992; Frost, 1992; Eckert and Clarkson, 2010). Performance-based or high-performance design aims to increase design value through selecting specific variables and implementing a plan that leads to successful exploration (Clevenger & Haymaker, 2011). During the early stage of design process, there is more opportunity to enhance the value and performance of a proposed project in comparison with the delivery time (Kolltveit and Grønhaug, 2004).

Conceptual design strategies relative to energy efficiency range from informal to exhaustive. The main goal of sustainable design is to discover architectural solutions to minimize the overall effect of built environment on living organisms and human health. Indeed, a sustainable design, as a futuristic perspective, should not be an afterthought in the design process. In other words, the process of design requires a new image for attaining sustainable buildings (Farahat & Bakry, 2012). Clevenger & Haymaker (2012) describe six design strategies relative to high-performance building including (Ross & Hasting, 2005):

- Validation. the model's ability to represent the real world),
- Screening (factors influencing performance),
- Sensitivity (model's output versus model's input),

- Uncertainty (potential effects of risks), and
- Optimization (calculation for the best performance)
- Trade-off analysis.

Clevenger & Haymaker (2012) extend exploration assessment methodology (DEAM) to compare and evaluate the effectiveness of these six strategies. They suggest supporting energy efficient design, the advanced computer analysis strategies need to be pursued.

Butera (2010) suggests that to design a 'zero-energy building (ZEB)', a group of energy and comfort expert must be integrated from the earliest phase of design process. He describes design process of ZEB a circular – not linear, interaction between architectural design, HVAC system design, and energy analysis experts. During the past several years, as a result of energy certifications, the design process is the issue to revision. However, the real revolving point for design process comes when new design tools and experts play their role in design of the ZEB (Butera, 2010; Hirsch, Pless, Guglielmetti, & Torcellini, 2011).

2.4.3. Design Process and Post-Occupancy Evaluation

Zimring and Reizenstein (1981) point out the significant differences between architectural criticism and post occupancy evaluation. They argue that architectural criticism methodology use historical and subjective view to study aesthetic, material performance, or evaluation of building systems, while POE gather data systematically to evaluate functional fit and client satisfaction. Evaluations from these two methods may result in conflicting conclusions for the same built environment.

Zeisel (1981) suggests POE procedure as the final phase of the cyclical design process, which can help provide feedback from the occupants. The lessons learned from the occupants can be used both to improve the quality of the built environment and to inform design of the next building. Zimmerman and Martin (2001) describe POE as a "logical final step" in this cyclical design procedure, delivering a set of information based on the lessons learned from previous projects to inform next building. Completing a feedback loop, POE test designers' assumptions and innovations and add a rigorous knowledge to the design process.

2.4.4. Lean Thinking in Design Process

This section provides a synopsis of the 14 Toyota way principles in architecture points of view. In the following, 14 principles at work in the development of design process in architecture firms are presented (Liker, 2004):

Principle 1: Base Management Decisions on a Long-Term Philosophy

Lean thinking would suggest having a specific philosophical sense toward the long-term purpose of the company. The architectural firm should understand their place in the world and work to bring the firm to the next step based on a planned program. In this approach, constancy of the goals explicate why, in any given year, clients can plan working with the company regardless of the size of the project.

Principle 2: Creating Continuous Process Flow to Bring Problems to the Surface

This principle can help architectural firm revise their design process in the company to achieve high value-added, continuous flow. The result of efforts to eliminate all muda activities can assist organizations to enhance the quality of work, create real

flexibility, create higher productivity, improve morale, and reduce costs. Architectural firms can apply this principle throughout for fast transformation of the information to link a design process and employees more effectively so that problems surface immediately.

Principle 3: Use "Pull" System to Avoid Overproduction

Connecting the design team with the clients could be an architectural interpretation of this idea for the consulting industry. Although "kanban system", as the main concept of this principle, is defined for leading and confirming the flow and production of materials in a just-in-time production arrangement, it can also play a role in the consulting world. The Kanbon system can be utilized by professional design teams through a systematic pre-occupancy evaluation and post-occupancy evaluation research.

Principle 4: Level out the Workload

Eliminating overburden workload (muri) and unevenness in the design phases schedule are just as important as eliminating waste (muda) in the process. Architectural companies can optimize the whole process of design through leveling out the workload of all employees. At the same time, looking at the whole map of the project to balance the timetable of each phase is crucial for making it an efficient procedure.

Principle 5: Build a Culture of Stopping to Fix Problems, to Get Quality Right the First Time

This principle recommends that the system be able to detect problems and stop itself. In the design process, the problems in different phases can break the development significantly. The problems in the design process such as questions of employees,

communication with clients, and applying the standards to the project should be addressed to the support system of the organization for rapid problem solving. As the Toyota way suggests, the team should go and observe, analyze the situation, and ask "why?" five times.

Principle 6: Standardized Tasks and Processes Are the Foundation for Continuous Improvement and Employee Empowerment

According to Taylor's (2004) scientific management, employees through a scientific process can work as efficiently as possible: scientifically defining the one best way of doing the job; scientifically discovering the one best way to train someone to do the job; scientifically choosing people who were most capable of doing the job in a particular way. This principle suggests using repeatable, a steady approach everywhere to keep the regular timing, certainty, and productivity of the procedure. The best way for the architectural firm is to provide the accumulated learning for their members as well as standardizing today's best practices.

Principle 7: Use Visual Control So No Problems Are Hidden

The visual aspects mean being able to look at the procedure, information, or employee performing a job and immediately see the standard being used to do the duty and whether there is a deviation from the standard (Liker, 2004). Using visual control with respect to the "5S programs" (sort, straighten, shine, standardize, and sustain), architectural companies can enhance the design process effectively.

Principle 8: Use Only Reliable, Thoroughly Tested Technology That Serves Your People and Processes

The new technology in professional design teams should be supportive to the members, process, and values. The new technology could be unreliable, hard to standardize, disruptive for the stability and predictability. On other hand, a thoroughly considered technology can improve flow in the processes. There is no doubt that architecture companies should conduct actual tests before adopting new software in the design process.

Principle 9: Grow Leaders Who Thoroughly Understand the Work, Live the Philosophy, and Teach It to Others

A common phrase used by Toyota that can be interpreted in the architecture industry is "before we design a building, we build people." A professional leader perceives the company's philosophy, applies it in daily works, and teaches it in great detail. Regarding this principle, the better way is to develop leaders from within, rather than buying them from outside the organization.

Principle 10: Develop Exceptional People and Teams Who Follow Your Company's Philosophy

This principle recommends establishing a stable and strong culture in which the firm's philosophy and values are widely lived and shared for several years. As a matter of fact, cross-functional teams can enhance the productivity and improve flow through solving difficult technical problems. Specifically, in an architecture firm, where the

integration of members plays a significant role in the success of a project, leaders should strive to teach individuals how to work together as a team toward common goals.

Principle 11: Respect Your Extended Network of Partners and Suppliers by Challenging Them and Helping Them Improve

An architecture company needs to respect their suppliers and partners. Challenging goals and assisting the outside business partners to reach them can make more win-win situations for a company.

Principle 12: Go and See for Yourself to Thoroughly Understand the Situation

By applying the culture of going to the source and personally observing and verifying data rather than theorizing on the basis of what other people or a computer screen tells you, a leader can understand the situation more deeply. As this principle offers, in an architecture firm, even a high-level manager should have a good understanding of details in each phase of the design process.

Principle 13: Make Decisions Slowly by Consensus, Thoroughly Considering All Options; Implement Decisions Rapidly (Nemawashi)

This principle suggests an organization should completely consider all alternatives then follow a single path continuously and rapidly. The result of this principle can have profound outcomes in a consulting firm. Although time-consuming, this process helps the company achieve additional creative, broad, and mature solutions.

Principle 14: Become a Learning Organization through Relentless Reflection (Hansei) and Continuous Improvement (Kaizen)

After launching a stable procedure, the architectural professional should use constant development instruments to decide the cause of inadequacy and apply efficient countermeasures. On the other hand, the principle reveals that companies can protect their organizational knowledge base through improving reasonable promotion, stable members, and careful succession schemes.

"Lean thinking" is a business philosophy used extensively in industry. Toyota pioneered the approach with a 14 principles in its production lines in the 1970s, expressively improving its effectiveness in both the price and the quality of its vehicles and boosting its market share. Lean thinking emphases on shortening procedures by classifying the fragments of a route that can deliver superior worth for the customer or client and removing whatever does not contribute to this purpose. Lean thinking is grounded on the statement that only a section of the total time and effort used in a company actually adds value to the final product or service. A lean procedure uses less of human effort, facilities, capital investment, inventories, and time. The result in the realm of architectural firms could be an increased efficiency in the design process. The key principles of lean thinking are (Liker, 2004):

1. Eliminate waste.
2. Define "value" according to what the clients wants and is willing to pay for.
3. Use the processes that deliver what the clients values in the shortest possible time.

4. Make the process flow smoothly.
5. “Pulling” toward it only work needed to accomplish the goal.
6. Pursue “perfection” by continuous improvement.

Elmuti (2001) declares that team-based management system is recognized as a beneficial strategy not only for the manufacturing industry but also the service industry. Leaner management structures tend to authorize team members to see the big picture. An architectural design project cycle is defined by a series of major phases, where some of the phases merge into one another. However, often each of the new phases requires a fresh set of skills and knowledge that can only be provided by different personnel. Tunstall (2006) outlines the total project delivery system as a complete series of operations leading to the occupancy of a completed building, as Figure 4 portrayed. In addition, in this figure, the 14 Toyota ways principles are applied to the building design process.

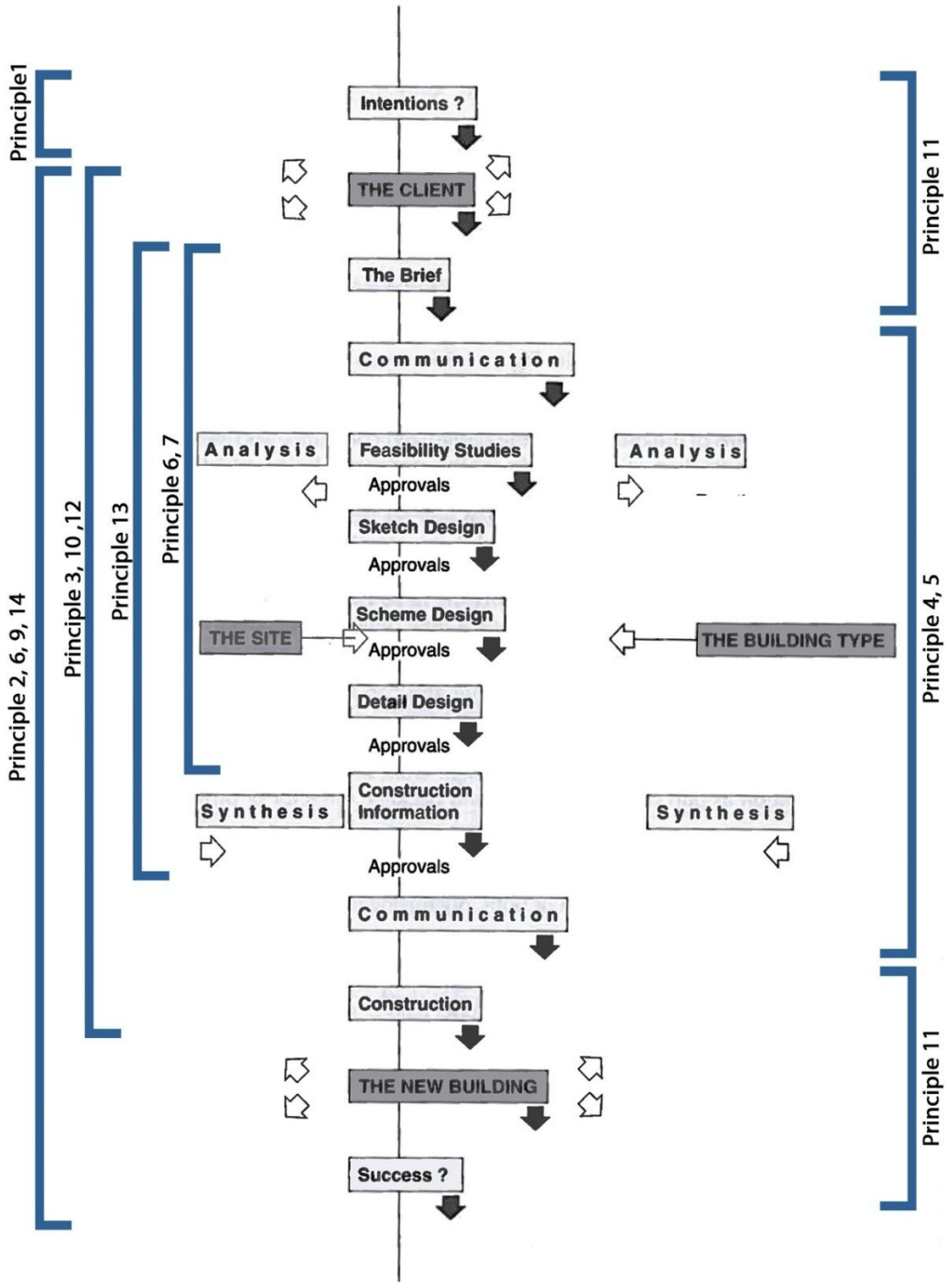


Figure 4. The Map of Managing the Building Design Process and 14 Toyota Way Principles

2.5.Facility Management Involvement in Design Process

2.5.1. Facility Management

Moore and Finch (2004, p. 259) defined facility management as a professional discipline that involves "the development, coordination, and management of all of the non-core specialist services of an organization, together with the buildings and their systems, plant, IT equipment, fittings, and furnishings, with the overall aim of assisting any given organization in achieving its strategic objectives." In other words, facility management is an extremely broad category of operations, and one whose scope can vary from one context to another. Different scholars, in fact, often have quite different understandings and definitions of what facility management consists of. The standard responsibilities of FMs under any definition include building maintenance, repair, and cleaning. Other issues that may fall under the umbrella of facility management may include real estate transactions, office organization, office equipment supply, and transportation arrangements for building occupants (Straub, 2003).

The idea behind the recent expansion and professionalization of facility management is that the effective maintenance of the physical environment is vital to the success and well-being of building occupants, especially corporate occupants (Grimshaw & Keeffe, 1993). The growth of large facility management firms has, in some parts of the world, allowed for a more proactive and integrated approach in which FMs collaborate with external technicians, suppliers, consultants, and other professionals—including architectural designers—to help improve the efficiency and reduce the costs of building operations (Federal Facilities Council, 2001). This integrated approach becomes

increasingly useful as buildings become larger, more complex, and more challenging to maintain. In today's world, FMs are called upon to confront the rapidly changing needs of building tenants, the growing importance of energy efficiency, and the never-ending expansion of new architectural materials and design concepts.

2.5.2. History of Facility Management Integration in Building Design Process

The idea that the knowledge of building operations managers could be useful in the design process has been around since at least the 1960s (Bröchner, 1996). However, the systematic investigation of formal collaboration between designers and FMs did not really become a factor in architecture until the late 1990s. During that era, scholars such as Jan Bröchner (1996) and Arditi and Nawakorawi (1999) claimed that significant building maintenance problems and inefficiencies could be prevented if there were better communication between designers and FMs. In the year 2000 the British Institute of Facilities Management became the first institution to investigate the prospect of incorporating the expertise of FMs into the architectural design process (Jensen, 2009). The results of this study, published by Denice Jaunzens (2001), was a report that affirmed the usefulness of collaboration between designers and FMs, as well as the not-insubstantial barriers to such collaboration. The obstacles cited by Jaunzens included a fundamental concern that FMs were not qualified with a great enough knowledge of the design process to be able to make worthwhile contributions.

Soon, however, researchers throughout the world were investigating how the integration of FMs' knowledge into the design process could become a reality. In addition to the British Institute's 2000 study, contributions were made by Dunston and

Williamson (1999), Meier and Russell (2000), Erdener (2003), Bröchner (2003), Silva and colleagues (2004), Jensen (2009), and Mohammed and Hassanain (2010). These efforts undoubtedly played a part in the increasing interest in collaboration on the part of practicing architects and facility management firms in recent years. Obstacles still remain, and both researchers and practitioners continue to seek ways to improve this transfer of knowledge. Meng (2013) argued that one of the principal concerns for research in this area is that previous studies involved an extremely limited amount of empirical data, relying mostly on individual case studies and the personal experiences of the researchers. As Meng sums up, "the limitations within previous studies form a barrier to a systematic understanding of how design integrates with FM in today's practice" (p. 501). One of the central goals of the current study is thus to help provide vital data to improve our understanding of the current collaboration processes between designers and FMs.

2.5.3. The Benefits of Facility Managers' Involvement in the Design

Researchers such as Jaunzens and colleagues (2001) and Duffy (2000) have argued not only that the input of FMs can help to improve the design process, but also that FMs have a responsibility to do so. In the outlook of these scholars, working with designers to ensure the best possible building performance is a fundamental aspect of FMs' responsibility to the needs of the building occupants—as well as an important way for facility-management providers to remain competitive in their field. According to Winch (2010), extensive communication and information exchanges between stakeholders are necessary throughout the life-cycle of an architectural project. These

exchanges are required to avoid what many designers describe as "wicked" dilemmas—fundamental problems that emerge from a lack of a consistent vision, conflicting values and interests, and situations where it is difficult to evaluate the efficacy of a proposed solution. (The opposite of a "wicked" design problem is a "tame" one—an issue that can be readily resolved using available information.) In short, to create a more effective design process it is vital that the design decision-making takes place within a robust framework of good communication.

The value of good communication between stakeholders increases proportionally as the complexity of an architectural project increases. In today's world, the size and intricateness of buildings is greater than ever, and the tolerances of construction standards are ever more exacting. For this reason, design decisions can have far-reaching effects on the ability of FMs to maintain building operations in an efficient fashion. In large, complex projects, integrating FMs into the communication loop during the design process can greatly reduce the later need for FMs to enact inefficient operational practices and/or expensive infrastructure alterations (Chew et al., 2004; Mohammed, 2010; Jensen, 2008).

One of the most comprehensive accounts of how collaboration between FMs and designers can create greater efficiency in today's building environment was given by Meng (2013). Meng conducted extensive interviews with facility management experts in the United Kingdom, and found that these FMs overwhelmingly agreed that effective collaboration with designers yielded better results in facility management. As the researcher explained, "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" (p. 503). Meng identified multiple ways in which this collaboration lead to better buildings—including architectural results that were more attractive to prospective occupants, more energy-efficient, more cost-effective to operate, more straightforward to construct, and more focused on minimizing the building's whole-life expenditures rather than just the initial capital costs.

According to Meng (2013), the collaboration also yielded specific advantages for facility management providers. These included the ability to minimize or avoid maintenance risks, the ability to better anticipate the requirements of a facility management contract for the building, and the ability to promote designs that allowed them to incorporate their preferred/most efficient maintenance solutions. Meng argued that while architects may be great designers, their lack of hands-on experience in working with completed buildings can sometimes lead them to overlook maintenance and functionality issues that would be obvious to FMs. In addition, Meng suggested that FMs also tend to have a more intimate perspective on the concerns of building occupants, which allows FMs to contribute valuable ideas in designing a healthier, safer, more attractive, and more flexible environment for the building's ultimate inhabitants.

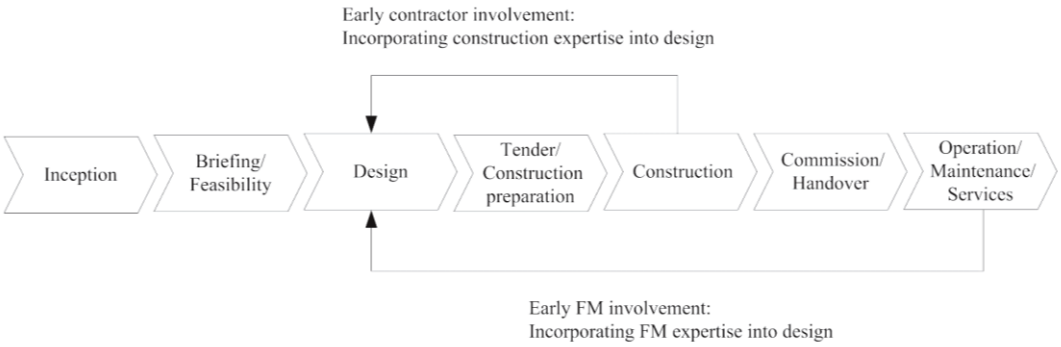


Figure 5. Project Lifecycle and Early Involvement (Meng, 2013, p. 501**;** With Permission from ASCE; These Figures May Be Downloaded for Personal Use Only. Any Other Use Requires Prior Permission of the American Society of Civil Engineers)

2.5.4. Problems that Arise When Facility Managers Are Not Involved in the Design Process

The biggest difficulty that results from a lack of collaboration between designers and FMs is that problems are not identified early. For every advantage identified in the previous section, there is a corresponding disadvantage that can emerge from poor communication. When these issues are not identified early on, fixing them can become prohibitively expensive or even impossible. The result is the construction of buildings that are more cumbersome to operate and more expensive to maintain. In Meng's (2013) study, the FMs who were interviewed claimed that without their input, design flaws that led to operational inefficiencies were almost inevitable. They also suggested that in many cases the facility management team, rather than the designers, were ultimately held accountable for these flaws. Designers may sometimes expect their buildings to

operate in ways that are not practically feasible, and FMs are the ones held to account when they are unable to enact the designers' impossible expectations.

2.5.5. At What Point in the Design Process Should Facility Managers Become Involved?

As the previous paragraph suggests, it is optimal for FMs to become involved as early as possible in the design process. Leung and colleagues (2003) found that such involvement stimulates vital early-stage discussion that allows problems and disagreements to be resolved before the detailed design stages commence. Likewise, Erdener (2003) argued that close collaboration among various project stakeholders in the earliest stages of design helps to ensure that buildings perform better and ultimately generates better value-for-cost. An architectural project generally goes through discrete phrases, from inception and feasibility studies, to various aspects of design, and ultimately to construction and occupancy (Meng, 2013). At each step along the way, the difficulties caused by an earlier mistake can be compounded, while the expense and complexity of fixing or managing these mistakes increases (Meng 2013; Project Management Institute, 2008). The most effective way to improve overall project results is thus to ensure that there is good and careful communication among stakeholders at the very earliest stages of project development (Kolltveit & Grønhaug, 2004; Mosey, 2009; Song et al., 2009).

Erdener (2003) also emphasized the value of FMs' involvement at the earliest stages of a building's life—in the preliminary planning stages of design, and even earlier, in the project conceptualization phase. Consistent with Meng's (2013) concern

that FMs should not be expected to implement unfeasible/impractical expectations, Erdener (2003) stated that, "Facility failures in general are attributable to the gap between expectation and the level of realization. Adequate representation of FM as a strategic resource in the programming and design team has an added potential to narrow, if not eliminate, the above gap observed in today's complex facilities" (p. 6). El-Haram and Agapiou (2002) likewise affirmed the value of early FM involvement, and identified four specific contributions that FMs could make during design: (a) identifying the best possible building-operation scenario, (b) identifying the best possible maintenance strategies, (c) collaborating with designers to identify cost-effective design solutions, and (d) reviewing the final design proposal from an operational point of view.

2.5.6. Models of Collaboration

In the remainder of this review, I turn to scholarly literature that discusses specific mechanisms of collaboration and information-management between designers and FMs. One of the most fundamental aspects of this collaboration is "process modeling" (Erdener, 2003; Tzortzopoulos, 2007; Trebilcock, 2009). Basically, process models are visual maps of the route that a project undergoes, from beginning to end, in order to move from the identification of an objective to the ultimate creation of a solution. A generalized model of the architectural process, formulated by Haviland (1994) and then further clarified by Erdener (2003), is shown in figures 6 and 7.

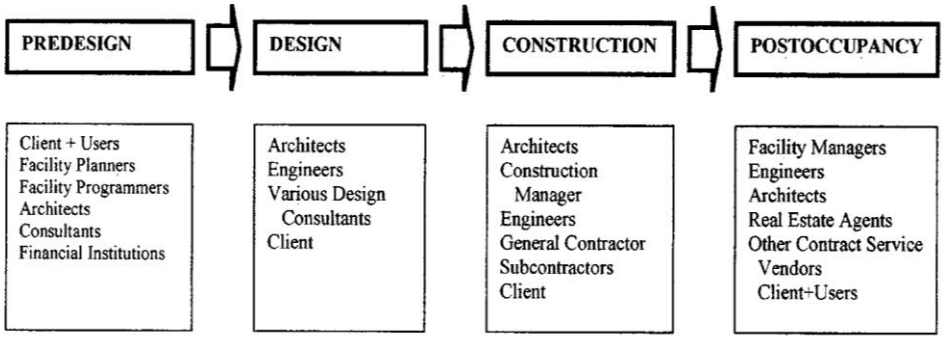


Figure 6. Present Framework (Erdener, 2003, p. 6; With Permission from ASCE; These Figures May Be Downloaded for Personal Use Only. Any Other Use Requires Prior Permission of the American Society of Civil Engineers)

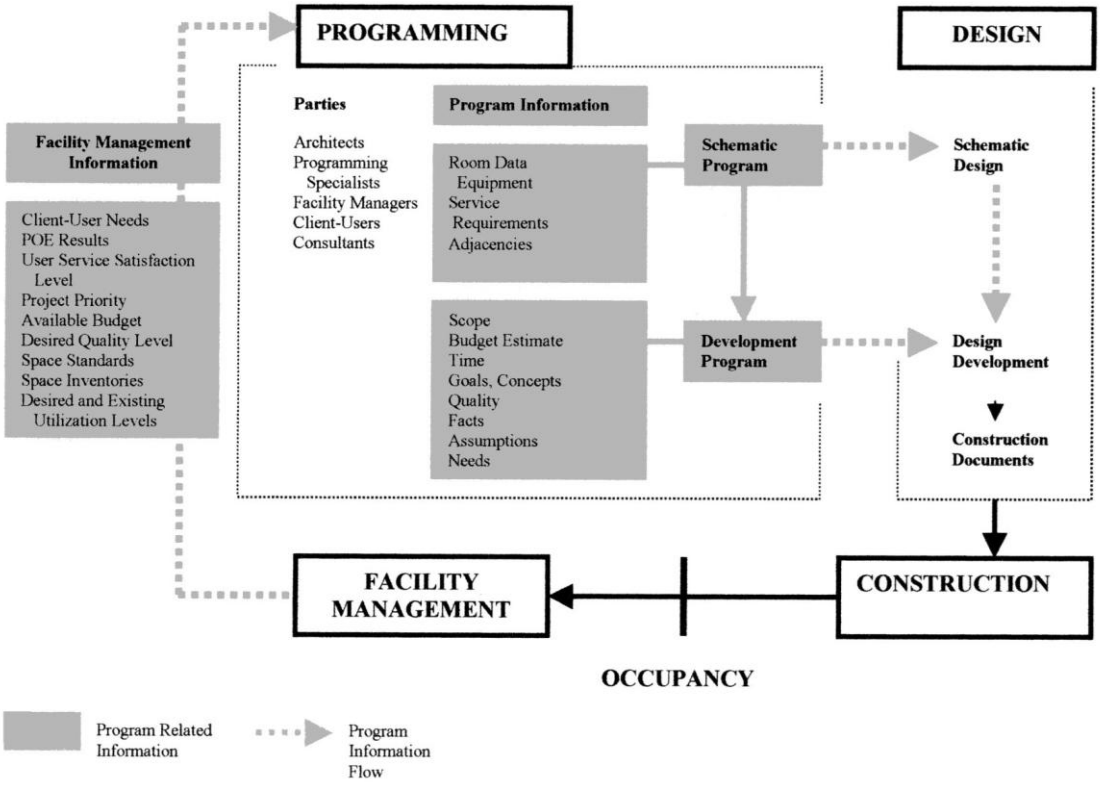


Figure 7. Modified Framework (Erdener, 2003, p. 7; With Permission from ASCE; These Figures May Be Downloaded for Personal Use Only. Any Other Use Requires Prior Permission of the American Society of Civil Engineers)

In Erdener's "Present Framework" (Figure 6), the architectural process is purely linear, with no feedback from the building operations stage to the design stage. However, in the "Modified Framework" (Figure 7), Erdener proposes a new design process in which lessons learned from previous projects and the knowledge from FMs' experiences can provide valuable input during design.

A similar process model for collaboration was developed by Mohammed and Hassanain (2010). In this model, all of the various contributors to the design process submit their contributions to the facility management team for a "maintainability check," before the contributions are compiled into a final design, which is then yet again checked by FMs. These multiple layers of review allow for a back-and-forth process of communication between designers and FMs (Figures 8 and 9).

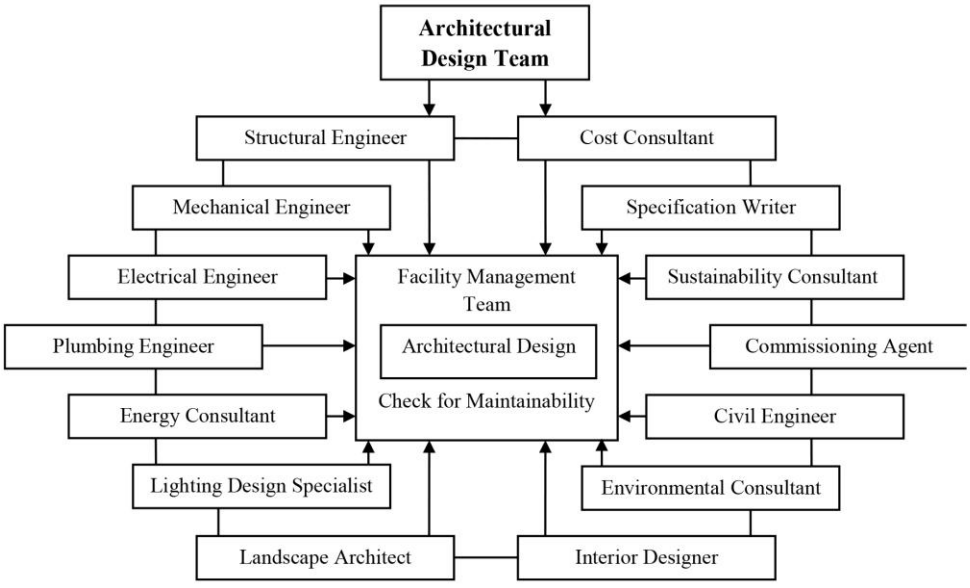


Figure 8. The Role of the Facility Management Team within the Integrated Design Team (With Permission from Mohammed & Hassanain, 2010, p. 76)

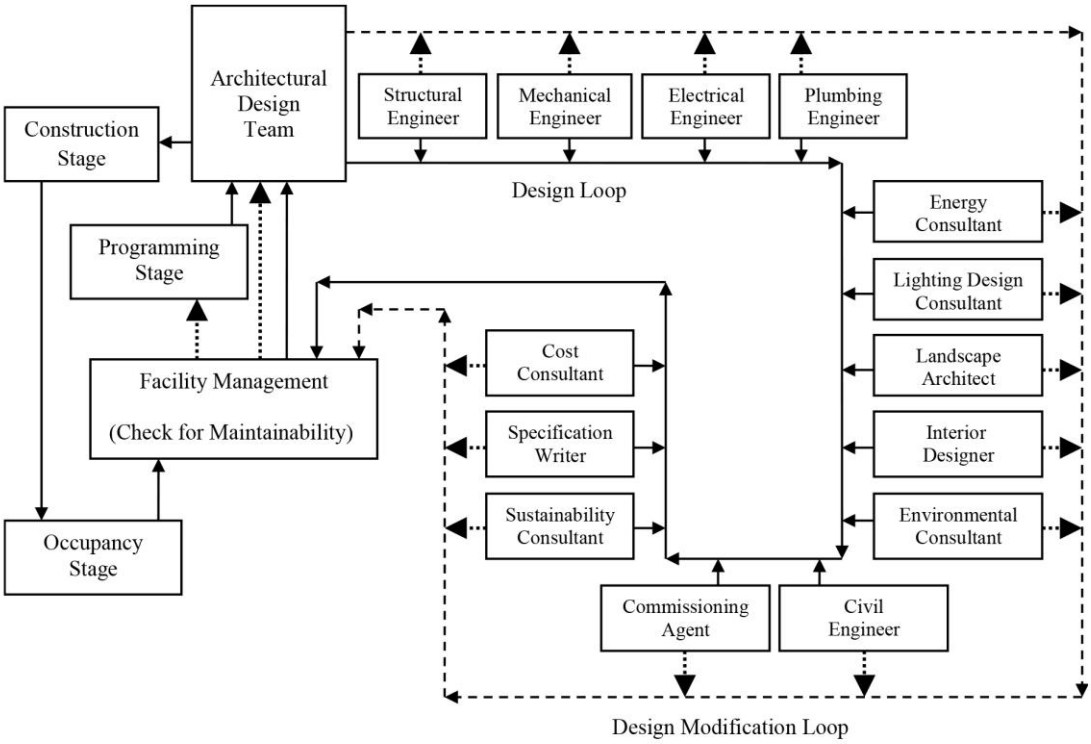


Figure 9. The Detailed Flow of the Design Modification Loop (With Permission from Mohammed & Hassanain, 2010, p. 78)

2.5.7. Barriers Against Facility Managers' Involvement in the Design

Despite the clear advantages of collaboration, there are also obstacles that prevent FMs from becoming involved in the design process. These barriers are straightforward and relatively easy to understand. One of the primary difficulties is that such collaboration extends the design process, involving more participants and thus increasing the cost. Even though these initial costs will be compensated many times over

during the lifespan of a more-efficient building, there is often a resistance on the part of clients/owners to fund the process—especially when the client will not be the end-user of the building (Meng, 2013). Due to the relative lack of research on this topic, designers and FMs may also encounter difficulties in explaining to clients what exactly the FMs can contribute to design, and how it can improve building efficiency. Many clients (as well as designers) do not have an entirely clear idea of what FMs do and how their knowledge and expectations are relevant to designers, and this can make the clients reluctant to foot the bill for collaboration (Bu Jawdeh, 2013).

A further problem is the temporal distance between designers and FMs during the life-cycle of an architectural project. When designers first begin working on a building, the FM provider may not even have been identified or employed—and if an FM firm has been engaged, that firm may not have yet set up a specific management team for the building (Meng, 2013). If collaboration is not established at this point then it may become even more unlikely further down the road. Once the designers have gotten well into their work, or even finished it, they are less likely to be interested in going back and receiving input from those who will ultimately manage the operation of the building. Likewise, FMs are generally less interested in providing feedback to designers at a later stage, because they recognize that this feedback will only benefit the designers' future work, rather than the project that the designer has already completed (see Figure 10).

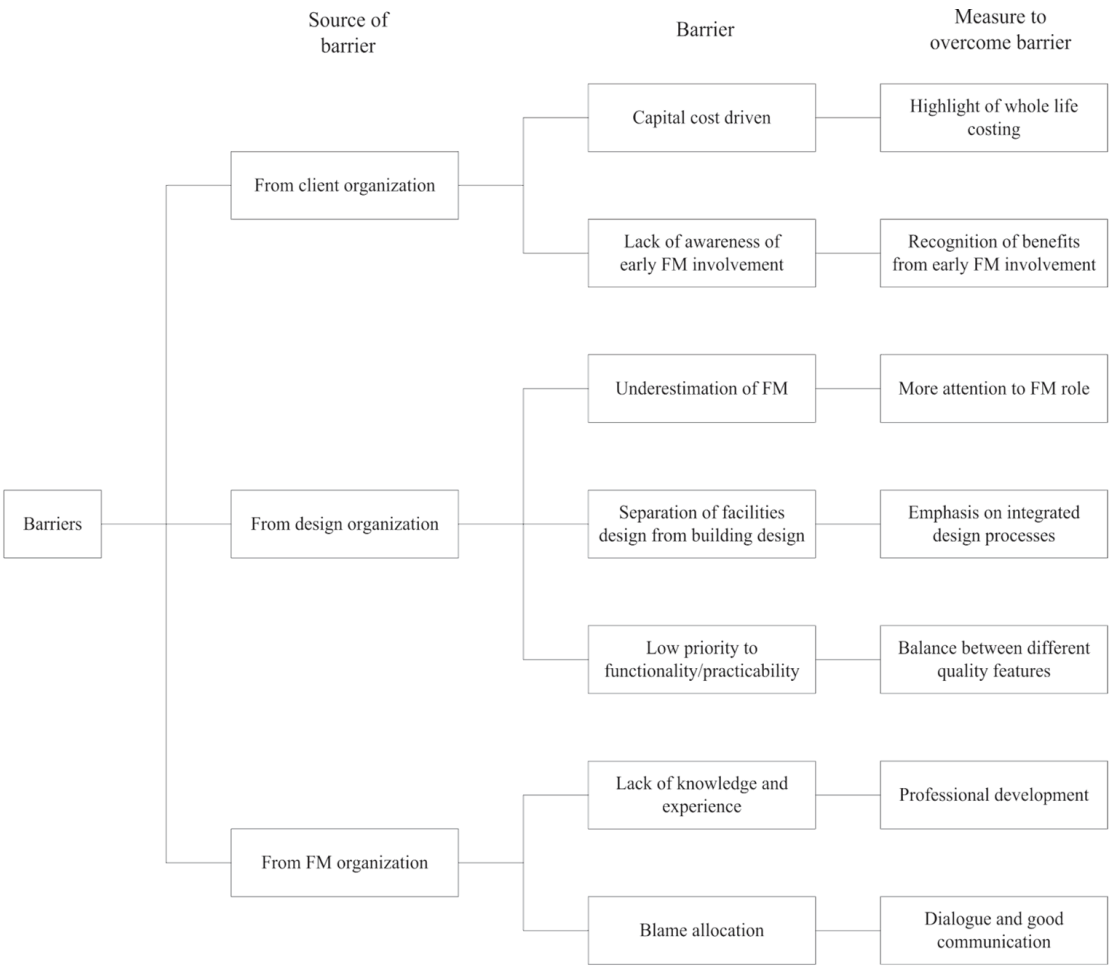


Figure 10. Model for How to Overcome the Barriers to Early FM Involvement in Design (Meng, 2013, p. 506; With Permission from ASCE; These Figures May Be Downloaded for Personal Use Only. Any Other Use Requires Prior Permission of the American Society of Civil Engineers)

2.5.8. Knowledge Management in the Design Process

Knowledge management is also a critical step for establishing an effective collaboration in the design process. The more complex an architectural project is, and the more diverse the various teams of designers, engineers, contractors, facility managers, etc. who are involved, the more vital knowledge management becomes. In recent years, specific information-technology experts in knowledge management have begun to make contributions to the architectural process. These experts provide software tools to enable Web-based collaboration and other forms of knowledge sharing. Some of the most important contributions in this field include the development of FIATECH (Fully Integrated and Automated Technology) in North America, IDS (Integrated Design Solutions) in the U.K., and the ECTP (European Construction Technology Platform) in Europe—as well as other initiatives taking place in Australia, France, and Finland (Shen et al., 2010).

Knowledge management experts tend to talk about collaboration in terms of "knowledge pull" from designers and "knowledge push" from FMs. The effectiveness of the "pull" depends on how motivated designers are to seek out the knowledge and how well they use it, while the effectiveness of the "push" depends on how motivated FMs are to provide knowledge and how well they express it (Jensen, 2009). The goal of knowledge management software is make these processes easier, more systematic, and more effective. By organizing all of the requested and supplied information in one place, it is possible to streamline interactions (so that, for example, different members of the FM team are not being asked the same question multiple times from different members

of the design team). In addition, these tools can allow designers and FMs to easily track their interactions and results over time, and in the future may even be able corroborate their discussions with references to design solutions that were enacted in previous projects (Shen et al., 2010).

2.5.9. Use of BIM and Integration of Facility Managers in Design Process

Building Information Modeling (BIM) allows for the creation of virtual representations of architectural spaces. Using BIM designers can visualize and easily improve upon their work, and various forms of BIM software have been pretty much universally adopted for that purpose. The potential of BIM extends far beyond design, however, as it can allow for other stakeholders involved in a building's life-cycle to maintain a single, working model of the structure and all associated data. Even peripheral information such as flowcharts for resolving maintenance issues can be kept in a BIM library, and linked with other building information critical to accomplishing such tasks (see Figure 12).

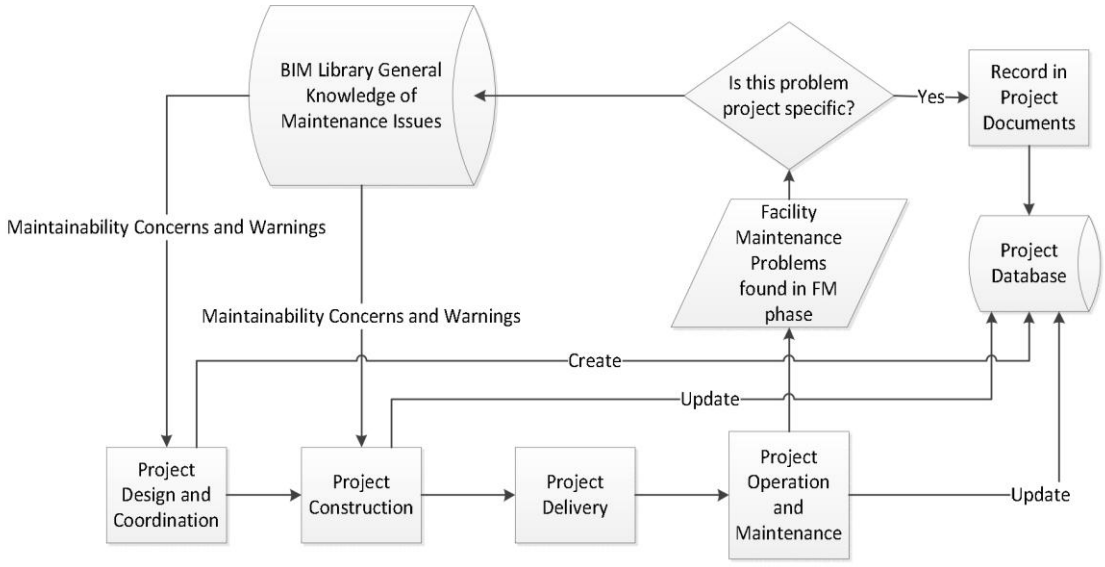


Figure 11. General Knowledge Database for Maintenance Issues (With Permission from Liu and Issa, 2013, p.6)

Unfortunately, the adoption of this technology has been uneven throughout the larger construction and facility-management community. One recent study, for example, found no use of BIM technology at all among mechanical, electrical, and plumbing contractors (Liu and Issa, 2013). Other studies have shown that less than 30% of facility management teams in smaller buildings (less than 250,000 sq. ft.) have adopted the use of BIM software (Teicholz, 2001; International Facility Management Association, 2014).

CHAPTER III

RESEARCH DESIGN AND METHODOLOGY

3.1. Introduction

The literature review that is presented in the previous chapter led to the construction of working hypotheses that guided this investigation. These hypotheses were as follows:

1. Early involvement of facility managers (FMs) in the design process is likely to enhance the ultimate quality of a building's performance.
2. FMs and designers are often unmotivated to undertake such collaborations, or otherwise fail to do so due to budgetary constraints and lack of established precedent.
3. The relationship between FMs and designers appears to be affected by the different cultures of facility management in different countries, and the associated linguistic/cultural communication difficulties.

This chapter discusses the study design that was used to investigate these hypotheses.

3.2. Multi-Methodology Approach

Many researchers limit their approach to either qualitative or quantitative methods. Each of these approaches has advantages and disadvantages— qualitative studies can often provide more nuanced and complex explorations of a topic, whereas quantitative studies can provide more discrete data and reduce subjective biases. A

multi-method approach—which is what was used in this study—can often be the best of both worlds. This approach is a form of triangulation (McNeill & Chapman, 2005; Cohen, Manion, & Morrison, 2000), in which different methods of data collection are compared in order to provide a more complete picture of the phenomenon that is being studied. In this research, the initial qualitative data was obtained through open-ended interviews, and then a more precise survey instrument was developed in order to obtain quantitative data. The following sections describe each of these methods in more detail.

3.3. Qualitative Method

3.3.1. Theoretical Paradigm

The qualitative portion of this study was grounded in a holistic/naturalistic paradigm of inquiry (Lincoln & Guba, 1985). Because of the complexity of the human interactions that were being studied, I wanted to maintain an open-minded outlook in regard to what truths might be revealed during the course of my investigation into the topic.

> *Constructions come about through the interaction of a constructor with information, context, setting, situations, and other constructors (not all of whom agree), using a process that is rooted in the previous experience, belief system, value, fears, prejudices, hopes, disappointments, and achievements of the constructor. To fall back on the terminology of the philosophy of science, constructions come about*

by the virtue of interaction of the knower with the already known and the still-knowable or to-be-known (Lincoln & Guba, 1985, p.143).

I also proceeded with the recognition that my qualitative investigation would not be disinterested or exhaustive (Lincoln & Guba, 1985, p. 37). My participation and personal knowledge in the areas of design and facility management was not only unavoidable, it was also necessary to allow me to frame appropriate questions and constructively engage with the interviewees. Thus, I approached the qualitative investigation as an open-ended process of discovering current issues, concerns, and practices in collaborations between designers and FMs. The information obtained from the interviews was then analyzed using the constant comparative method to reveal important themes and consistent concerns (as discussed in Chapter 4).

3.3.2. Interviews

Interviews are among the most common methods of data collection in qualitative research. Interviews are stressed as powerful tools within the naturalistic paradigm not because the paradigm is anti-quantitative but because these techniques can be applied more easily to the following key concepts in the qualitative method (Guba & Lincoln, 1985):

- Natural setting. Inquiry must be configured in a natural setting where objects of study take their sense as much from their environments as from themselves.
- The human as instrument. The characteristics such as responsiveness, adaptability, knowledge base expansion, procession immediacy, holistic

emphasis, opportunities for clarification and summarization, and opportunities to explore atypical or idiosyncratic responses qualify the human as the tool of choice for naturalistic inquiry (Guba & Lincoln, 1981).

- Tacit knowledge. A concept, which allows us to understand metaphor, identify faces, and "know ourselves." Qualitative methods allow the study of tacit knowledge, which would otherwise remain unnoticeable to the positivist approach. Tacit knowledge includes a multitude of inexpressible connotations, which give growth to new concepts, new senses, and new applications of the old (Stake, 1978).
- Grounded theory. A theory that is grounded in the data collected in the field, and theorizes multiple realities and makes transferability dependent on local contextual elements.
- Emergent design. Within the naturalistic paradigm, designs must be emergent rather than pre-ordinate because of the meaning in context, the existence of multiple realities, the interaction between site and context, and the complex nature of mutual shaping.

On the other hand, there are some concepts in research that are considered weaknesses of interviews in the study of human relations and social sciences (Guba & Lincoln, 1985):

- Investigator Bias. Qualitative inquiry usually can be influenced by the personal judgment of the participants or the researcher. It is also seriously

reliant on the investigator's interpretation (Particularly in the analysis of focus groups and interviews data).

- Trustworthiness. Based on their understanding that validity and reliability cannot be addressed in the same path in naturalistic inquiry, positivists generally mention trustworthiness as a weakness of qualitative techniques. Considering validity and reliability as concepts that should separately authenticate the research process, the trustworthiness of naturalistic methods of inquiry is problematic.
- Generalizability. The aptitude to generalize findings to other populations is considered one of the limitations of qualitative method, especially where it is usually designed to investigate the needs of one population.
- Time and cost. Regarding wider implication, physical attendance, and multiplicity for collecting credible data, qualitative research takes a more significant amount of time and cost.

An interview, as Dexter (1970) has suggested, is a conversation with a purpose. According to Lincoln and Guba (1985), interviews can be classified by their degree of overtness, their degree of structure, and the quality of the relationship between interviewer and interviewee. The following are particular pros and cons for this qualitative technique. Interview is an important method since it:

- Allows the candidates to see, feel and/or taste a research question.
- Has the potential to find the target population more easily compared to other research methods.

- Has the ability to reconstruct experienced entities in the past.
- Can better-explain responses through the observation of candidates' behavioral, verbal, and body language. Topics can be discovered in depth through applying probes.
- Provides an opportunity to analyze both the affective and cognitive aspects of the responses.
- Has the potential to clarify or describe questions in order to enhance the accuracy of the information collected.
- Allows for flexibility in times and locations in which interviews can be conducted.
- Raises unintended ideas or themes through attaining here-and-now constructions of events, organizations, individuals, activities, senses, concerns, incentives, claims, and other entities.
- Permits for personal interaction with the candidates can assure that the responses are direct feedback.

On the other side, interview has some limitations as a research technique:

- The costs of individual interviews are more than other types of research techniques, especially where amount of time required to train, schedule, conduct, input data and analyze are concerned.
- Preparation for the interview, leading the interview, and organizing notes for analysis is significantly time-consuming.

- Special skills and trainings are required to ensure that the interviewer has enough knowledge, confidence, and ability to handle the interview.
- Elements such as gender and appearance of interviewer, the way that a question might be rephrased, tone of voice, and inadequate note taking may result in errors and bias.
- Variation and flexibility in interview environment can lead to lack of control over the setting and inconsistencies across interviews.
- Multiplicity of materials generated in an interview makes the data analysis complex as well as subjective.

The interview part of the study consisted of interviews with facility management professionals. A semi-structured interview process was used, in which pre-defined questions (Appendix G) acted only as the starting point for conversation. This interview format is widely recognized as being effective in recording the respondent's honest thoughts, opinions, and experiences. Demographic information was also collected from the interviewees, including years of professional experience, educational background, and experience in public or private institutions, gender, and age. Most of the interviews were conducted in person, though some had to be conducted through video-conferencing (Skype) to account for the physical distances involved and the availability of the interviewees.

A total of 20 interviews were completed—nine face-to-face interviews and one Skype interview in London, three face-to-face interviews and two Skype interviews in College Station and Houston in Texas, and two face-to-face interviews and three Skype

interviews in Doha, Qatar. Each interview lasted between 30 and 45 minutes, and all of the interviews were carried out in English. The interview responses were audiotaped. Informed consent (including consent to be recorded) was obtained from each informant (see Appendix C). The researcher mailed a formal letter of thanks following each session.

3.3.3. Sampling

Purposive sampling (Tongco, 2007) was used in order to obtain interviews with experienced facility managers. The initial interview respondents (five individuals) were suggested by scholars who have previously done research in this area. These interviewees were then asked to suggest other potential respondents, which allowed me to expand the breadth of my coverage. This purposive sampling technique thus provided an opportunity to obtain a significant amount of high-quality data from informants who were well-situated and knowledgeable in the field of facility management. Assisted by the support of the Qatar Green Building Council, the British Facility Management Institute, Texas A&M University, and FIATECH, the researcher was able to travel to conduct interviews in Doha, Qatar in June of 2013, London, U.K., in March of 2014, and College Station, Texas, in April of 2014.

3.4. Quantitative Method

3.4.1. Developing the Survey Questionnaire

Surveys are an effective means of collecting large samples of quantitative data (Martin & Guerin, 2006). The survey developed for this study was directed at

individuals involved in facility-management fields. It consisted of 32 short-answer and narrative questions. Seven of the questions asked about the respondent's background, 10 questions addressed organizational protocols, and 15 questions addressed the FM's experience in collaborations with architectural designers. The survey was designed to collect data in several important categories, including collaboration rates, the nature of communication among different stakeholders in the design process, how FM's proposals were received by designers, and suggestions for improvements in communication. The survey was generated using Qualtrics online survey software hosted through Texas A&M University, and took approximately 15 minutes to complete. Respondents did not provide information that revealed their identities. A copy of survey is provided in Appendix H.

3.4.2. Participant Recruitment and Data Collection Procedure

The survey respondents included 171 facility managers, architects, construction managers, academic consultants, owners, general contractors, upper managers, project managers, and others who were professionally involved in managing a built environment. These individuals were recruited through the organizational membership lists of the British Facility Management Institute (BIFM), the International Facility Management Association (IFMA), the Middle Eastern Facility Management Association (MEFMA), the Qatar Green Building Council (QGBC), SSC Services at Texas A&M University, and the FIATECH group.

3.5. Research Validity

To ensure the validity of statistical results from the survey, a large sample was obtained, consisting of 171 respondents mostly drawn from the three main international facility management organizations (BIFM, IFMA, and MEFMA). The organizational membership lists used for recruitment had a large variability in terms of independent variables, and non-redundant covariates were minimized by control factors. Generally, confounding variables are the most important threat to validity. Factors such as an individual's training, level of education, and years of experience have been controlled for in the data analysis, but differences may still exists in other variables that the survey did not measure, such as the typical size of the projects handled by the different respondents or the internal culture of their organization. To help limit these potential problems, each of the three countries investigated in this research (the United States, the United Kingdom, and Qatar) was treated as a separate population.

External validity—the extent to which conclusions can be generalized beyond the survey sample—is also a concern in a survey of this nature (William et al., 2002). To increase the external validity of the study, efforts were made to distribute the questionnaire to a wide cross-section of the industry, including facility managers, project managers, upper-level managers, and consultants. Sampling from the membership lists of the three main international facility management organizations also helps to ensure that the conclusions of the research will be generalizable to the whole facility management industry.

3.6. Research with Human Subjects

In regard to U.S. Department of Health and Human Services (2011) regulations (45 CFR 46), all studies related to human subjects must receive approval from an Institutional Review Board (IRB). An application for this study was submitted to the Texas A&M University IRB office. The IRB reviewed the relevant materials and, after a few stipulations, approved the research project with the protocol number of IRB2013-0693.

3.7. Summary of Methodology

This research began with a comprehensive literature review of previous studies related to FMs' involvement in the design process. It then proceeded to qualitative interviews with experts in the field, and finally to a quantitative survey. The use of both quantitative and qualitative approaches allowed for the triangulation of data, revealing a more nuanced outlook on the phenomenon being investigated. Unlike previous studies, this investigation of collaborations between designers and FMs took an international approach, so that populations in three different countries could be compared. In the qualitative part of the study, 20 semi-structured interviews were conducted with prominent facility management professionals. In the quantitative part of the study, a survey questionnaire was widely distributed to the members of the primary international facility management organizations.

CHAPTER IV

INTERVIEW ANALYSIS

4.1. Introduction

The qualitative part of this study used a holistic/naturalistic paradigm of inquiry. As is customary for such investigations, a repeated pattern of data analysis was conducted based on the constant comparative method (Lincoln & Guba, 1985). As explained by Gall, Borg, and Gall (1996), this form of analysis is a "method for discovering unforeseen or unexpected patterns in the data and consequently . . . gaining new insights and understanding" (p. 197). Rather than trying to support or disprove a particular hypothesis, the constant comparative approach collects data and then seeks to discover new patterns or themes that emerge within it.

4.2. Data Analysis Procedure

4.2.1. Unitizing Information

Unitizing information means transforming raw data (in this case, recorded interviews) into the smallest possible pieces of discrete meaning (Erlandson, Harris, Skipper, & Allen, 1993). To do this, the recorded interviews were transcribed and then fragmented into individual statements, each labeled with a code indicating its source. These statements, or data units, were transferred to 4x6 index cards (578 cards in total). Names of individuals and institutions were removed in order to maintain the confidentiality of the study. An example of a data-unit card is illustrated in Figure 13.

The unit card includes:

- Card number
- Interview Code
- Date of the interview
- Line numbers
- Unit
- Page number in the original transcript

An example of a unit card is illustrated in Figure 16.

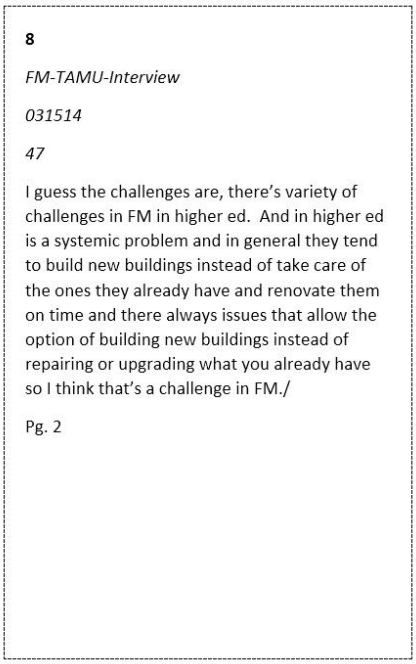


Figure 12. Example of a Unit Card

4.2.2. Categorization

The next step in the process was to organize the cards into provisional categories of data. Each card was examined and then grouped together with other data units that seemed to address a similar topic. These provisional categories were reviewed and re-organized until the researcher felt comfortable with the general outlines of the categories that had emerged. A label was then given to each category. Finally, each card was re-examined and analyzed to ensure that its contents could indeed be justified as belonging to the category that it inhabited. If its inclusion could not be justified, then it was either relocated to another pile or else used to start a new category (Alsmeyer, 1994). Table 2 includes the 20 categories that were identified in this study through the analysis of the data units.

4.2.3. Classifying Themes

Finally, the researcher examined the data categories and their contents to identify themes that had emerged during this organization process. The five themes that emerged in this analysis are presented in Table 3. In the following sections, each theme is examined in detail.

Table 2. Identified Categories of the Study

Category	
1.	Background
2.	Facility Management in the United Kingdom
3.	Facility Management in the United States
4.	Facility Management in the Middle East
5.	Comparison of Facility Management Cultures: The United Kingdom vs. the United States
6.	Comparison of Facility Management Cultures: The United Kingdom and the United States vs. the Middle East
7.	Facility Management Meetings
8.	Feedback Loops Within Facility Management Firms
9.	Facility Managers' Vision of Their Industry
10.	Facility Managers' Vision of Designers
11.	Communication Issues
12.	Relationships between Designers and Facility Managers after Building Occupancy
13.	The Need for Better Training
14.	Knowledge Management
15.	Motivators and De-motivators of Facility Managers for Collaboration in Design
16.	Benefits of FM Integration in Design Process
17.	Other Factors Affecting the Likelihood of Collaboration
18.	The Benefits of Collaboration
19.	When Should Collaboration Begin?
20.	Solutions for Integrating Facility Managers into the Design Process

Table 3. Themes of the Research

Themes	
Theme I.	Context
Theme II.	The Current State of Facility Management in the United Kingdom, the United States, and the Middle East
Theme III.	Communication Within Facility Management Firms
Theme IV.	Relationships between Designers and Facility Managers
Theme V.	Facility Managers' Involvement in the Design Process

4.3. Theme I: Context

As I traveled through College Station, TX, London, U.K., and Doha, Qatar, to collect the data for this study, I kept a journal of observations and details about the environment. After each interview I also wrote a description of the person interviewed, a description of his or her office, and a general impression of the experience. Re-examining these journals during the data analysis process helped to bring the experience of interviewing to life again, and to recall the context of the data collection process. Jarvis (1987) has argued that "learning always occurs within a social context and that the learner is also to some extent a social construct" (p. 15). Without an understanding of the social and physical context in which the interviewees live, the analysis of the information obtained would be necessarily diminished.

The interviews were conducted with 20 upper level-facility managers who had experience in contributing to the architectural design process. For the interviews in Qatar, all participants were members of the Qatar Green Building Council. Two face-to-face interviews were conducted during the summer of 2013, and three video-conference (Skype) interviews were conducted in the spring of 2014. For the interviews in the United Kingdom, all participants were affiliated with the British Facility Management Institute. Nine face-to-face interviews and one Skype interview were conducted in the spring 2014 with key persons in London's facility management industry. For the interviews in Texas, the researcher conducted three face-to-face interviews with high-level managers at Texas A&M University's Facility Services, and two Skype interviews with members of the FIATECH group in spring 2014.

Demographic data for the interview participants, including age, location of interview, gender, and educational level, are presented in Table 4. The percentage breakdowns for gender and education level are given in figures 14 and 15. Of the 20 facility managers participating in the research interviews, four were female and 16 were male. Their ages ranged from 38 to 66 years. Three held doctoral degrees, nine held master's degrees, and eight held bachelor's degrees.

Table 4. Age, Gender, Location, Method of Interview, and Educational Level for the Participants

Participant	Age	Gender	Location	Method of Interview	Educational Degree
Interviewee#1	54	Male	London, U.K.	Face-to-Face	Masters
Interviewee#2	52	Female	London, U.K.	Face-to-Face	Bachelors
Interviewee#3	60	Female	London, U.K.	Face-to-Face	Masters
Interviewee#4	63	Male	London, U.K.	Face-to-Face	Doctoral
Interviewee#5	45	Male	London, U.K.	Face-to-Face	Doctoral
Interviewee#6	51	Male	London, U.K.	Face-to-Face	Masters
Interviewee#7	47	Male	London, U.K.	Face-to-Face	Masters
Interviewee#8	66	Male	London, U.K.	Face-to-Face	Masters
Interviewee#9	58	Male	London, U.K.	Face-to-Face	Bachelors
Interviewee#10	43	Female	London, U.K.	Skype	Bachelors
Interviewee#11	60	Male	Texas, U.S.	Face-to-Face	Masters
Interviewee#12	55	Male	Texas, U.S.	Face-to-Face	Bachelors
Interviewee#13	61	Male	Texas, U.S.	Face-to-Face	Maters
Interviewee#14	64	Male	Texas, U.S.	Skype	Doctoral
Interviewee#15	58	Male	Texas, U.S.	Skype	Masters
Interviewee#16	38	Female	Doha, Qatar	Face-to-Face	Bachelors
Interviewee#17	54	Male	Doha, Qatar	Face-to-Face	Bachelors
Interviewee#18	39	Male	Doha, Qatar	Skype	Bachelors
Interviewee#19	43	Male	Doha, Qatar	Skype	Masters
Interviewee#20	38	Male	Doha, Qatar	Skype	Masters

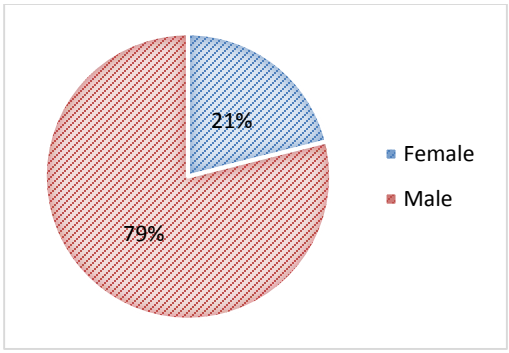


Figure 13. Demographic Information of Participants: Gender

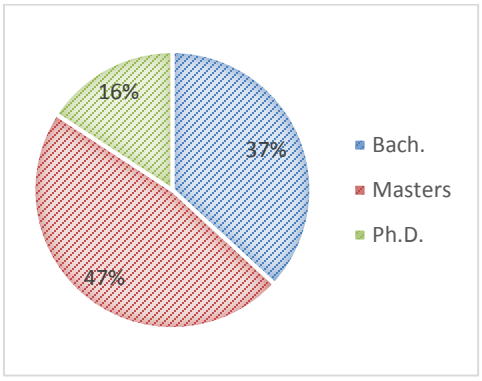


Figure 14. Demographic Information of Participants: Level of Education

Table 5 is a comparison of the interviewees' role within their companies/institutions and the length of their tenure at those institutions. Figure 16 provides a percentage breakdown by employment position. On average, the interviewees had been with their current institution for 18.6 years, and they had been in their current position for 5.9 years.

Table 5. Positions of Interviewees

Participant	Position	Number of Years in the Institution	Number of Years in the Current Position
Interviewee#1	FM Contract Managers	20	9
Interviewee#2	Director	20	12
Interviewee#3	Director	24	1
Interviewee#4	Consultant	30	14
Interviewee#5	Consultant	8	2
Interviewee#6	Architect	12	5
Interviewee#7	FM Consultant	13	6
Interviewee#8	Construction Manager	25	6
Interviewee#9	Facility Managers	27	12
Interviewee#10	Facility Managers	8	4
Interviewee#11	Director	22	2
Interviewee#12	FM Contract Managers	22	2
Interviewee#13	Architect	18	12
Interviewee#14	Facility Managers	30	3
Interviewee#15	Consultant	23	3
Interviewee#16	FM Contract Managers	9	3
Interviewee#17	Director	29	5
Interviewee#18	Facility Managers	12	12
Interviewee#19	Facility Managers	13	3
Interviewee#20	Facility Managers	6	2

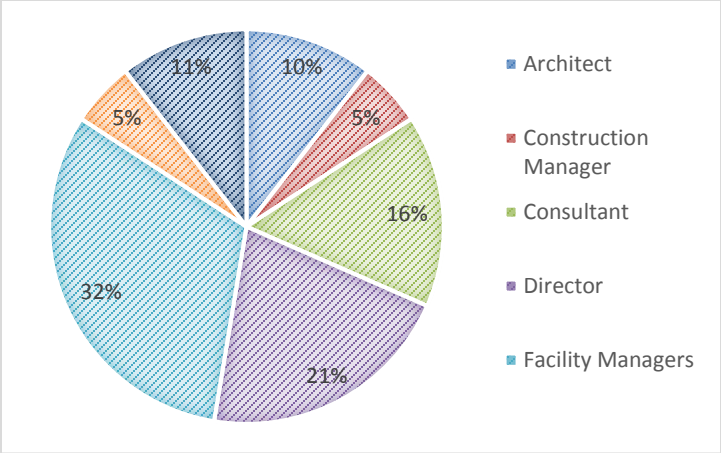


Figure 15. Distribution of Interviewees' Roles

These demographic results verify the experience of the interviewees in terms of the substantial number of years that they have worked in the field of facility management. It should be noted that the interviewees who are listed as "Architects" are in fact employees of facility management institutions and have chosen to apply their training in that context.

4.4.Theme II: The Current State of Facility Management in the United Kingdom, the United States, and the Middle East

The interviewees were asked about the current state of the facility management industry in their own countries. These results were classified based on the locations of the interviewees' institution. Additionally, the researcher asked all interviewees to make a comparison between facility management cultures in the United States and United

Kingdom, and then to compare both of these cultures together in contrast against the current facility management culture in the Middle East.

4.4.1. Facility Management in the United Kingdom

The researcher conducted ten interviews in the U.K. (specifically, in London). Most of these interviewees believed that facility management in their own country was beginning to mature. They indicated that facility management teams were no longer considered a "side note" to other aspects of building design, but were instead fully integrated into the business model:

> *I think in the U.K. we have a greater presence, so people have a greater understanding of what we can bring to the table . . . we are starting to lead projects.*

> *I believe facility management industry has grown in last five years and become a well-established field . . . you can find students who after finishing their education want to be a facility manager.*

Other interviewees expressed the belief that facility management had gained traction as a profession in the U.K. starting in the 1980s, partly because buildings were becoming more complicated, and partly because the public sector was beginning to outsource its buildings and support services to private firms.

Another of the interviewees in the U.K. took pains to classify the differing degrees of professionalism that had come to be associated with FMs in the country. "Level 1" (the lowest status) was given to employees who conducted the ongoing daily

maintenance and mechanical operation of buildings. “Level 2” included FMs who had come to the field from other professions. “Level 3” (the highest status) was given to those who had received formal training in facility management and often carried titles such as Head of Workplace. The development of these higher levels of professional respectability was seen as a sign that the field was beginning to mature.

In one of the interviews, an informant expressed a more negative view that earlier excitement about the prospects of the industry had since turned into a feeling of jadedness:

> *When I and my partner first came together in the late 1980s, the facility management included meetings with the fledgling Institute of Facilities Management and the Facilities Management group of the Institute of Administrative Management. In the late 1990s, these merged into the BIFM [British Institute of Facilities Management]. At the time, we had great hopes for the development of facilities management as a profession. Sadly, however, it had become more of an instrument of corporate takeover; and often offers a mediocre service—certainly worse than that achievable by good in-house FMs.*

This disappointing experience led the interviewee to develop some hypotheses about facility management companies in the U.K. As recounted in the interview, these hypotheses were:

1. The most profitable approach to facility management may conflict with the best design solution, so there is little incentive to strive for really good performance.

2. Even on their advance projects, FMs tend be better at dealing with symptoms (i.e., fixing things when they go wrong) than they are at examining underlying causes (why things went wrong in the first place).

3. Once a facility management firm has a portfolio of buildings, there are significant dangers in sharpening up their operational performance in any one of them. Doing so leads their clients to ask things like, "why did not you do this last year?" or "Why are not you doing the same in the other buildings that you are managing?" This fear of standing out reinforces a tendency toward mediocrity.

These negative outlooks indicated that the changes accompanying a maturing climate of facility management operations might not be universally positive or well-received.

In four out of the ten interviews, the informants mentioned that an aging work population was the main problem faced by facility managers in the U.K. There seemed to be a significant amount of consensus that many of the "old guard" were preparing to retire, with no intentions to pass on their experience to younger FMs. The younger generation was seen as having greater respectability and greater technical savvy, but there were concerns that the knowledge and experience of the older generation was being abandoned. Thus, there seemed to be a distinct generation shift occurring in the nature of the profession, one that included both gains and losses and was regarded more positively by some and less positively by others.

4.4.2. Facility Management in the United States

Five detailed interviews were conducted with FMs in the United States. Three of the five interviewees mentioned that training was one of the biggest current concerns for facility management in their country. They agreed that finding qualified employees was one of their main challenges, and that there did not seem to be a great interest in the field among the younger generation:

> *For these types of jobs the average age is about 55 and 60. It is very difficult finding a young person who is interested in operating buildings . . . The two big challenges are training and old generation of facility managers.*

The interviewees also indicated that there was a general lack of understanding among the U.S. public about what exactly FMs do, as well as a scarcity of formal training programs for FMs in the country's university system. These results indicate that in the next 10 years there is likely to be an inadequate number of professionals entering the facility management industry in the U.S., which may pose a serious risk to the stability and service quality of the profession.

4.4.3. Facility Management in the Middle East

The five interviewees in Qatar were asked about the current state of facility management in the Middle East. None of these individuals were native to the region—three were originally from European countries, and two were from India. All of them, however, agreed that facility management was a new but rapidly expanding field in the

Middle East. Fueled by wealth from oil production, all aspects of architecture, construction, and the associated fields have been growing strongly in this region and are predicted to continue to do so throughout the foreseeable future (Kumar, 2010). The interviewees emphasized, however, that facility management is still a fairly immature industry in the Middle East. They explained that the vast majority of the region's people were not even aware that such professions existed. Four out of five of interviewees in Qatar mentioned that the quality of workmanship was a particular challenge for the region's FMs. They cited a lack of consistent production standards, as well as language barriers and an absence of formal training systems, as the primary obstacles facing their profession.

One of the informants in Qatar offered a representation of the hierarchy of management levels in Middle Eastern facility management companies, which is reproduced in Figure 17. This interviewee added that there was a huge difference between the salaries of individuals in upper levels vs. those in the lower levels, and that access to the best-paying positions was largely based on personal background rather than merit. Such a situation, the interviewee suggested, contributed to a sense of indifference when it came to improving the quality of facility management services.

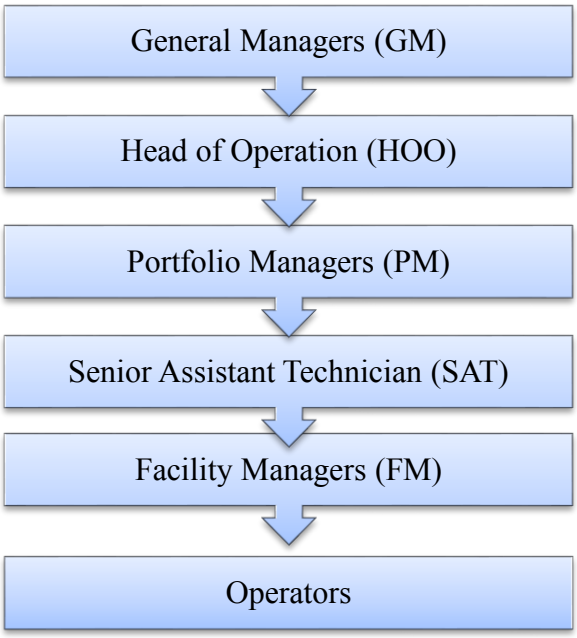


Figure 16. A Common Hierarchy of Management Levels in Facility Management Companies in the Middle East

Other interviewees made remarks that seemed to concur with this assessment. They frequently cited conflicts of interest and cultural barriers between different levels of management, and suggested that in many cases upper-level decision makers have a shallow understanding of actual facility management operations.

4.4.4. Comparison of Facility Management Cultures: The United Kingdom vs. the United States

Most of interviewees agreed that the facility management industry is more mature and firmly established in the United Kingdom than it is in the United States. One of the most commonly cited pieces of evidence in support of this assessment was that

there are a much larger number of educational programs giving degrees or certificates in facility management in the U.K. In addition, several of the interviewees mentioned that the facility management industry was more heavily established in Europe before it began to emerge in the Americas.

4.4.5. Comparison of Facility Management Cultures: The United Kingdom and the United States vs. the Middle East

One of the interviewees who had experience working both in the United Kingdom and in the Middle East stated that the differing quality of workmanship was the main thing that distinguished the two regions:

> *We have to do cost-ownership but they [FMs in Middle East] do not. If I go back to Building X, I had 6,000 people coming to a building each day—one security guy, one-person reception, and nobody goes longer than 30 seconds to get in . . . over here [Qatar] you have one person, [it] can be three security guys, and it can be an hour to get in.*

However, according to most of the interviewees, the biggest difference was that the Middle East suffered from problems with communication and cultural divergences that were not nearly as troubling in the U.K. and the U.S. They cited cases in which attempts to provide knowledge management throughout the life-cycle of an architectural project floundered due to language barriers and inefficient management processes. All of the interviewees who had an opinion on the differences between the regions (15 out of 20 individuals) agreed that differences in communicating between diverse cultural

outlooks and worldviews was a factor that made facility management more difficult in the Middle East.

The interviewees also agreed that as a result of these difficulties, there was currently very little collaboration between designers and FMs in the Middle East. Some of the informants pointed out that the Middle East Facility Management Association was working on a benchmarking report that would emphasize the need for such collaboration, but at the time of the interviews this effort had yielded little in the way of actual progress. While the collaboration between designers and FMs in the U.K. and the U.S. was not always seen as productive, the interviewees agreed that this collaboration was better than in the Middle East, where for the most part it was not happening at all.

4.5.Theme III: Communication Within Facility Management Firms

4.5.1. Facility Management Meetings

All 20 of the interviewees were asked about their meetings with other FMs, in order to better understand the kinds of communication that took place within the facility management industry. Sixty-five percent of the interviewees stated that they meet at least once a week with other FMs. The descriptions of what took place during these meetings, however, varied quite a bit. A director of a facility management firm in the U.S. offered the following description:

> *We have a meeting once a week is called the communications meeting and all the senior staff comes, [and] most of the managers, and then we rotate people from the field to come and to see the kind of stuff*

we're talking about, the things we're doing, and everyone has an opportunity to talk about what's going on in their particular division . . . we do once-a-week senior leadership meetings talking about the things which help us make better decisions . . . we do have a quarterly meeting in which we bring all managers. We do some training, some education, maybe some entertainment.

In contrast, the head of operations for a facility management firm in Qatar described a more hierarchical and formal approach:

We have a weekly meeting, what we call "senior leadership team." Which is the GM, heads of department, and portfolio managers. [We talk about] what's good, what's bad, what's pending, etc. The portfolio managers have weekly meeting with the delivery teams, and the FMs have weekly meeting with the operational delivery teams to cascade the information going through.

There did not seem to be any differences in the frequency of meetings between the three different countries examined in this study. However, the participants and the purpose of the meetings were different in each region. Sharing lessons-learned with other FMs was the most commonly stated reason for meetings in the U.K., communication and group spirit was reported as the main concern in the U.S., and efficiently distributing the workload was the most popular explanation for meetings in Middle East.

4.5.2. Feedback Loops Within Facility Management Firms

All of the interviewees were asked about feedback loops and the use of post-occupancy evaluation (POE) systems within their firms. The results of these discussions revealed a significant lack of structurally integrated feedback loops in facility management firms in all three regions of the study. Interviewees in the U.K. mentioned that there were government-run programs in their country that sought to establish POE databases in which FMs could share the lessons they had learned during the course of their operations. Also, in both the U.K. and U.S., interviewees explained that they sometimes used "customer surveys." However, these efforts at post-occupancy evaluation were haphazard at best, and in the Middle East region no experience with POE was reported at all. Some representative responses from the U.K. and the U.S. are as follows:

> *[U.K.] We obviously have a system, so we can get the raw data out of the system in terms of what's happening but we have different forums that I attend or my deputy attends . . . we meet quarterly and I go to that every time and we talk about what we are doing and get feedback from people . . . in a two-way dialogue where we actively seek input from our staff about what we are doing. I've done customer satisfaction surveys as well just to know that we are talking about the right things and that we do support the business in what it needs.*

[U.S.] We check on our customers randomly see if they are doing OK, to see if the tradesperson completed the work and if they didn't, [we] find out why . . . we do have a customer survey which is attached to each project. We do also have a one-year inspection of all the buildings that we are operating . . . to find out issues we need to solve . . . we are also looking at lessons learned, trying to see if we find anything we can do better.

All the interviewees agreed that establishing more robust survey tools and databases for POE feedback would enhance the quality of their operations, reduce the cost of facility management, and increase customer satisfaction. However, they felt that implementing a more robust system would be a difficult undertaking, and possibly not worth the hassle. Four of interviewees volunteered that they would be interested in sharing the contents of their feedback system with designers, but also stated they never been asked by designers to do so.

4.5.3. Facility Managers' Vision of Their Industry

The interviews revealed a high level of job satisfaction among these elite facility managers. They described their careers with phrases such as "field of innovation," "variety of jobs and tasks," "enjoyable and happy career," and "responsibility." However, some of the interviewees said that they felt like the public had little understanding of the importance of what they do, and that this was a source of disappointment for them, as well as for other FMs at all career levels:

It's a very interesting field, it's probably the happiest I've been in my career as far as enjoying doing what I do. I think it's very underrated. Everyone knows what needs to get done in FM and I don't think people are aware of the career possibilities and secondly how fun it is to do that, to have to deal with the different aspects of it. It allows you to work in different venues.

4.5.4. Facility Managers' Vision of Designers

The interviewees were also asked about their opinion of building designers. Eight of the twenty were positive, and suggested that they would be happy to work more closely with designers. However, nine interviewees were more disparaging, stating that designers were "busy" and "prudish" and that they often seemed to look down on FMs. One frequent complaint was that even though designers had limited knowledge about building operations, they were not respectful of FMs experience and were not interested in learning from them about maintenance issues. Some of the interviewees also characterized designers as more concerned with the aesthetic aspects of design than with practicality and building maintainability:

We identify and tell them [designers] things because we understand that it's not going to work, but sometime architects have blinders, trying to make their design look pretty, get it in the book, get a design award, but they don't come back and look at the problems. The X

Building won a design award, but it has a lot of maintenance problems.

Architects don't like being told that they cannot do something or that something won't work, because [they think] "I am the architect." So unless there is a new breed of architects coming through that can accept the input of few people.

One interviewee expressed the outlook that designers are trained to be innovators, and the nature of innovation is that you always have to be moving onward to the next experiment. As a result, the interviewee believed that considerations of practical functionality were not regarded by designers as having much importance. It is notable, however, that these negative outlooks were more commonly expressed by interviewees from the U.S. and the Middle East, where there was a less established culture of facility management and less involvement of FMs in the design process.

4.6.Theme IV: Relationships between Designers and Facility Managers

4.6.1. Communication Issues

Among the interviewees, 60% stated that there were significant communication problems between designers and FMs. One of the most commonly expressed frustrations was simply the use of abbreviations and acronyms. The facility management industry has a unique list of shorthand terms that are known by everyone in the field, and

designers have a similar playbook. Unfortunately, most of this terminology is not shared between the two professions:

> *We need to stop using abbreviation because not everyone, unless you are in the industry, you won't understand . . . if architects use a three-letter acronym for something which FM will not understand at all, so that's when the breakdown in communication will come into place . . . so I think it's making everything simple and plain so we can all understand.*

The interviewees also indicated that they did not feel confident about getting helpful responses from designers if they asked a question. Many of the disparaging outlooks that facility managers expressed about designers (as discussed in the previous section) really boiled down to the fact that FMs did not see designers as taking their concerns seriously. When this dynamic was altered, communication issues improved. This was the case, for example, when larger facility management companies hired designers directly to be a part of their building-alteration and renovation teams. The interviewees involved in these projects evaluated their communication with the in-house designers to be very effective:

> *In the last five years we worked with X design team, and the process was absolutely exciting. We have had regular contact, regular knowledge sharing, we have had conversation about how the design*

has worked, everything we have done—but not with the original designers.

Two interviewees in the U.K. declared that over the last five years communications with designers have become significantly easier in their country, and they attributed this change to the fact that FMs have become more powerful in the industry. From the perspective of these interviewees, much of the basis of communication problems between the two fields was simply that designers did not have an interest in communicating.

4.6.2. Relationships between Designers and Facility Managers after Building Occupancy

A common perspective among the interviewees was that very few designers ever returned to their previous projects to evaluate the outcomes of their design innovations:

I think good architects should come back and walk through the building and see what the occupants and facilities managers think of the facility and see what works and what didn't work, but I don't think many of them do that.

One of the interviewees in this study had been managing a building for 22 years that was designed by the world-renowned architect, Richard Rogers. This informant explained that in the last 22 years, the designer had only come to visit the building twice, and that each time it was a reluctant response to the FMs' request. Other interviewees strongly agreed that after occupancy there is usually no ongoing relationship between a

building's designers and the FMs. Only two of the interviewees had ever experienced collaborating with designers to run a post-occupancy evaluation at some point during their careers (one in the U.K. and one in the U.S.).

The most common post-occupancy collaborations between designers and FMs occurred when FMs decided to renovate a building. In these cases, the interviewees described the process of working with the building's original designers to be extremely difficult and frustrating. In one of the U.S. interviews, the informant described an attempt to replace the lighting system of a building with a new, energy-efficient LED configuration. After seeking assistance and information multiple times from the original building designers, with no response at all, the FMs eventually gave up and hired an external architect to help evaluate and solve the problem.

4.6.3. The Need for Better Training

The interviewees frequently mentioned that there was a need for better education and training, both of designers and of FMs, in order to help alleviate communiation problems and improve collaboration efforts. Such processes would be easier, they suggested, if designers and FMs knew more about each other's roles:

> *I think if anything young architects and facility managers need to be trained to understand more about building maintenance and the role of each other in reaching a successful design.*

University programs in facility management were seen as the solution to this problem, because they would not only provide better training for FMs, but also allow the

facility management profession to have a greater cross-fertilization with academic training programs for designers. Some of the interviewees also emphasized the value of continuing education, conferences, and workshops in helping to establish the importance of facility management within the larger architecture and construction industries.

4.6.4. Knowledge Management

A common view among the interviewees was that in the current environment FMs are not able to adequately share their knowledge with designers. In addition to transforming the social barriers to knowledge-sharing as described above, the FMs frequently suggested that better knowledge management software could be a useful tool to improve this situation. Some interviewees described their own institutional databases for "lessons learned," and indicated that the information in these databases could be of great value for designers and other project stakeholders. A full 25% of the interviewees brought up Building Information Modeling software (BIM) as having the potential to enhance this transfer of knowledge. However, they also confirmed that there are currently many problems of inadequate information-sharing capabilities and concerns about interoperability across different software platforms. Environments such as Autodesk Revit, which is now the most popular platform for design firms, were not created with the needs of FMs in mind and are not particularly effective for facility management operations. Thus, for the time being most FMs prefer to stick with software applications that are specifically designed for their industry.

4.7.Theme V: Facility Managers' Involvement in the Design Process

4.7.1. Motivators and De-Motivators of Facility Managers for Collaboration in Design

The interviewees frequently brought up the idea that FMs are interested in collaboration with designers, but are not confident enough to speak up and request it. They indicated that most FMs find it difficult to engage in a dialogue with designers because they feel that their outlooks will be regarded as boring and lacking in imagination. For example, one interviewee said:

> *FM has an amazing and an important role to play . . . the FM has to be confident enough to speak up and say no, that is not going to work. They have different aims and aspirations as teams. An architect will want to deliver a statement that is part of their portfolio and show the creativity, and an FM has to maintain a building. So the two have to meet in the middle and they have to communicate and share that knowledge.*

Some interviewees also suggested a more cynical perspective on why FMs might not want to participate in the design process. They suggested that design problems give FMs a reason to expand their own budgets, as well as a convenient scapegoat for poor facility management results. Being involved in the design process would eliminate these conveniences:

A systemic problem is that where an FM provides a good service seemingly effortlessly, they will be in the frame for downsizing. Therefore, to justify their existence and budget, it is useful to have a good crisis to deal with from time to time. Too close an involvement in design makes it more likely that the crisis will be seen to be of the FM's making.

Other interviewees refused this hypothesis, insisting that better collaboration can strengthen a facility management provider's competitiveness. These motivational optimists argued that stronger designs benefit everyone and that there is no end to the need for better building performance and the role of FMs in maintaining it:

I wouldn't think that collabortion in design makes FM's jobs insecure or anything like that. I don't think so because if architects make a building and it runs efficiently you still need someone to make sure that it actually does. So I think you still need a degree of FM involvement into the running of the building.

4.7.2. Other Factors Affecting the Likelihood of Collaboration

The interviewees indicated that the rate of collaboration between designers and FMs depends on whether the facility management for a building is outsourced or retained in-house. In-house FMs were significantly more likely to be involved in the design process. Projects in which the client planned to occupy the building themselves were also seen as entailing a higher likelihood of collaboration—presumably because the

client was more motivated to ensure a successful outcome, and thus more likely to fund the collaboration process. Many of the interviewees also indicated that the chance of FM involvement in the design process depended on the size of project—larger and more complex undertakings were more likely to be seen as opportunities for effective collaboration.

Finally, two interviewees in Qatar indicated that cultural factors could affect the likelihood of collaboration between designers and FMs. While "cultural differences" could be broadly interpreted to include pretty much all of the social obstacles and differences in perspective between designers and facility managers, these two interviewees described specific ethnic and geographical concerns. They explained, for example, that due to lower labor costs and prevailing environmental attitudes in the Middle East, many clients considered it easier to just demolish a facility and build a new one in order to save costs on long-term maintenance. Thus, the greater likelihood of collaboration in the U.S. and U.K. as compared to Qatar could to some extent be attributed to cultural differences.

4.7.3. The Benefits of Collaboration

The interviewees indicated different types of benefits that could emerge from the integration of FMs into the early stages of design. A full 90% of the informants volunteered the factors of improved building performance and reduced maintenance costs as the primary benefits of collaboration. They emphasized the likelihood of a reduction in the long-term expenses of the building, and added that collaboration resulted in greater satisfaction for both clients and occupants:

FMs need to learn a lot about the design process. But a well-informed FM is a very well client for a design team, and there aren't many of them. But where they do exist I bet the building will last a long time. Where they do exist I bet you have more clients and even users' satisfaction.

FMs should be at the table during the design because they can give more feedback other than users . . . they can tell the architect what works as far as performance, and what works as far as material, and what has been issues in facilities. You can gain a lot of insight by talking to the people who are over there working every day.

Many of the interviewees provided specific examples of how their contributions helped designers to avoid costly mistakes. One FM argued with a designer about the choice of an outdoor elevator, providing extensive information about the cost increases and maintainability issues associated with such a design. Ultimately, the designer was convinced and decided to alter the arrangement.

The interviewees also mentioned that collaboration would tend to lead toward safer and healthier environments, both for building maintenance personnel and for occupants. Some emphasized that they could help in the creation of more "flexible" designs by presenting realistic knowledge of building operations. For example, one interviewee described working with a designer to create a space that could be used as a café during the lunch hour and as a studio during the afternoon. Such a design would

have been extremely difficult to conceptualize without a detailed knowledge of the operational procedures required to enact the transformation each day.

4.7.4. When Should Collaboration Begin?

The interviewees were asked at what stage in the design process the collaboration between designers and FMs should begin. Twenty-five percent said that it should be initiated during the earliest programming or project evaluation phase. An additional 10% suggested collaboration should start at the concept design phase, and 15% suggested that it should begin with detailed design. In general, the interviewees tended to emphasize that earlier involvement would lead to better results:

> *From the beginning, from the concept stages where you know what you want, so you have a concept and you collaborate and work between architects, designers, FMs, and construction people to make sure that your concept can be finalized so if you have the collaboration of all these industries you're going to get a better product at the end.*

Some interviewees, especially those who had more experience in working with designers, mentioned that the appropriate time to initiate collaboration depended on the type and size of the project:

> *It really depends on the facility. I've done multimillion projects where we have met at 10 percent, 50 percent, 90 percent, 100 percent, we met all four times. Of course we are always communicating back and*

forth, I've done a lot of projects and met only four times but if you're like doing a hospital you're going to be meeting a lot more.

4.7.5. Solutions for Integrating Facility Managers into the Design Process

One of the most common suggestions that the interviewees made for improving the likelihood of collaboration was to enhance the client's awareness about the effectiveness of facility managers' involvement in design. The interviewees indicated that this could be done directly, by demonstrating the value of FMs in creating better-performing buildings, and the value of better-performing buildings in reducing long-term operating expenses. Alternatively, they noted that it could be done indirectly, by establishing academic programs in facility management and promoting the public image of the field.

Another suggestion frequently made in the interviews was that the likelihood of productive collaboration could be improved by promoting FMs' use of software tools such as BIM. This would need to be a multi-direction process—at the same time that FMs were taking steps to adopt the complex, design-oriented software platforms, these platforms would need to expand to better meet the operational needs of facility management. Finally, two interviewees suggested that facility management organizations could take steps to promote better collaboration. They suggested that these organizations create training programs to enhance FMs' confidence in engaging with designers, and to remind FMs of their "design responsibility." In addressing this issue one of the interviewees said:

So I think that's the challenge: if they can accept the idea that they have design responsibility and a design skill, they can come to the table with valuable contributions.

CHAPTER V

SURVEY ANALYSIS

5.1.Introduction

In this chapter I provide an analysis of the data that was gathered in the online survey. The survey questionnaire was distributed to the members of principal facility management organizations in the United Kingdom, the United States, and the Middle East. It was generated in order to test 30 hypotheses related to the current state of the facility management industry and the existing relationships between facility managers (FMs) and architectural designers. The international context of the survey allowed for a comparative analysis of facility management cultures and relationships with designers in three different regions.

5.2.Procedure

The survey was distributed to approximately 8,500 individuals. The recipients were recruited through the membership lists of prominent facility management organizations including the British Institute of Facility Management (BIFM), the International Facility Management Association (IFMA), the Middle East Facility Management Association (MEFMA), and the Qatar Green Building Council (QGBC), as well as through the e-mail lists of important facility management firms such as FIATECH and SSC Service Solutions. The recipients included general managers, heads of operations, portfolio managers, senior assistant technicians, facility managers, and

other professionals engaged in occupations related to building maintenance. Respondents did not provide information that revealed their identities. (The e-mail invitation that was sent to potential respondents is provided in Appendix D).

In the first month after the invitations were sent, only 35 complete responses were received. After sending a reminder e-mail, however, an additional 136 responses were submitted, for a total of 171 completed surveys. It is not possible to ascertain the exact number of people who received the survey link, as all recipients were invited to share the survey with their colleagues. The total number of 8,500 recipients is a conservative estimate. Out of these recipients, 298 individuals visited the survey site (see figures 18 and 19). Thus, the estimated response rate for the recruitment e-mail (number of people who clicked on the link) was 298/8500=3.50%. The estimated effective response rate (number of people who completed the survey) was 171/8500=2.01%. The percentage of respondents who went on to complete the survey after visiting the site was 171/298= 57.38%. On average, the respondents took 12 minutes and 23 seconds to fill out the survey (Figure 20). For the purpose of analysis, respondents who answered less than five of the survey questions were excluded. This led to 19 responses being omitted from the study, leaving 152 responses to be considered.

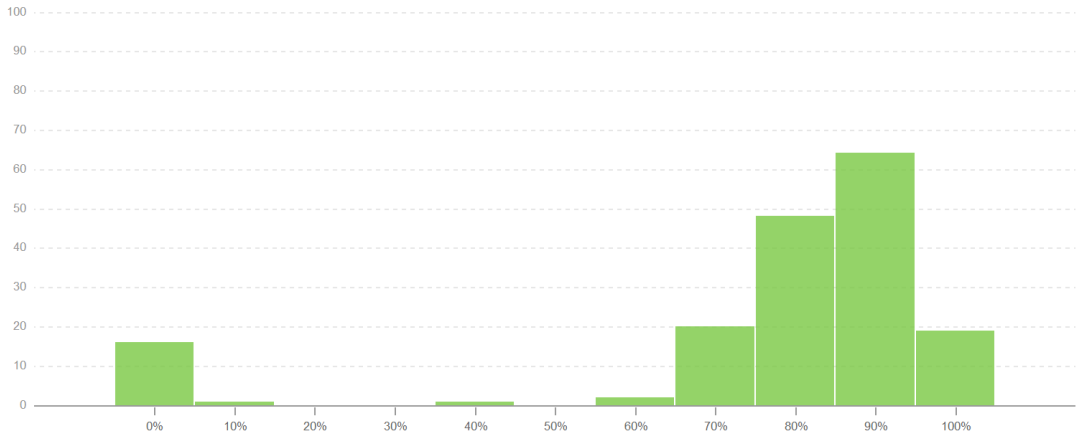


Figure 17. Survey Completion Rate (Percentage of Survey Questions Answered by Number of Individuals)

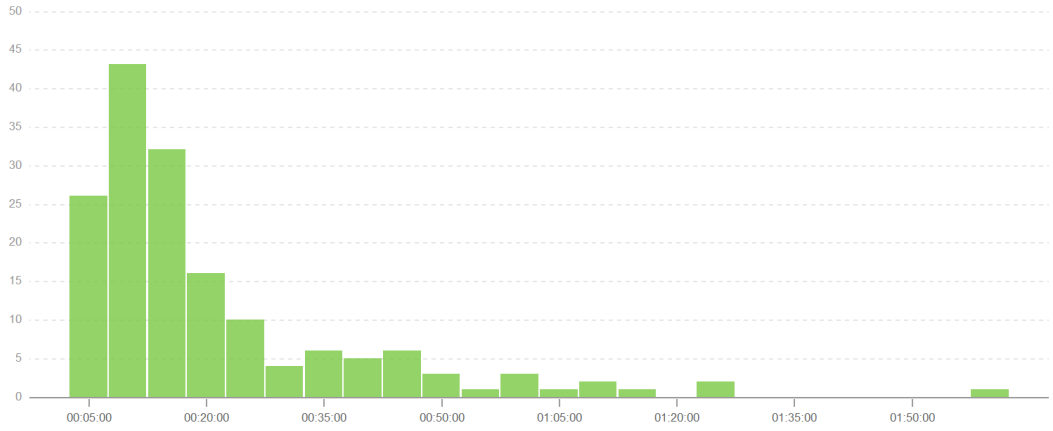


Figure 18. Survey Duration (Amount of Time Individuals Spent Completing the Survey)

5.3.Data Analysis Method

5.3.1. Tool

The survey consisted of 32 items, including 26 short-answer questions and 6 narrative questions. The short-answer questions varied between multiple choice and Likert-scale format. Demographic information was solicited primarily through multiple-choice responses, including the individual's role in his or her company, education, work experience, areas of specialization, geographic location, and organizational protocols. The Likert-scale questions included:

- Work experience
- Relationships with employees and supervisors
- The extent of information-sharing in the organization
- Feedback received from building occupants
- Most important issues in the facility management profession
- The application of LEAN principles in the organization
- Performance standards
- Experience of working with designers in the design process
- Experience of working with designers after occupancy
- Use of knowledge management platforms
- Overall perspective on communication with designers

5.3.2. Descriptive Statistics

Descriptive statistics were used to present the collected data and to summarize important features such as the mean (average) responses. In descriptive statistics, the

mean is a particularly important measure, along with confidence intervals and the shape of the data distribution (Ott & Longnecker, 2001). Box plots were used as a convenient graphical means of presenting this information.

5.3.3. Analysis of Variance (ANOVA) and Chi-Square tests

For the Likert scale items in the survey, both parametric (ANOVA) and non-parametric (Chi-square) statistical methods were used to analyze the data and to test hypotheses. There is some dispute among researchers as to which of these forms of analysis is appropriate—parametric analysis assumes that the distance between each point in the Likert scale is exact, whereas non-parametric analysis assumes that these distances are relative among different respondents (Jamieson, 2004; McCrum-Gardner, 2008). Generally speaking, the purpose of analysis of variance (ANOVA) is to test for significant differences between means.

5.4.Demographic Information

5.4.1. Job Title

The respondents worked mainly as facility managers (34%), general managers (15%), and heads of operation (14%). Additionally, 7% of the respondents were portfolio managers and senior assistant technicians. The other titles (31% in total) included director, supervisor, educator, researcher, project coordinator, architect, interior designer, business development, and team leader (see Figure 20).

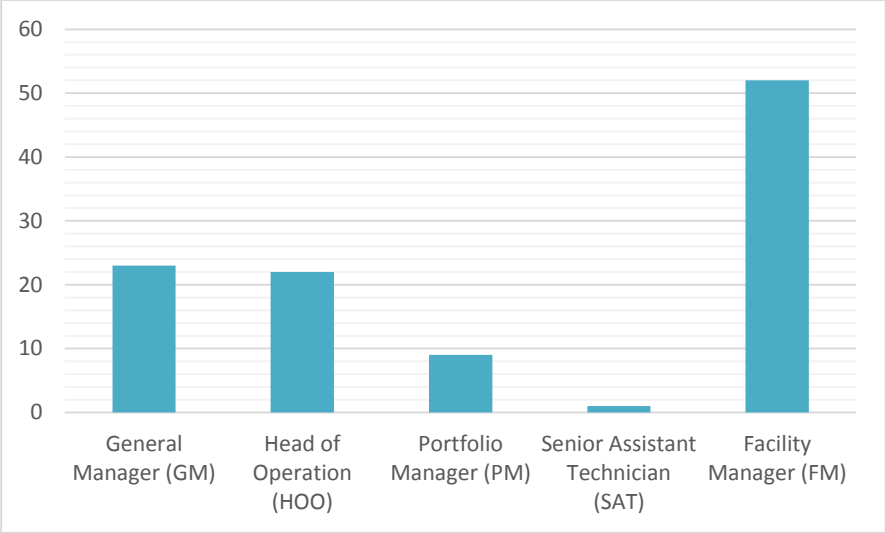


Figure 19. Respondents' Job Titles (Partial List)

5.4.2. Training

Thirty percent of the respondents completed graduate school, and 11% of them had some graduate school classes. Twenty-eight percent completed an undergraduate degree (with no further academic training), while 19% had withdrawn after taking some university classes (see Figure 21). Thirty-five percent stated that they had technical certificate or licenses including Maintenance Management Certificate (MMC), Master of Business Administration (MBA), Certified Facility Management (CFM), Facility Management Professional (FMP), and Project Management Professional Certification (PMP).

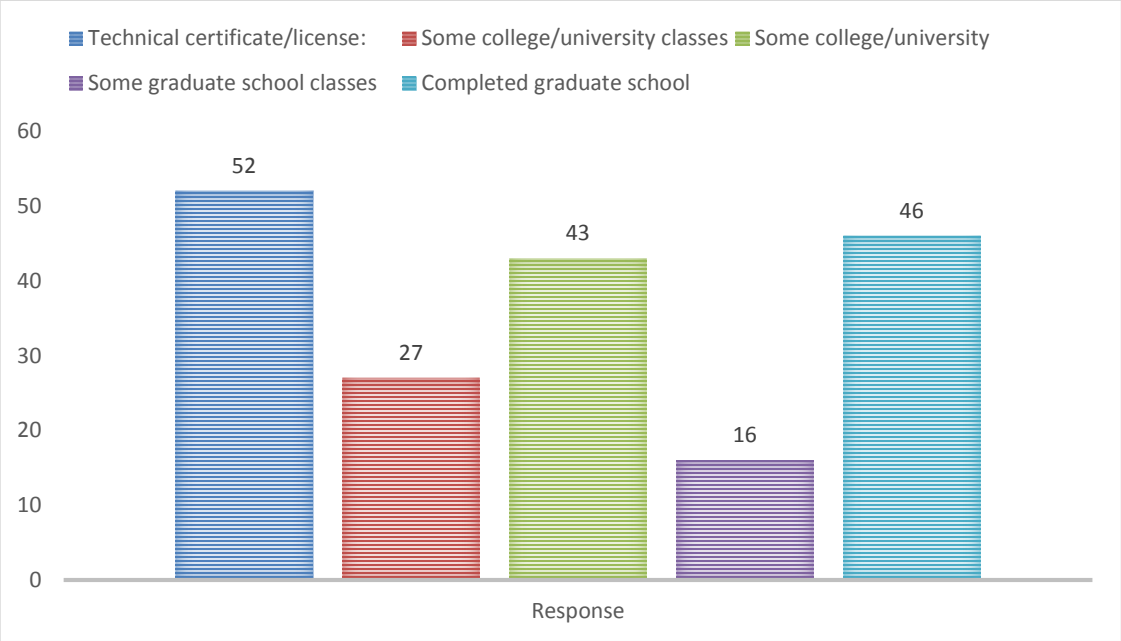


Figure 20. Level of Training

5.4.3. Work Experience

Fifty-nine percent of respondent had the experience of working more than 10 years in the facility management industry. Twenty-one percent had between 5 and 10 years of experience, and 16% had between 1 and 5 years. Only 3% had less than 1 year of experience. In regard to their current position, 16% of the respondents had held the position for more than 10 years, 30% had held the position for 5 to 10 years, 38% had held the position for 1 to 5 years, and 16% had held the position for less than 1 year (see Figure 22).

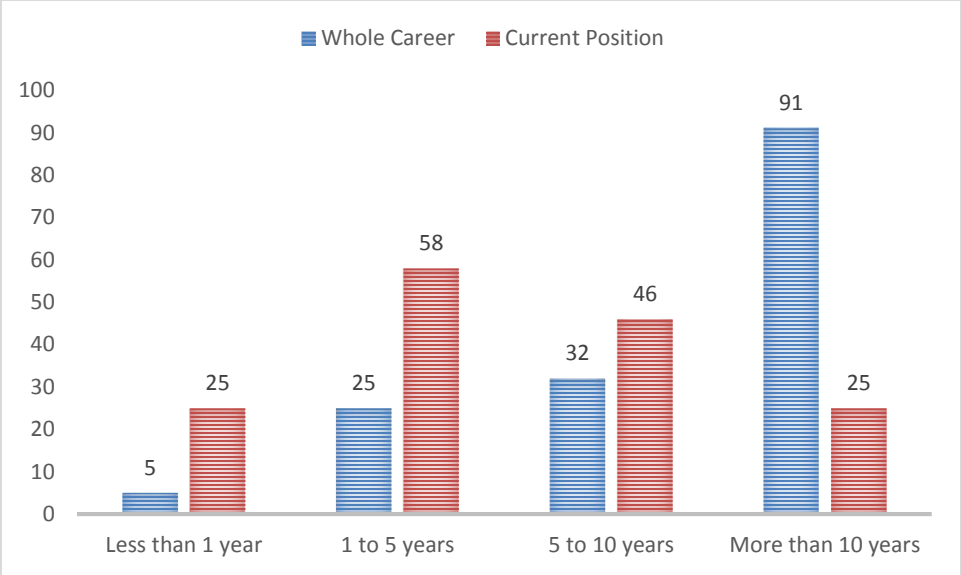


Figure 21. Work Experience

5.4.4. Location

Respondents were asked to select locations where they had experience working in the facility management industry, as well as the locations where they were currently working. At the time of filling out the survey, 45% of the respondents were working in the Middle East, 32% were working in the United States, and 23% were working in the United Kingdom.

In regard to their overall background, 53% of the respondents had the experience of working in the Middle East, 38% had worked in the U.S., and 25% had worked in the U.K. Thirteen percent stated that had the experience of working in Europe, 8% in Canada, and 8% in India. Finally, 8% indicated that they had worked in other countries such as Malaysia, Brazil, and Thailand (see figures 23 and 24).

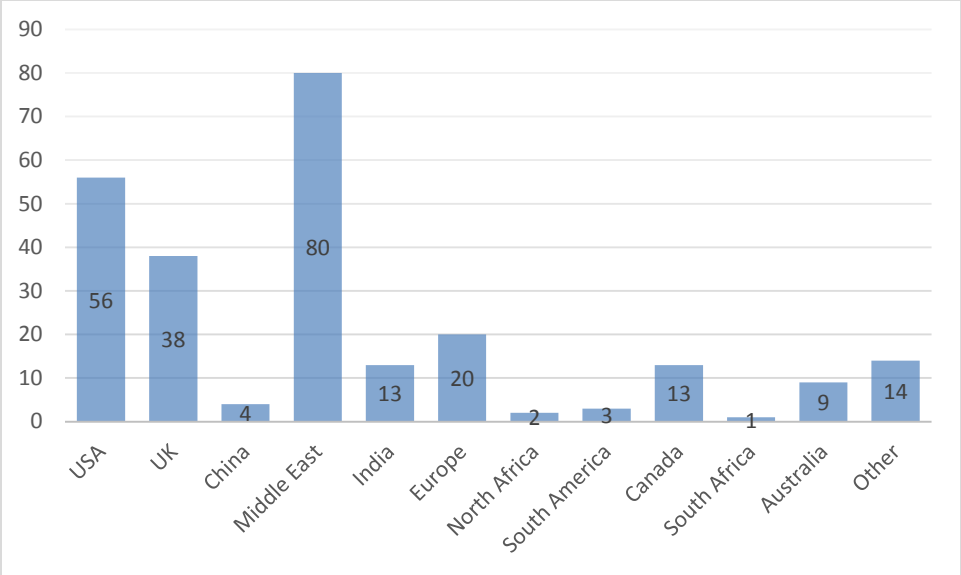


Figure 22. Distribution of Locations Where Respondents Have Worked in the Facility Management Industry

Figure 23. Map of Locations Where Respondents Have Worked in the Facility Management Industry

5.4.5. Specialization

The respondents were asked to identify areas of facility management in which they had specialized knowledge. Thirty-eight percent reported skill in maintaining and operating HVAC systems, and 30% reported specialized knowledge in working with electrical wiring and power distribution. The other responses were varied, including items such as project management, interior space planning, soft service, energy management, administration, architecture, real state, custodial operation, financial management, janitorial service, and sport field management (see Figure 25).

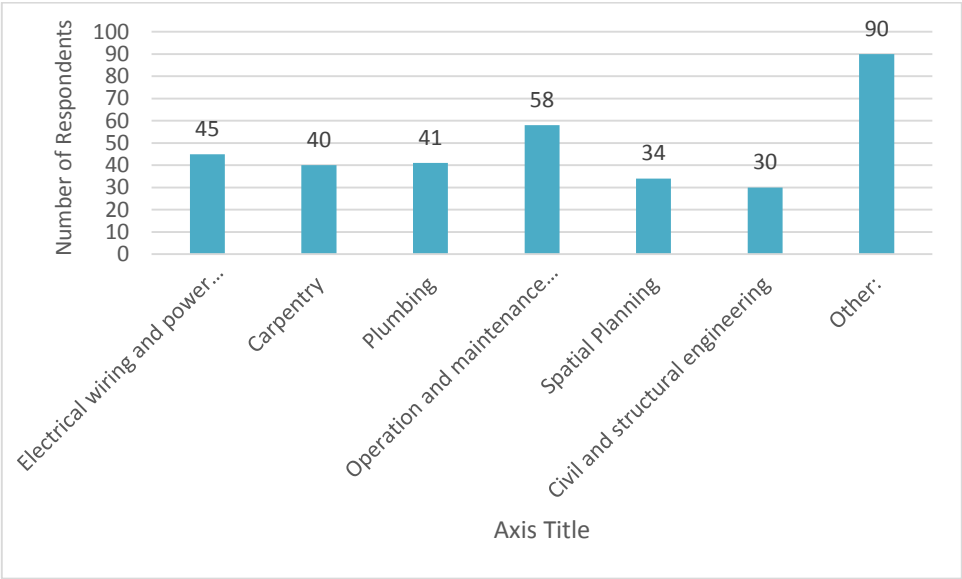


Figure 24. Areas of Specialization

5.5.General Results

5.5.1. Organizational Protocol

Of the 154 respondents, 81 indicated that they had a meeting with their management team once a week. Thirty-one respondents stated that they had a meeting once a month. Twenty-five respondents specified that there was no regular meeting schedule in their company/organization (see Figure 26). In regard to who participated in these meetings, 72% of respondents indicated that facility managers were present, while other participants included heads of operation (57%), general managers (55%), portfolio managers (39%), and senior assistant technicians (24%) (see Figure 27).

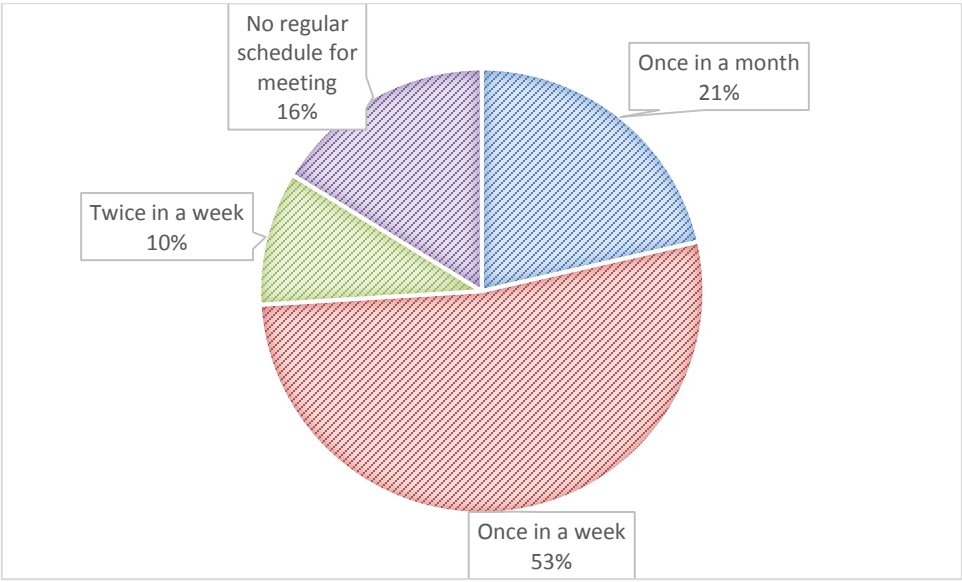


Figure 25. Meeting Regularity

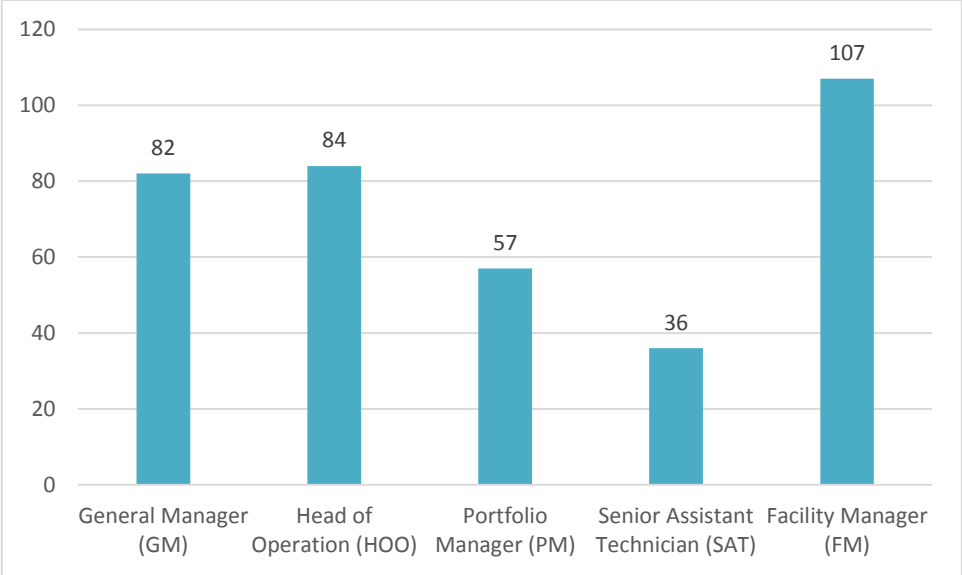


Figure 26. Participants in the Management Meetings

Respondents were also asked how comfortable they felt in sharing their opinions in management meetings, and how frequently they did so. More than 85% of respondents said that they felt very comfortable in sharing their opinions, while just 4% said that they rarely voiced their opinions. In Figure 28, the bars labeled as “Series 1” represent the feeling of respondents about sharing their opinions, while the bars labeled as “Series 2” illustrate how frequently they actually did share their opinion.

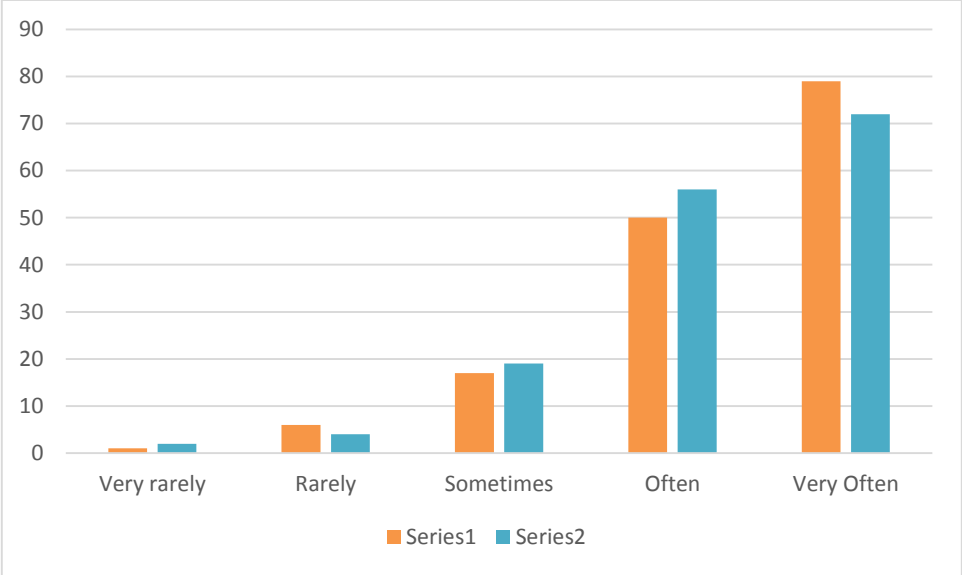


Figure 27. Sharing Opinions in Management Meetings

The results from the survey indicated that 73% of the respondents believe their company was “often” or “very often” successful in enhancing a building’s performance. Only 7% indicated that that their company was “rarely” or “very rarely” successful in this endeavor (see Figure 29).

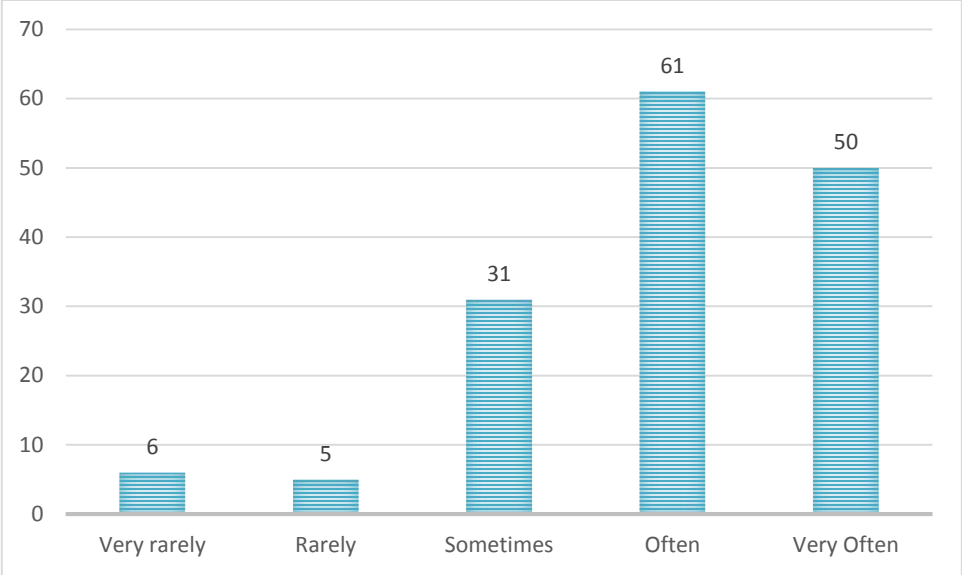


Figure 28. Facility Management Companies' Success in Enhancing Building Performance, as Perceived by Respondents

In regard to how many people they supervise, 10% of the survey respondents did not have any supervisory duties, 30% supervised between 2 and 10 individuals, 13% supervised between 10 and 20 individuals, and 47% supervised more than 20 people (see Figure 30).

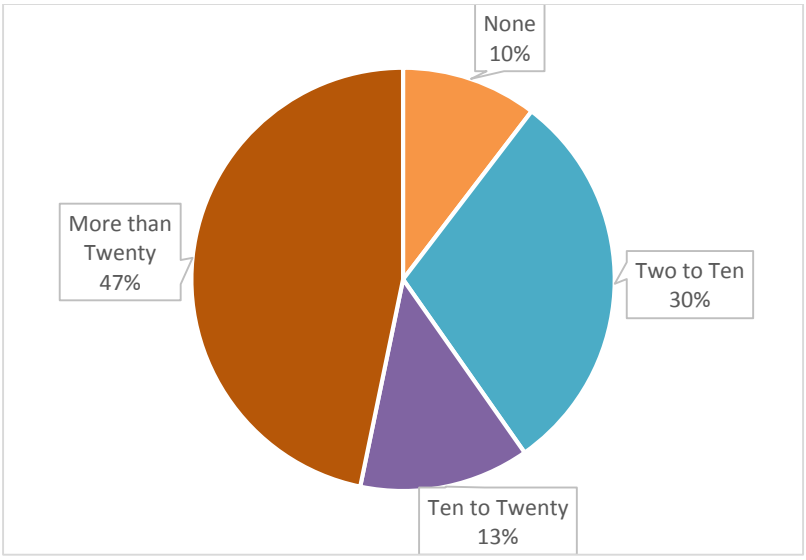


Figure 29. Number of Respondents by Amount of People They Supervise

In another question, respondents were asked about receiving complaints from building occupants. Fifty-two percent of respondents "sometimes" received complaints, while 25% rarely receive complaints and 23% regularly receive complaints about the building operation (see Figure 31).

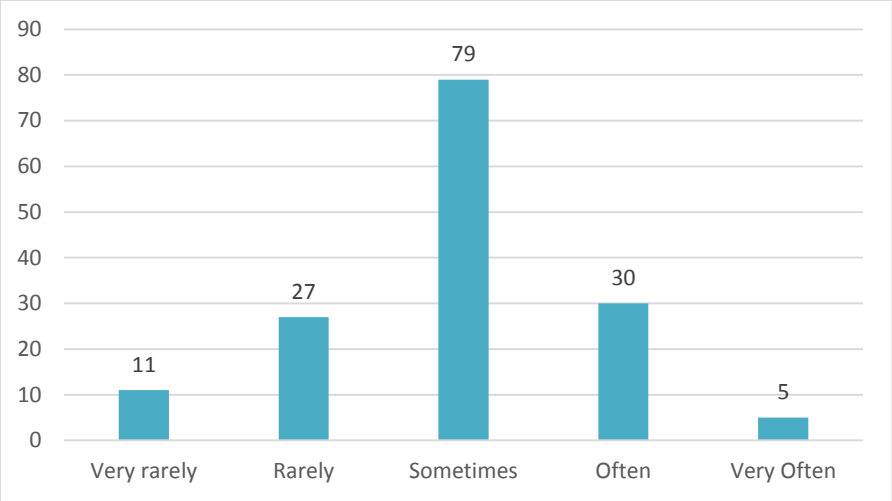


Figure 30. Regularity of Receiving Complaints from Building Occupants

5.5.2. Lean Principles in Facilities Management

Respondents were asked to indicate how often they use Lean principles in their facility management approach. As shown in Figure 32, a large number of the survey respondents said that they rarely use Lean principles (52%), and only 26% stated that regularly applied this management outlook. This results shows that "Lean" is still an unfamiliar term for much of the facility management industry. However, in the narrative responses to this topic, some respondents pointed out that identifying problems, recognizing forms of waste, 5S, Kaisen, and the continuous improvement feedback loop were elements of the Lean approach that were becoming better understood. One respondent explained:

We try to be more proactive than reactive with maintenance. With a regular maintenance schedule, we predetermine when an asset needs to be replaced or will come up for replacement versus waiting for it to break down. In addition, we look ahead for growth of the facility or area when selecting an asset.

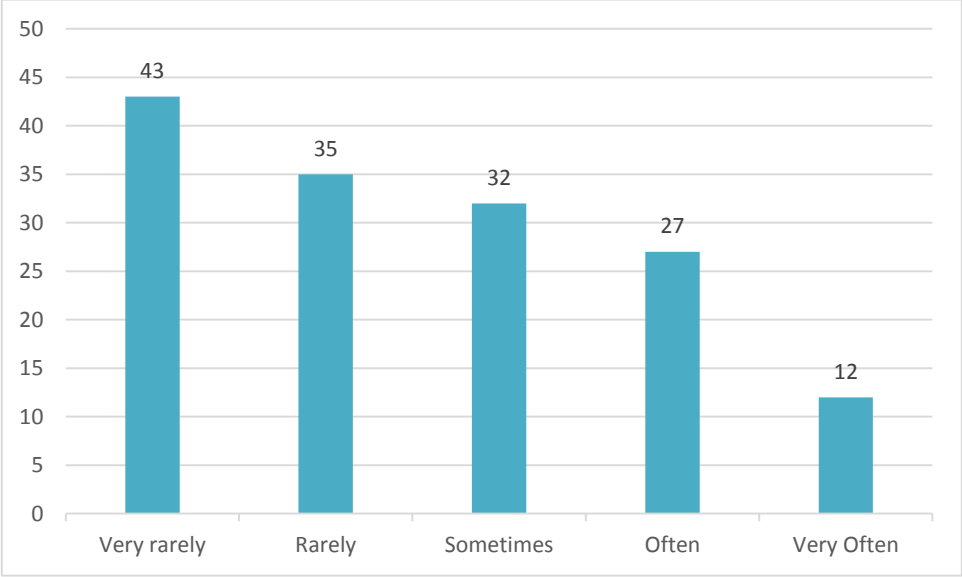


Figure 31. The Use of Lean Principles in Facility Management

5.5.3. Current Challenges in the Facility Management Industry

The respondents were asked to explain the most important challenges for today's facility management industry, and to suggest recommendations to improve the industry

in their countries. One hundred and one narrative responses were collected for this question, ranging from two-word replies to multi-paragraph explanations. In the Middle East, the respondents most frequently mentioned that there is a lack of understanding by building owners about what facility management is and how it can improve the operational efficiency of a structure. In all locations, training and education were mentioned as a central challenge. Respondents also indicated that the employee base in the facility management industry was aging and that there was a need for younger participants who were familiar with current technologies. Respondents from the United States and the Middle East mentioned the lack of a well-established facility management market in their countries. Respondents in the Middle East also stated that poor workmanship contributed to low performance in the facility management industry.

The respondents were forthcoming with specific recommendations to improve the current state of facility management in their countries. More than half of the respondents who answered this question pointed out that it would be useful to instill a greater awareness of what FMs do among designers, academics, and the general public. For example, one respondents said:

> *The industry itself needs to be clear on the definition of FM. I think the approach by Global FM is an improvement in the right direction. "How can a catering company call itself a FM company?" The industry needs to then sell the message to the owners of structures—what FM is and what it can do to sustain the structure over the [building's] life cycle.*

Additionally, respondents explained that better training programs could improve the quality of the facility management industry. They drew attention to the need for collaboration and better knowledge-sharing between experts. Five of the respondents indicated that the industry should focus more on customer service. As one explained:

> *My experiences in FM services are that managers focus entirely on repairs and project work rather than providing a service program that engages the client in determining what they want.*

Several respondents from the Middle East also indicated that in their region, a proper certification program of qualified facility management companies would be useful. They indicated that both education and legislation could be used to ensure that only certified companies would be eligible for facility management contracts.

5.5.4. Experience in Working with Designers

In two of the survey questions, respondents were asked to estimate the percentage of their own projects, and of all international projects, in which FMs were involved in the design process. The responses varied widely, with 38% stating that FMs were very rarely involved in design, but 14% estimating that FMs were very frequently involved in design. On average, the respondents estimated that collaboration with designers happened on around 35% of their projects (see Figure 33).

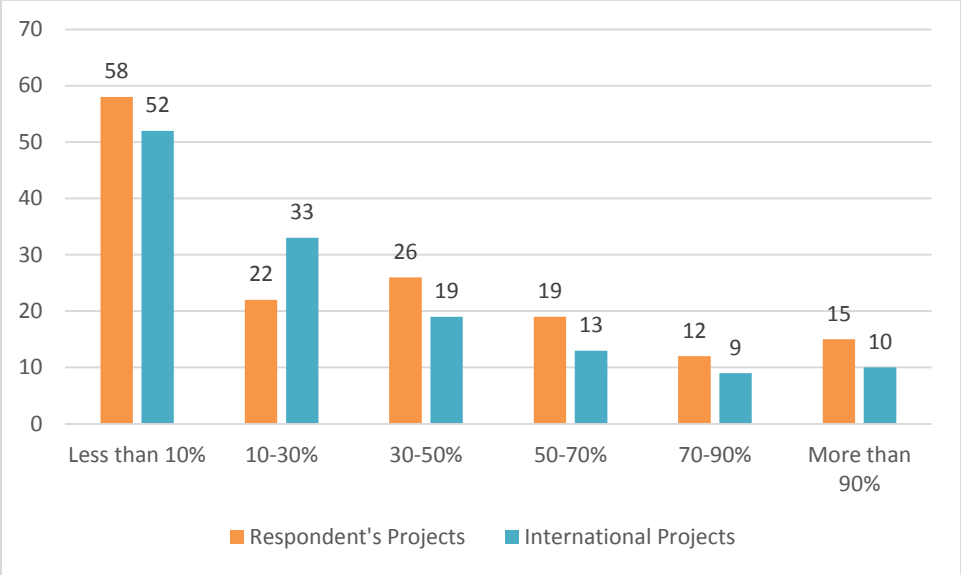


Figure 32. FM's Experience in Working with Designers

Responding to a question about post-occupancy relationships between designers and FMs, 17% had never asked for a designer's help in solving a facility management problem. An additional 34% had only done so in 1 to 2 projects. However, 18% of the respondents indicated that they collaborated with designers in solving problems in more than 10 projects (see Figure 34). In a separate question the respondents were asked if they felt that having a relation with the designer was important in solving problems; 36% agreed that it was "very helpful for most projects," and 40% agreed that it was "crucial for all projects" (see Figure 35).

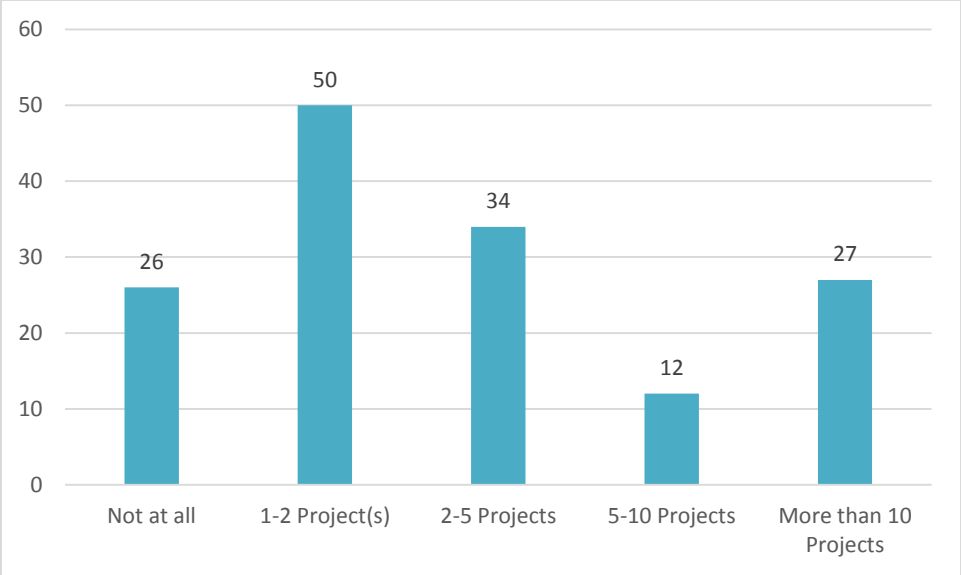


Figure 33. Post-Occupancy Relationships between FMs and Designers

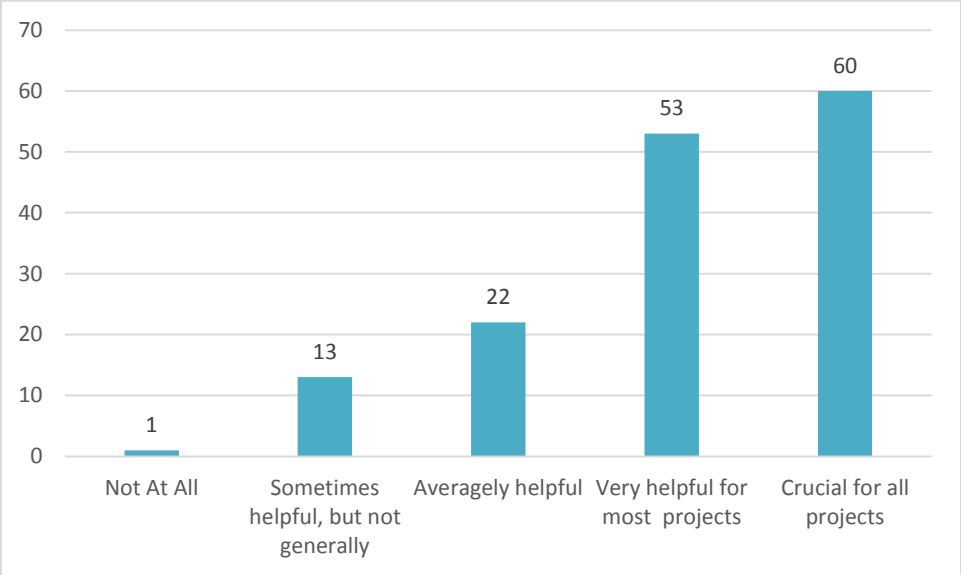


Figure 34. FMs' View of the Importance of Having a Relationship with Designers

5.5.5. FMs' Early Involvement in Design Process

A separate survey question asked FMs about the number of projects in which they had an early involvement in the design process. Of the 149 respondents who answered this question, 40 individuals (27%) said that they had an early involvement in more than ten projects. However, 35 respondents (23%) said that they had no experience at all of early involvement in project design. In average, the respondents indicated that they had an early involvement in project design on between 2 and 4 projects during the course of their entire career (see Figure 36).

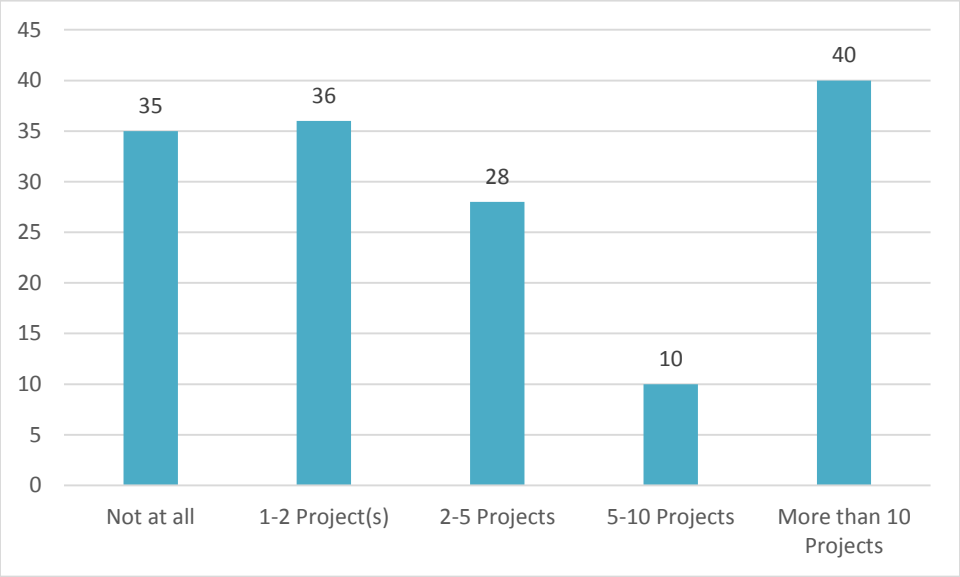


Figure 35. Early Involvement of Facility Managers in the Design Process

The respondents were also asked to rank the kinds of external consultants that they most often turned to for feedback. Architects were chosen most frequently, followed by mechanical engineers, interior designers, and civil/structural engineers (see Figure 37). In another question, they were asked to rank these occupations based on the level of common understanding. Respondents ranked mechanical engineers highest in this regard, followed by architects, then interior designers and civil/structural engineers (see Figure 38).

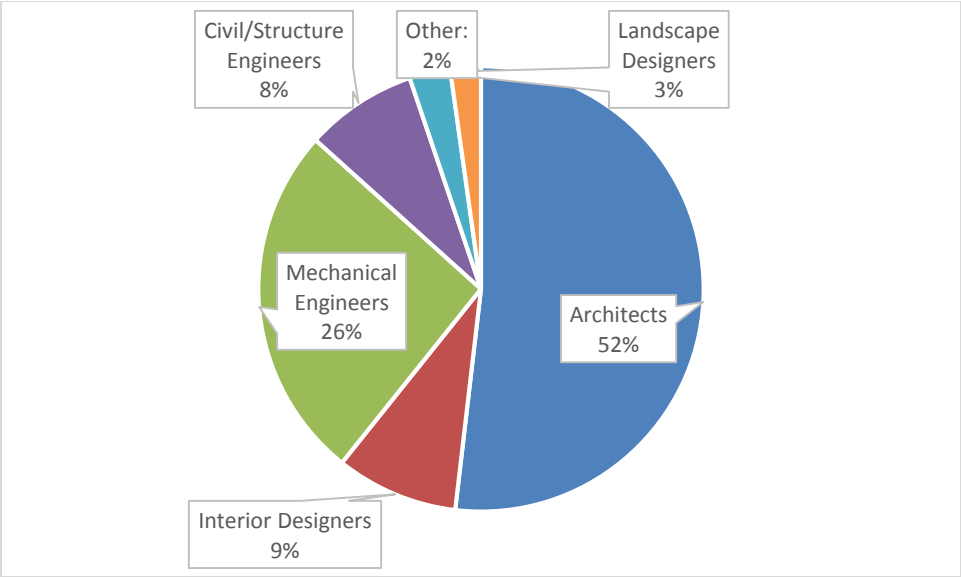


Figure 36. FM's Most Commonly Referenced Consultants

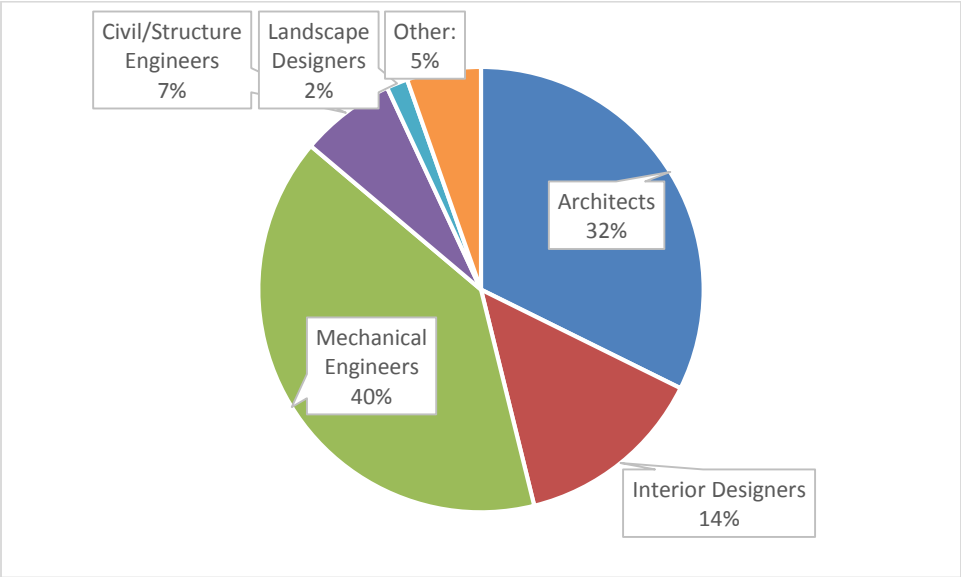


Figure 37. Fields That FMs Believe Have the Most Shared Understanding with Facility Management

5.5.6. Communication Between FMs and Designers

Seventy-nine percent of the respondents believed that the feedback from FMs can give designers a better understanding of building users and their needs. However, FMs were less optimistic about the likelihood of this feedback being heard. Forty-one percent agreed that their feedback only "sometimes" affected decision-making in the design process (see Figure 39).

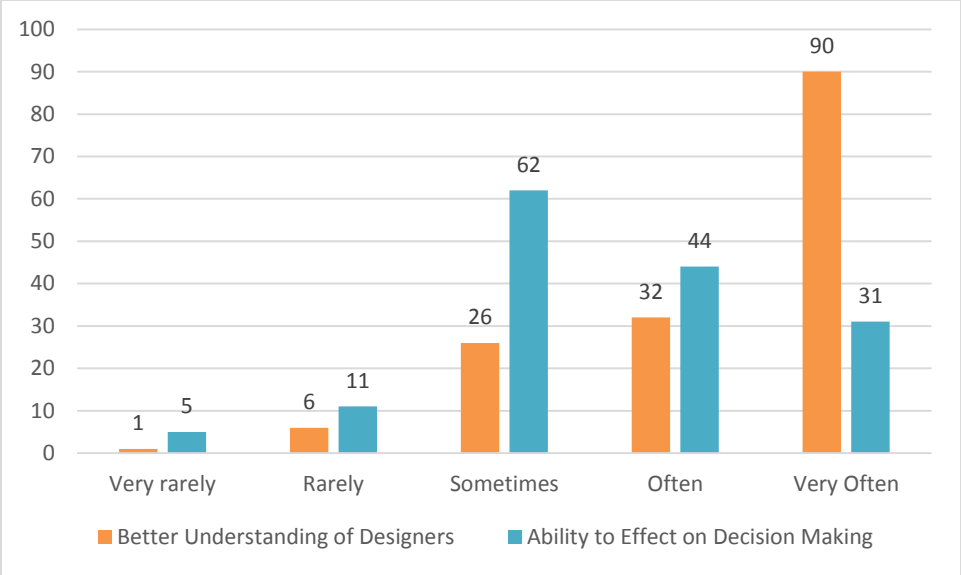


Figure 38. FMs' Beliefs about the Value of Their Feedback in the Design Process, and Their Beliefs about the Likelihood of that Feedback Being Heard

About half of the respondents (47%) stated that designers are not positive in regard to collaborating with FMs in the design process. An additional 28% agreed that designers are only "averagely positive" toward the idea of working with FMs. Only a small number of respondents (25%) felt that designers had a positive outlook toward collaboration (see Figure 40).

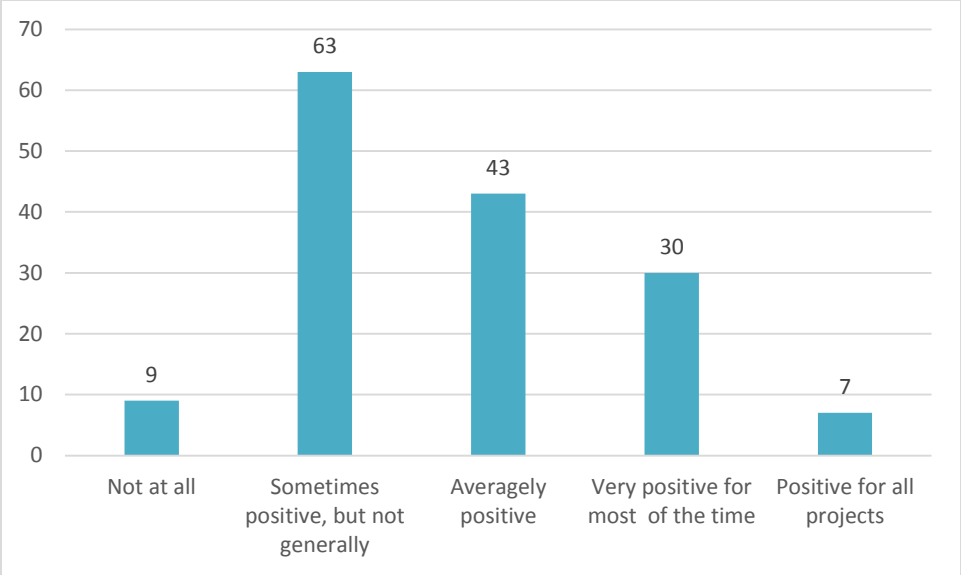


Figure 39. Positivity of Designers about Collaboration with FMs in the Design Process

When asked about the effectiveness of designers' solutions to building maintenance issues, 54% of the respondents indicated that designers' proposals are "effective, but need FMs' input." An additional 32% stated that designers' solutions are "rarely effective, and need FM input" in order to achieve a high-performance result (see Figure 41).

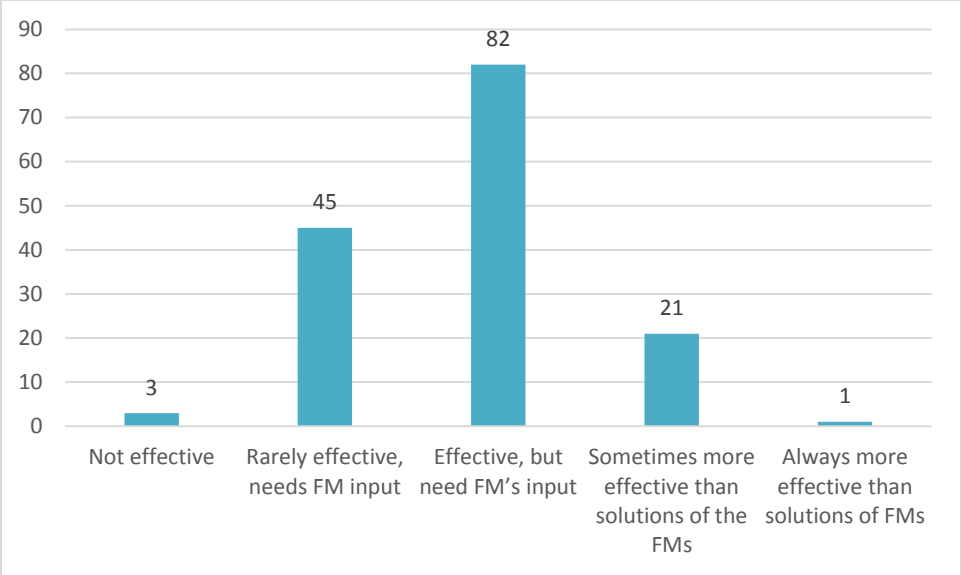


Figure 40. Efficiency of Designers' Proposals in Solving Building Maintenance Problems

5.5.7. Suggestions for Integrating FMs into the Design Process

Eighty-three respondents provided suggestion for how to better integrate FMs into the design process. These narrative replies again ranged from two words to multiple paragraphs. Most of the respondents mentioned the role of education in enhancing the quality of FMs' involvement in design. They pointed out that education can help both designers and FMs to better communicate with each other. Some respondents specified the need for a specific major in universities with the title of facilities management, as well as certificate programs in related interdisciplinary fields. Another popular response was that better communication could be established with the help of written guidelines for cost-effective solutions. According to the respondents, such documents could provide

a framework for all stakeholders to focus on during the design process. Additionally, some respondents indicated that solutions should address the problem of time and scheduling. For example a British facility manager said:

> *Extra training and commissioning assures a more efficiently operated building long after the designers are gone. Establish these relationships with designers during the project and provide recurring and relevant design follow-up after the project. This is a long term approach but is quickly forgotten as designers move on to other projects. In summary, there is a lot of pressure to perform on budget and on schedule for any project, but if more time/consideration was given to developing a design team comprised of the owner/operator, designers, commissioning, training, and trending, a project could be not just successful after the project but continually for the life of the building, equipment, and maintenance.*

Respondents were also asked to select the phases of the design process in which they felt most confident to provide suggestions. The most common responses were the strategic planning stage and the design development stage. Other respondents were divided among feeling it was best to get involved during the programming stage, schematic design stage, construction administration stage, or after the building was completed (see Figure 42).

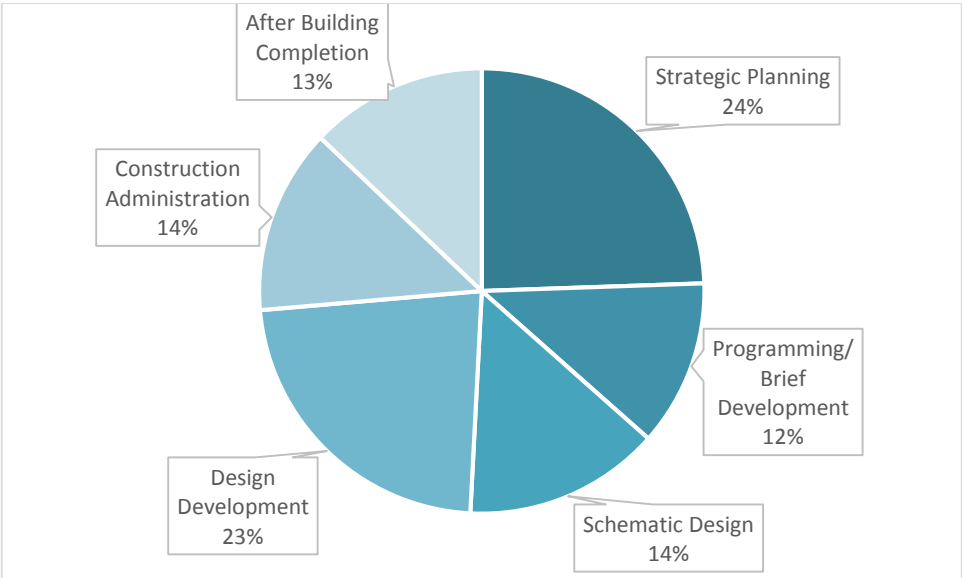


Figure 41. Respondent's Perceptions of the Best Time to Initiate Collaboration

5.6. Hypotheses Testing

Using the Likert-scale survey questions, 30 statistical hypotheses were tested. Both ANOVA and Chi-squared analyses were performed (for perceived interval data and perceived non-parametric data, respectively). Most of the results were similar regardless of whether the data were analyzed as parametric or non-parametric. The technical results of this analysis are given below, indicating the survey question responses used as dependent and independent variables in each hypothesis (see Appendix H for a full list of survey questions). A more descriptive interpretation of these hypotheses is provided in chapter 6.

5.6.1. The Impact of Training and Role in the Company

Hypothesis 1 (Questions 1, 2, and 3 relative to Question 10)

Regardless of the respondent's role in the company (Q1), highest level of training/education (Q2), or length of work experience (Q3), respondents feel that they can share their opinion in the company meetings (ANOVA *p*-value= 0.3769, 0.0700, and 0.0043; Chi-square *p*-value= 0.5774, 0.3327, and 0.0141). Therefore, Hypothesis 1 was supported.

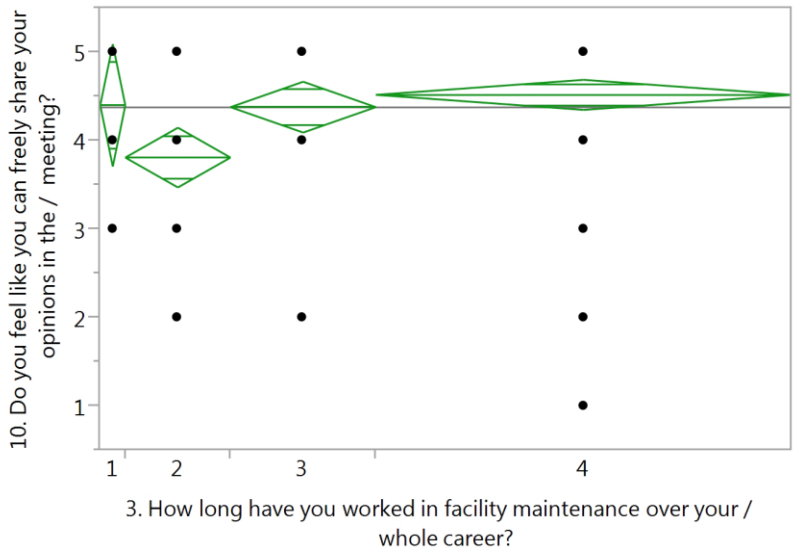


Figure 42. ANOVA Analysis: Impact of Length of Work Experience on Sharing Opinion in the Company Meetings (*p-value*=0.0043)

Hypothesis 2 (Questions 1, 2, and 3 relative to Question 24)

Regardless of the respondent's role in the company (Q1), highest level of training/education (Q2), or length of work experience (Q3), respondents think a relationship with designers is a necessary step to achieve good building performance (ANOVA *p*-value= 0.1167, 0.7267, and 0.0118; Chi-square *p*-value= 0.0109, 0.8601, and 0.0195). Therefore, higher length of work experience is associated with respondents thinking about a relationship with designers is a necessary step to achieve good building performance.

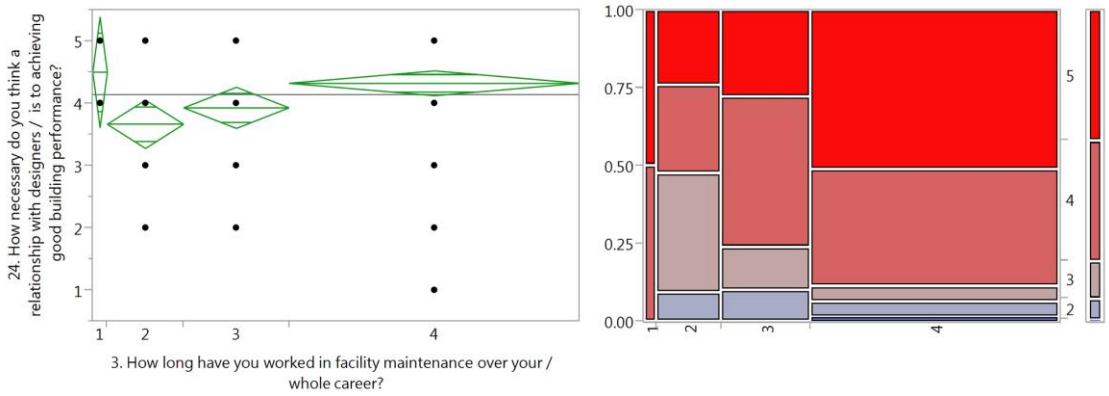


Figure 43. ANOVA and Chi-Square Analysis: Impact of Length of Work Experience on the Believe of Relationship with Designers as a Necessary Step to Achieve a High-Performance Building (*p-value*=0.0118 and 0.0195)

Hypothesis 3 (Questions 1, 2, and 3 relative to Question 27)

The hypothesis that regardless of the respondent's role in the company (Q1), highest level of training/education (Q2), or length of work experience (Q3), respondents feel that their ideas can affect decision-making in the design process (ANOVA *p*-value= 0.7878, 0.6239, and 0.2617; Chi-square *p*-value= 0.5630, 0.0357, and 0.3630) was not supported.

Table 6. Analysis of Hypotheses 1 to 3 (*p*-value<0.01 is marked in green; *p*-value<0.05 is marked in red; *p*-value<0.10 is marked in purple)

NO.	Questions	Independent Variable	Dependent Variable	P-value	
				ANOVA	Chi-Square
H1	Questions 1, 2, 3 relative to Question 10	Role in the company	Share their opinion in the company	0.3769	0.5774
		Highest level of training/education		**0.0700**	0.3327
		Length of work experience		**0.0043**	**0.0141**
H2	Questions 1, 2, 3 relative to Question 24	Role in the company	Relationship with designers is a necessary step to achieve a good building performance	0.1167	**0.0109**
		Highest level of training/education		0.7267	0.8601
		Length of work experience		**0.0118**	**0.0195**
H3	Questions 1, 2, 3 relative to Question 27	Role in the company	Respondents feel that their ideas can affect decision-making in the design process	0.7878	0.5630
		Highest level of training/education		0.6239	**0.0357**
		Length of work experience		0.2617	0.3630

5.6.2. Country of Origin

Hypothesis 4 (Question 6 relative to Question 10)

The hypothesis that the countries in which respondents have worked are related to the extent to which they feel they can freely share their opinions in meetings (ANOVA *p*-value= 0.6302; Chi-square *p*-value= 0.9069) was not supported.

Hypothesis 5 (Question 6 relative to Question 11)

The hypothesis that the countries in which respondents have worked are related to the extent to which they actually share problems in meetings (ANOVA *p*-value= 0.4760; Chi-square *p*-value= 0.7135) was not supported.

Hypothesis 6 (Question 6 relative to Question 12)

The hypothesis that the countries in which respondents have worked are related to their opinion about whether or not their company is successful in enhancing building performance (ANOVA *p*-value= 0.5513; Chi-square *p*-value= 0.9341) not supported.

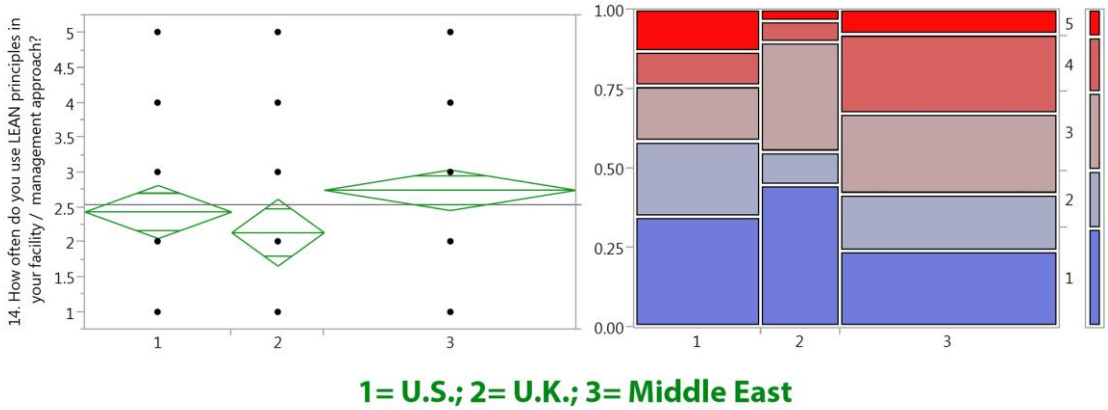
Hypothesis 7 (Question 6 relative to Question 13)

The hypothesis that the countries in which respondents have worked are related to the amount of complaints they receive about the building from occupants (ANOVA *p*-value= 0.2627; Chi-square *p*-value= 0.5889) was not supported.

Hypothesis 8 (Question 6 relative to Question 14)

The countries in which respondents have worked are related to the extent to which they use LEAN principles in their facility management approach (ANOVA *p*-value= 0.0844; Chi-square *p*-value= 0.0501). The results indicate that using Lean principles in facility management is more common in the Middle East than the U.K. (*p*-

value= 0.0334) (see Figure 46). Therefore, Hypothesis 8 was supported.



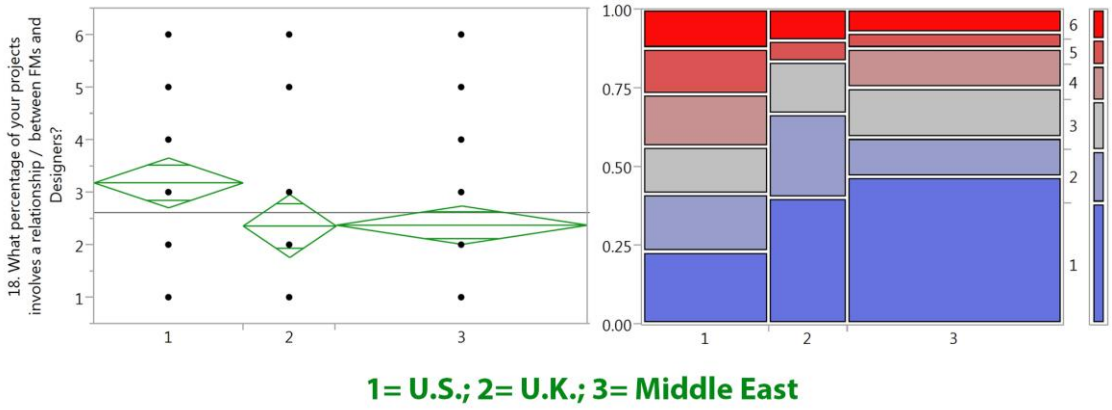
Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
3	2	0.6089044	0.2836345	0.048500	1.169309	0.0334*
3	1	0.3120528	0.2422826	-0.166649	0.790755	0.1997
1	2	0.2968516	0.3097508	-0.315154	0.908857	0.3394

Figure 44. Using LEAN Principles in the Facility Management Industry: The U.S., the U.K., and the Middle East

Hypothesis 9 (Question 6 relative to Questions 18 and 19)

The countries in which respondents have worked are related to perceived levels of involvement of FMs in the design process (ANOVA *p*-value= 0.0209 and 0.9647; Chi-square *p*-value= 0.0328 and 0.2272). The results show that the rate of involvement in the U.S. is higher than in both the U.K. (*p*-value= 0.0355) and the Middle East (*p*-value= 0.0087). Therefore, Hypothesis 9 was supported.



Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
1	2	0.8208333	0.3870360	0.056326	1.585341	0.0355*
1	3	0.8047840	0.3029124	0.206445	1.403123	0.0087*
3	2	0.0160494	0.3554215	-0.686010	0.718109	0.9640

Figure 45. FMs' Early Involvement in the Design Process: The U.S., the U.K., and the Middle East

Hypothesis 10 (Question 6 relative to Question 20)

The countries in which respondents have worked are related to the level of designers' involvement in post-occupancy problem solving (ANOVA *p*-value= 0.0473; Chi-square *p*-value= 0.2646). The findings illustrate that the chance of a relationship between FMs and designers after occupation is higher in the U.S. than in the Middle East (*p*-value= 0.0189). Therefore, Hypothesis 10 was supported.

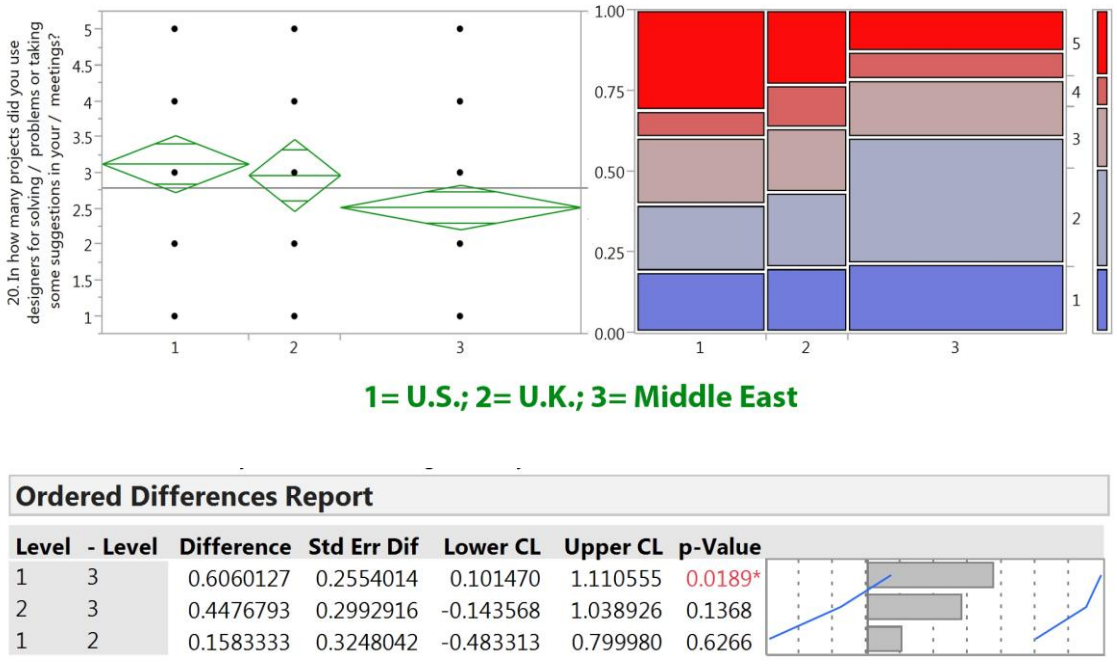
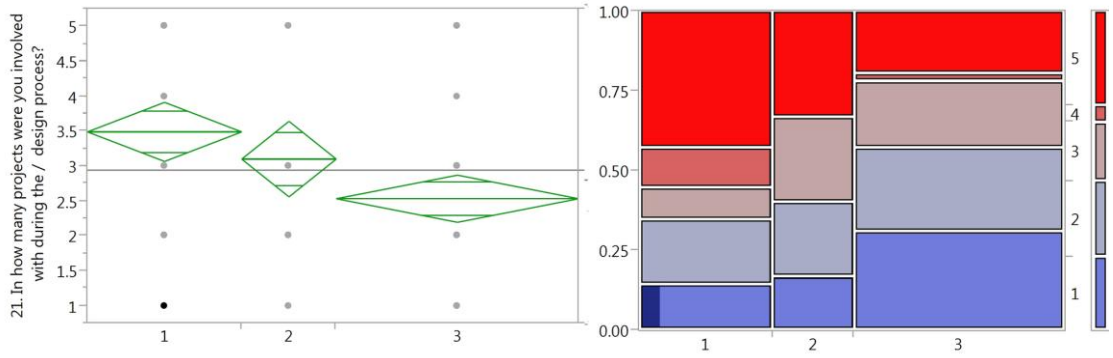


Figure 46. Rate of Collaboration with Designers for Solving Problem after Occupancy: The U.S., the U.K., and the Middle East

Hypothesis 11 (Question 6 relative to Question 21)

The countries in which respondents have worked are related to the number of projects in which they had an involvement during the design process (ANOVA *p*-value= 0.0023; Chi-square *p*-value= 0.0056). The results indicate that the number of projects in which FMs have collaborated in the design process is lower in the Middle East than in the U.S. (*p*-value= 0.0006) and the U.K. (*p*-value= 0.0807). Therefore, Hypothesis 11 was supported.



Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
1	3	0.9573284	0.2740609	0.415896	1.498761	0.0006*
2	3	0.5675325	0.3227685	-0.070126	1.205191	0.0807
1	2	0.3897959	0.3476644	-0.297046	1.076638	0.2640

Figure 47. Rate of Collaboration in the Design Process (Number of Projects): The U.S., the U.K., and the Middle East

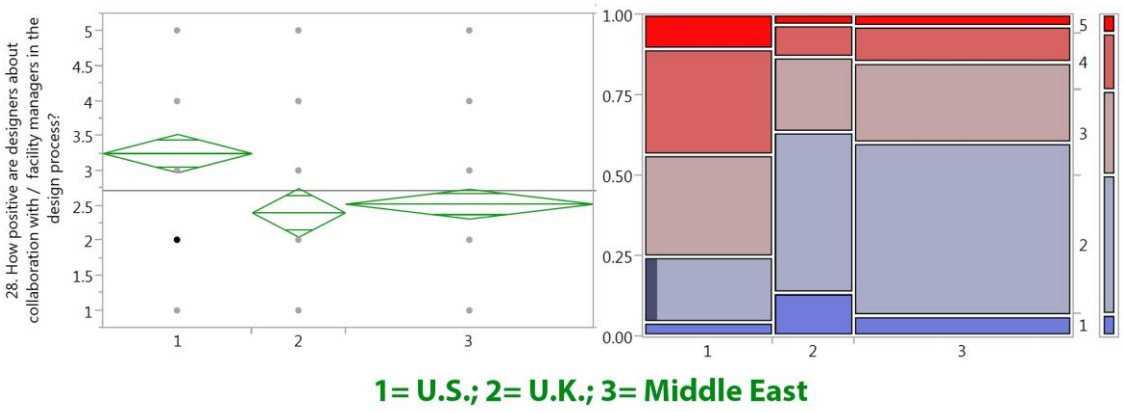
Hypothesis 12 (Question 6 relative to Questions 26 and 27)

The hypothesis that the countries in which respondents have worked are related to the confidence of FMs to actively contribute to the design process (ANOVA *p*-value= 0.8729, and 0.5330; Chi-square *p*-value= 0.8690, and 0.9400) was not supported.

Hypothesis 13 (Question 6 relative to Questions 28 and 29)

The countries in which respondents have worked are related to the perceived positivity of designers about collaborating with FMs (ANOVA *p*-value= 0.0001, and 0.1281; Chi-square *p*-value= 0.0036, and 0.1789). The results show that the perceived

positivity of designers toward collaboration is higher in the U.S. than in the U.K. (*p*-value= 0.0001) and the Middle East (*p*-value= 0.0002). Therefore, Hypothesis 13 was supported.



Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
1	2	0.8500000	0.2244438	0.406637	1.293363	0.0002*
1	3	0.7250000	0.1760682	0.377197	1.072803	<.0001*
3	2	0.1250000	0.2064582	-0.282835	0.532835	0.5458

Figure 48. Perceived Positivity of Designers about Collaborating with FMs: The U.S., the U.K., and the Middle East

Table 7. Analysis of Hypotheses 4 to 13 (p-value<0.01 is marked in green; p-value<0.05 is marked in red; p-value<0.10 is marked in purple)

NO.	Questions	Independent Variable	Dependent Variable	P-value	
				ANOVA	Chi-Square
H4	Question 6 relative to Question 10	The countries that respondents have the experience of working in	The extent to which they feel that can freely share their opinion in the meeting	0.6302	0.9069
H5	Question 6 relative to Question 11	The countries that respondents have the experience of working in	How regularly they share problems in the meetings	0.4760	0.7135
H6	Question 6 relative to Question 12	The countries that respondents have the experience of working in	FMs' belief that their company is successful in enhancing building performance	0.5513	0.9341
H7	Question 6 relative to Question 13	The countries that respondents have the experience of working in	Amount complaints received about the building from occupants	0.2627	0.5889
H8	Question 6 relative to Question 14	The countries that respondents have the experience of working in	Use of Lean principles in their facilities management approach	**0.0844**	**0.0501**
H9	Question 6 relative to Questions 18 and 19	The countries that respondents have the experience of working in	Perceived percentage of FMs early involvement in the design process	**0.0209**	**0.0328**
				0.9647	0.2272
H10	Question 6 relative to Question 20	The countries that respondents have the experience of working in	Designers' involvement to solve problem after occupancy	**0.0473**	0.2646
H11	Question 6 relative to Question 21	The countries that respondents have the experience of working in	The number of projects in which they were involved during the design process	**0.0023**	**0.0056**
H12	Question 6 relative to Questions 26 and 27	The countries that respondents have the experience of working in	Confidence of FMs to actively contribute to the design process	0.8729	0.8690
				0.5330	0.9400
H13	Questions 6 relative to Questions 28 and 29	The countries that respondents have the experience of working in	Perceived positivity of designers about collaborating with FMs	**0.0001**	**0.0036**
				0.1281	0.1789

5.6.3. Confidence in Sharing Opinions

Hypothesis 14 (Questions 10 and 11 relative to Question 27)

The confidence of respondents in sharing their opinions in meetings is related to the extent to which respondents feel that their idea can affect decision-making in the design process. The results indicate that the FMs who are more confident to share their

opinions with their colleagues are also more confident about the influence of their ideas (ANOVA *p*-value= 0.0050, 0.0019; Chi-square *p*-value= 0.0133 and 0.0001). Therefore, Hypothesis 14 was supported.

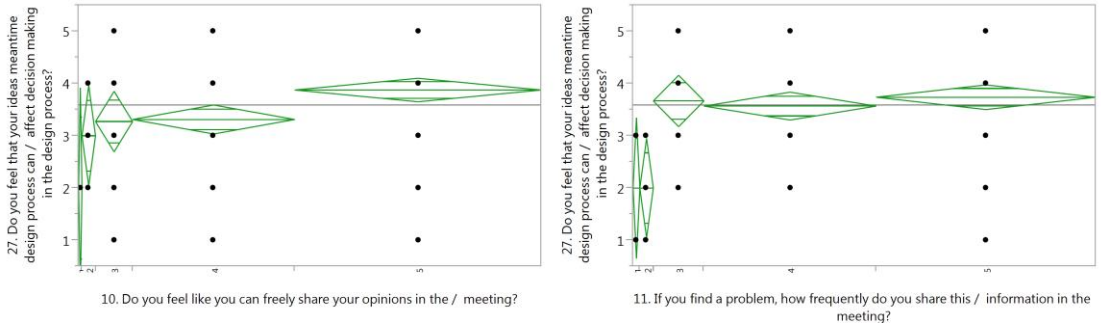


Figure 49. Respondents' Confidence in Sharing Their Opinions in Meetings vs. Their Feeling about Their Ability to Affect Decision-Making in the Design Process

Hypothesis 15 (Question 27 relative to Questions 18, 19, and 21)

When respondents feel that their ideas can affect decision-making in the design process, they are more likely to be involved in the design process. The findings suggest that FMs who are more positive about the impact of their ideas on decision making process are more likely to have collaborated in the design process (ANOVA *p*-value= 0.0125; Chi-square *p*-value= 0.0107). Therefore, Hypothesis 15 was supported.

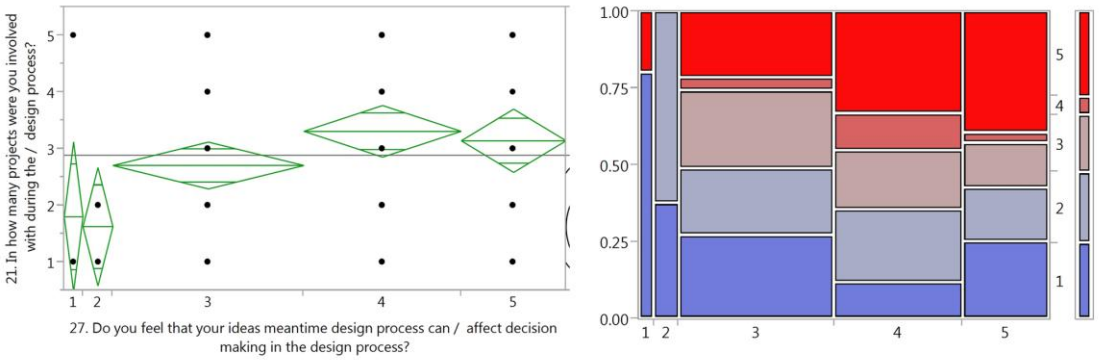


Figure 50. Respondents' Positive Feelings about Their Ability Influence Decision-Making in the Design Process vs. Their Rate of Collaboration

Table 8. Analysis of Hypotheses 14 and 15 (*p*-value<0.01 is marked in green; ***p*-value<0.05 is marked in red; *p*-value<0.10 is marked in purple)**

NO.	Questions	Independent Variable	Dependent Variable	P-value	
				ANOVA	Chi-Square
H14	Questions 10 and 11 relative to Question 27	The confidence of respondents in sharing their opinion in meetings	Respondents' feeling that their idea can affect decision-making in the design process	**0.0050**	**0.0133**
				0.0019	**0.0001**
H15	Question 27 relative to Questions 18, 19, and 21	Respondents' feeling that their ideas can affect decision-making in the design process	The chance of FMs' early involvement in design	0.4250	0.2826
				0.5979	0.8001
				0.0125	**0.0107**

5.6.4. Respondents' View of Designers

Hypothesis 16 (Question 28 relative to Questions 18, 19, and 21)

Positive perceptions towards designers were related to attitude about collaboration with designers. The findings show that when FMs perceived designers to be more enthusiastic about collaboration, the FMs were more likely to have been involved in the design process (ANOVA *p*-value= 0.0001, 0.0693, and 0.0007; Chi-square *p*-value= 0.0025, 0.2861, and 0.0007). Therefore, Hypothesis 16 was supported.

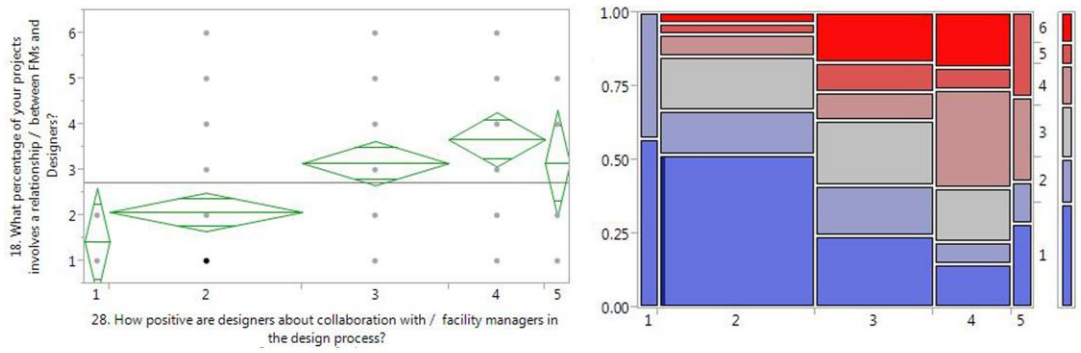


Figure 51. Positive Perceptions toward Designers vs. Collaboration with Designers

Hypothesis 17 (Question 26 relative to Questions 18, 19, and 21)

The hypothesis that lower perceived effectiveness of FMs' input into the design process is associated with lower collaboration rates between designers and FMs (ANOVA *p*-value= 0.1506, 0.7271, and 0.4050; Chi-square *p*-value= 0.4978, 0.9217, and 0.6177) was not supported.

Hypothesis 18 (Question 29 relative to Question 20)

The hypothesis that lower perceived effectiveness of designers' proposals in solving operational problems is associated with lower collaboration rates after occupancy (ANOVA *p*-value= 0.2061; Chi-square *p*-value= 0.2201) was not supported.

Hypothesis 19 (Question 24 relative to Questions 18, 19, and 21)

Higher perceived necessity of collaboration with designers as a key element in achieving good building performance is associated with the higher rate of collaboration between designers and FMs (ANOVA *p*-value= 0.3122, 0.1001, and 0.0595; Chi-square *p*-value= 0.1089, 0.0195, and 0.4793). Therefore, Hypothesis 19 was supported.

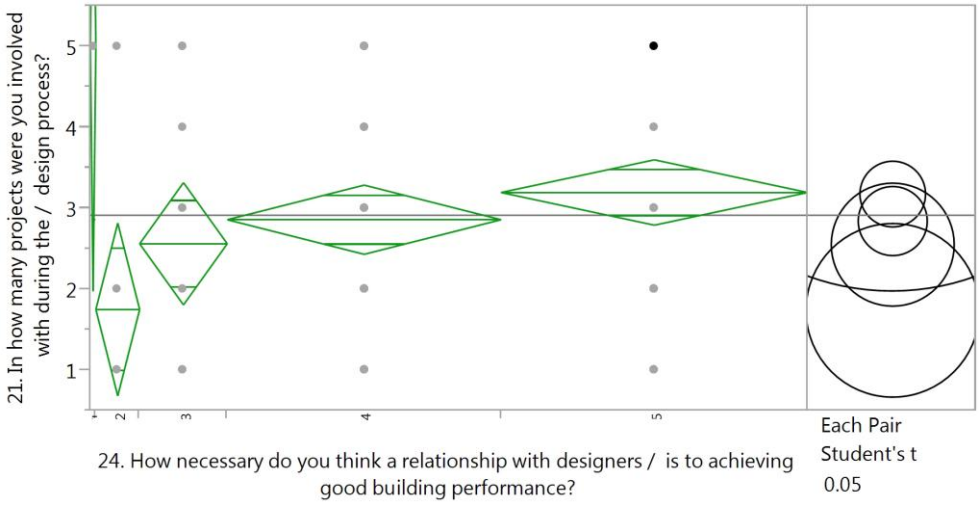


Figure 52. Belief in the Effectiveness of the Relationship between FMs and Designers vs. the Rate of Collaboration between FMs and Designers

Table 9. Analysis of Hypotheses 16 to 19 (***p*-value<0.01 is marked in green; *p*-value<0.05 is marked in red; *p*-value<0.10 is marked in purple)**

NO.	Questions	Independent Variable	Dependent Variable	P-value	
				ANOVA	Chi-Square
H16	Question 28 relative to Questions 18, 19, and 21	Positive perceptions towards designers as expressed by respondents	FMs' attitude toward collaboration with designers.	**0.0001**	**0.0025**
				0.0693	0.2861
				0.0007	**0.0007**
H17	Question 26 relative to Questions 18, 19, and 21	Perceived effectiveness of FMs' input in the design process	Collaboration rate between designers and FMs in the design process	0.1506	0.4978
				0.7271	0.9217
				0.4050	0.6177
H18	Question 29 relative to Question 20	Perceived effectiveness of designer' proposals in solving operational problems	Collaboration rate after occupancy	0.2061	0.2201
H19	Question 24 relative to Questions 18, 19, and 21	Perceived necessity of collaboration as a key element in achieving good building performance	The rate of collaboration between designers and FMs	0.3122	0.1089
				0.1001	**0.0195**
				0.0595	0.4793

5.6.5. Impact of Occupants

None of hypotheses were supported.

Hypothesis 20 (Question 13 relative to Question 20)

The hypothesis that a higher rate of complaints about the building performance by occupants is associated with a greater chance of collaboration between designers and FMs after occupancy (ANOVA *p*-value= 0.6526; Chi-square *p*-value= 0.1428) was not supported.

Hypothesis 21 (Question 13 relative to Questions 18, 19 and 21)

The hypothesis that a higher rate of complaints about the building performance by occupants is associated with a greater chance of collaboration between designers and FMs during the design process (ANOVA *p*-value= 0.6768, 0.5176, and 0.9674; Chi-square *p*-value= 0.7200, 0.2350, and 0.7906) was not supported.

Table 10. Analysis of Hypotheses 20 and 21 (*p*-value<0.01 is marked in green; *p*-value<0.05 is marked in red; *p*-value<0.10 is marked in purple)

NO.	Questions	Independent Variable	Dependent Variable	P-value	
				ANOVA	Chi-Square
H20	Question 13 relative to Question 20	Rate of receiving complaints about the building performance by occupants	The chance of collaboration between designers and FMs after occupancy	0.6526	0.1428
H21	Question 13 relative to Questions 18, 19, and 21	Rate of receiving complaints about the building performance by occupants	The chance of collaboration between designers and FMs during the design process	0.6768	0.7200
				0.5176	0.2350
				0.9674	0.7906

5.6.6. Lean Principles

Hypothesis 22 (Question 14 relative to Question 20)

The hypothesis that using Lean principles in an FM organization is associated with a higher rate of post-occupancy collaboration between FMs and designers (ANOVA *p*-value= 0.5613; Chi-square *p*-value=0.7447) was not supported.

Hypothesis 23 (Question 14 relative to Questions 18, 19, and 21)

The hypothesis that using Lean principles in an FM organization is associated with a higher rate of involvement of FMs in the design process (ANOVA *p*-value= 0.3092, 0.8066, and 0.6972; Chi-square *p*-value= 0.1914, 0.1097, and 0.3070) was not supported.

Table 11. Analysis of Hypotheses 22 and 23 (*p*-value<0.01 is marked in green; *p*-value<0.05 is marked in red; *p*-value<0.10 is marked in purple)

NO.	Questions	Independent Variable	Dependent Variable	P-value	
				ANOVA	Chi-Square
H22	Question 14 relative to Question 20	Using Lean principles in a FM organization	FMs' collaboration with designers in solving post-occupancy problems	0.5613	0.7447
H23	Question 14 relative to Questions 18, 19, and 21	Using Lean principles in an FM organization	The rate of early involvement of FMs in the design process	0.3092	0.1914
				0.8066	0.1097
				0.6972	0.3070

5.6.7. Number of People Supervised

Hypothesis 24 (Question 5 relative to Questions 18, 19, and 21)

The hypothesis that a higher number of people who are supervised by respondents is associated with a higher rate of collaboration in the design process (ANOVA *p*-value= 0.0982, 0.6210, and 0.0679; Chi-square *p*-value= 0.1067, 0.4209, and 0.2564) was not supported.

Hypothesis 25 (Questions 5 relative to Question 14)

A higher number of people who are supervised by respondents is associated with a higher chance of Lean principles being used in the respondents' organization (ANOVA *p*-value= 0.0038; Chi-square *p*-value= 0.0377). Therefore, Hypothesis 25 was supported.

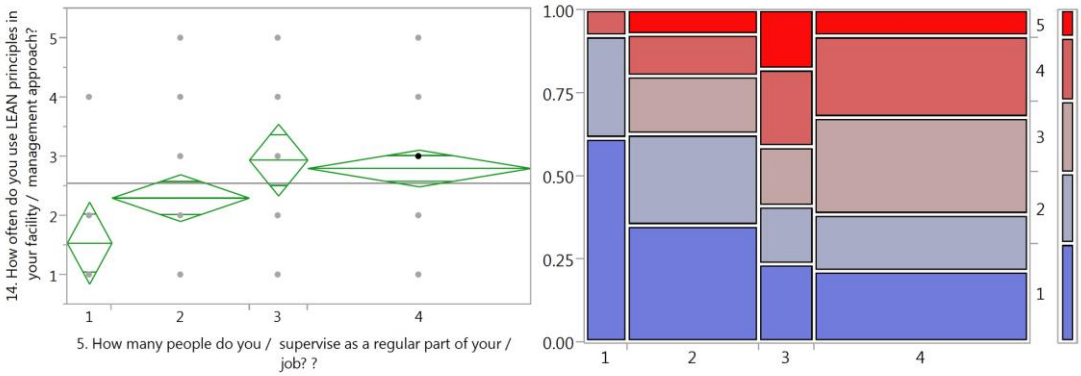


Figure 53. Number of Employees Supervised By Respondents vs. the Use of LEAN Principles in the Respondents' Organizations

Table 12. Analysis of Hypotheses 24 and 25 (***p*-value<0.01 is marked in green; *p*-value<0.05 is marked in red; *p*-value<0.10 is marked in purple)**

NO.	Questions	Independent Variable	Dependent Variable	P-value	
				ANOVA	Chi-Square
H24	Question 5 relative to Questions 18, 19, and 21	Number of people who are supervised by respondents	Rate of collaboration in the design process	**0.0982**	0.1067
				0.6210	0.4209
				0.0679	0.2564
H25	Question 5 relative to Question 14	Number of people who are supervised by respondents	Higher chance of using Lean principles in the respondents' organization	**0.0038**	**0.0377**

5.6.8. Rates of Collaboration

Hypotheses 26 and 27 were supported.

Hypothesis 26 (Questions 3 and 4 relative to Questions 18, 19, and 21)

Greater work experience as an FM is associated with a higher rate of collaboration in the design process (ANOVA *p*-value= 0.0940, 0.3820, 0.0341, 0.0903, 0.2996, and 0.0103; Chi-square *p*-value= 0.0369, 0.0696, 0.1270, 0.0474, 0.0995, and 0.1409). Therefore, Hypothesis 26 was supported.

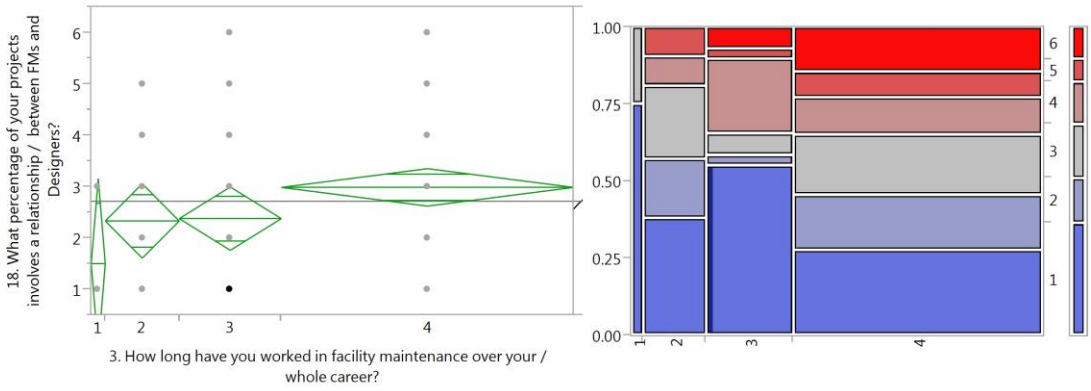


Figure 54. Length of Career Experience vs. Rate of Collaboration in the Design Process

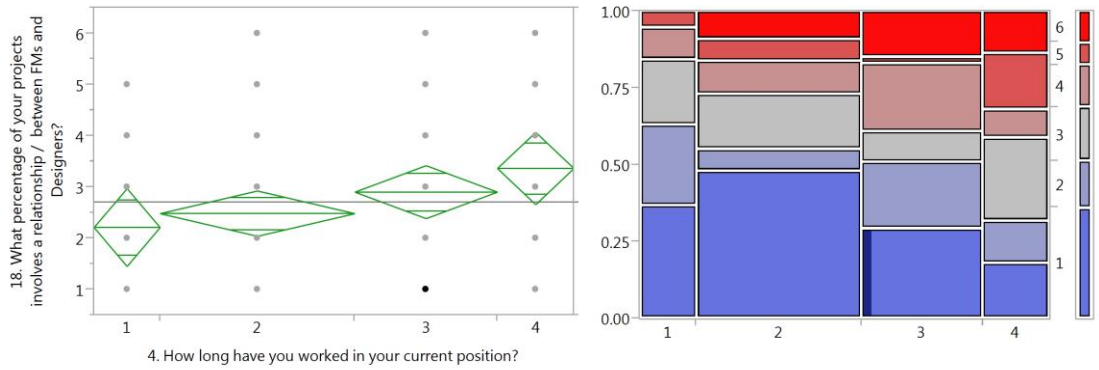


Figure 55. Length of Experience in Current Position vs. Rate of Collaboration in the Design Process

Hypothesis 27 (Questions 18, 19, and 21 relative to Question 28)

A higher rate of collaboration in the design process is associated with a higher degree of perceived designer positivity (ANOVA *p*-value= 0.0001, 0.0177, and 0.0011; Chi-square *p*-value= 0.0016, 0.2454, and 0.0195). Therefore, Hypothesis 27 was supported.

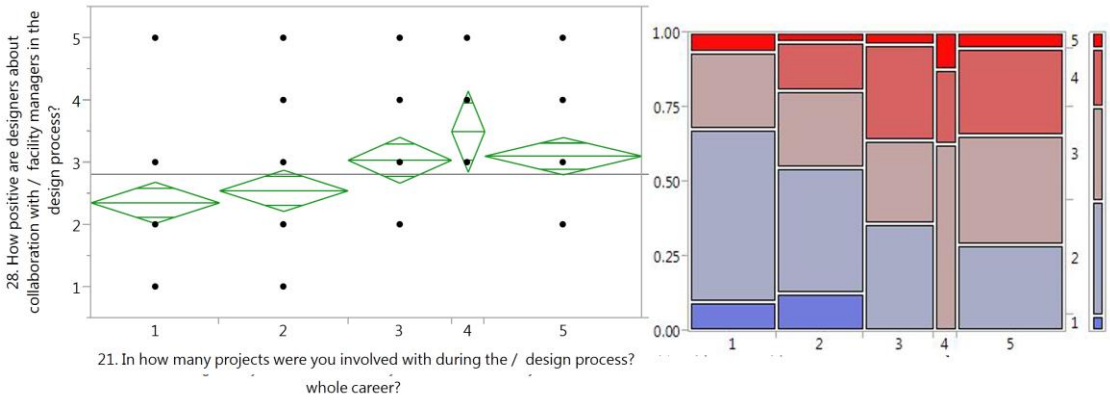


Figure 56. Degree of Experience with Collaboration in the Design Process vs. Perceptions about the Positivity of Designers

Table 13. Analysis of Hypotheses 26 and 27 **(***p*-value<0.01 is marked in green; *p*-value<0.05 is marked in red; *p*-value<0.10 is marked in purple)

NO.	Questions	Independent Variable	Dependent Variable	P-value	
				ANOVA	Chi-Square
H26	Questions 3 and 4 relative to Questions 18, 19, and 21	Length of work experience as an FM	The rate of collaboration in the design process	**0.0940**	**0.0369**
				0.3820	**0.0696**
				0.0341	0.1270
				0.0903	**0.0474**
				0.2996	**0.0995**
				0.0103	0.1409
H27	Questions 18, 19, and 21 relative to Question 28	Respondents' rate of collaboration in the design process	Perceptions about designers' positivity	**0.0001**	**0.0016**
				0.0177	0.2454
				0.0011	**0.0195**

5.6.9. Training

None of following hypotheses were supported.

Hypothesis 28 (Question 2 relative to Questions 18, 19, and 21)

The hypothesis that lack of training/education is associated with lower collaboration rates in the design process (ANOVA *p*-value= 0.8287, 0.9360, and 0.8774; Chi-square *p*-value= 0.6546, 0.9387, and 0.9337) was not supported

Hypothesis 29 (Question 2 relative to Question 28)

The hypothesis lack of training/education is associated with the lower perceived positivity of designers (ANOVA *p*-value= 0.7043; Chi-square *p*-value= 0.2438) was not supported.

Hypothesis 30 (Question 2 relative to Question 20)

The hypothesis lack of training/education is associated with the lower collaboration rate between designers and FMs after occupancy (ANOVA *p*-value= 0.5584; Chi-square *p*-value= 0.3555) was not supported.

Table 14. Analysis of Hypotheses 28 to 30 (p-value<0.01 is marked in green; p-value<0.05 is marked in red; p-value<0.10 is marked in purple)

NO.	Questions	Independent Variable	Dependent Variable	P-value	
				ANOVA	Chi-Square
H28	Question 2 relative to Questions 18, 19, and 21	Lack of training/education	Lower collaboration rate between designers and FMs in the design process	0.8287	0.6546
				0.9360	0.9387
				0.8774	0.9337
H29	Question 2 relative to Question 28	Lack of training/education	Perceived positivity of designers	0.7043	0.2438
H30	Question 2 relative to Question 20	Lack of training/education	Collaboration rate between designers and FMs after occupancy	0.5584	0.3555

5.7.Summary

The results in this chapter indicate that higher levels of education, greater work experience, higher confidence levels, and greater positivity of FMs all have a significant association with higher rates of FMs' involvement in the design process. Additionally, the findings from the survey indicate differences between the United Kingdom, the United States, and the Middle East in regard to FMs' involvement with designers. These differences can be broken down into discrepancies in the use of Lean principles, the rate of collaboration between FMs and designers, the likelihood of post-occupancy relationships, and perceived positivity of designers about collaborating with FMs. The next chapter moves on to provide a more detailed discussion of the findings from the survey as well as the interview analysis, and to compare these results with the findings from previous studies.

CHAPTER VI

DISCUSSION

6.1. Collaboration Between Facility Managers and Designers: Comparing the United Kingdom, the United States, and the Middle East

This section is a comparison of the current state of the facility management industry in each of the three regions examined in the study. Findings from both the interviews and the survey analysis are interpreted and compared with previous studies. This section answers the following research questions:

- What are some of the most pressing challenges in facility management in the United States, the United Kingdom, and Qatar?
- Has the involvement of FMs in the design process significantly increased in recent years?
- How effective is the communication of FMs with designers located in the United Kingdom, as compared to their communication with designers located in the United States?
- How effective is the communication of FMs with designers located in Qatar, as compared to their communication with designers located in the United Kingdom and the United States?

The first concern to be addressed here is the current challenges in facility management in the three areas of study (the U.K., the U.S., and the Middle East). In the United Kingdom, the primary finding was that facility management teams were no

longer considered a "side note" to other aspects of building design, but were instead fully integrated into the business model. The development of higher levels of professional respectability for FMs was seen as a sign that the field was beginning to mature. However, in terms of FMs' early involvement in the design process in the U.K., the findings reveal that there is a negative perception. The interview and survey results reveal several possible reasons for this:

1. The most profitable approach to facility management may conflict with the best design solution, so that there is little incentive to strive for really good performance.
2. FMs tend be better at dealing with symptoms than they are at examining underlying causes.
3. Once a facility management firm has a portfolio of buildings, there are significant dangers in improving their operational performance in any one of them. Doing so leads their clients to ask things like, "why did not you do this last year?" or "Why are not you not making the same improvements in the other buildings that you are managing?" This fear of standing out reinforces a tendency toward mediocrity.

In the U.S., the findings of the current study are consistent with those of Sullivan, Georgoulis, and Lines (2010), who indicated that during the next 10 to 15 years there is likely to be an inadequate number of professionals entering the facility management industry. This may pose a serious risk to the stability and service quality of the profession in the United States. Another important finding about the current state of

facility management in the U.S. was that there is a lack of public understanding about what exactly FMs do, as well as a scarcity of formal training programs for FMs in the country's university system. This may be related to the lack of interest among young people in adopting FM as a career. The lack of understanding among members of the public was also associated with FMs input being neglected in design process and communication barriers between FMs and designers.

The findings from the Middle East were in agreement with Bu Jawdeh's (2013) study, which showed that relationships between FMs and design professionals in the Middle East is nearly non-existent. This is true despite the fact that nearly 60% of the world's top designers have worked in the Middle East's booming construction arena (Reina & Tulacz, 2010). Facility management is a rapidly expanding field in the Middle East, but it has not yet reached anything close to the level of integration with designers that is experienced in the U.K. and the U.S. There is also a lack of understanding among the region's people as to what exactly facility management is. The findings from interviews are that language barriers, an absence of formal training systems, cultural problems between different levels of management, and a lack of consistent production standards are the principal obstacles facing the facility management industry in the Middle East.

The findings in the current study were that the FM industry is more mature and firmly established in the United Kingdom than it is in the United States and the Middle East. One of the most commonly cited pieces of evidence in support of this assessment was that there are a much larger number of educational programs granting degrees or

certificates in facility management in the U.K. Another central difference among the regions is the quality of workmanship, which was widely perceived to be inferior in the Middle East in comparison to the U.K. and the U.S. While the collaboration between designers and FMs in the U.K. and the U.S. was not always seen as productive, the findings of this study were that this collaboration was seen as far superior to that in the Middle East, where for the most part it was not happening at all. Findings about the current state of the FM industry in the study's three regions are summarized in Table 15.

Despite the interview finding that the facility management industry was seen as more mature in the U.K. than in the U.S., the survey analysis showed that that the rate of FMs' early involvement in the design process was highest in the U.S. The average number of projects in which FMs collaborated in the design process varied between 1 to 3 projects in the Middle East, 2 to 4 projects in the U.K., and 4 to 8 projects in the U.S. Moreover, the level of designers' involvement in post-occupancy problem solving was highest in the U.S., followed by the U.K. and then the Middle East. The survey found a significant gap between these levels of involvement.

Table 15. Summary of Findings: The current State of the FM Industry in the United Kingdom, the United States, and the Middle East

United Kingdom	United States	Middle East
• Beginning to mature • Fully integrated into the business model • An aging work population • A distinct generational shift occurring in the nature of the profession • Larger number of educational programs giving degrees or certificates in facility management • Little incentive for FMs to strive for really good building performance	• Beginning to mature • Training as the biggest current concerns for the facility management industry • Difficulty in finding qualified employees • Less interest in the field among the younger generation • Lack of understanding among the public about what exactly FMs do	• A new but rapidly expanding field • Immature industry • Absence of formal training systems • Communication barriers • Low quality of workmanship • Lack of consistent production standards • Conflicts of interest and cultural barriers between different levels of management • Lack of understanding among the public about what exactly FMs do • Poor integration process

The reasons for these differences were not entirely clear, but they may be related to a greater cultural emphasis on corporate communication in general in the U.S. The study also indicated that the number of in-house facility management teams was greater in the U.S. than in the U.K. and the Middle East, with the latter countries relying more frequently on outsourcing. It seems reasonable to suppose that in-house teams would be

more likely to be integrated into corporate communications in general, and would thus be more likely to be involved with designers.

In addition, the study indicated that the perceived positivity of designers toward collaboration with FMs is higher in the U.S. than in the U.K. and the Middle East, and that higher positivity was in general associated with higher rates of collaboration. While a causal relationship cannot be determined from this statistical association, evidence from the interviews suggests that increasing positive outlooks is likely to lead to greater collaboration. This finding has important implications in backing up the interview participants' statements that instilling a greater public awareness of what FMs do can help to improve the quality of collaboration and knowledge-sharing between FMs and designers. In the U.K. and the Middle East, facility management organization such as the British Institute of Facilities Management (BIFM) and Middle East Facility Management Association (MEFMA) can help to enhance the perceived positivity of designers toward collaboration by reaching out to broaden awareness. They can expand their membership to include designers, encourage interactions between FMs and designers in social media sphere such as LinkedIn, and promote educational incentives such as interdisciplinary conferences.

6.2.The Early Involvement of Facility Managers in the Design Process

Section 6.2 is a discussion of the benefits of FMs' involvement in design process, as well as factors that were found to affect the rate of involvement. This section addresses the following research questions:

- How do facility management practices affect building performance?

- What are some of the benefits of good communication between FMs and designers?
- What factors are important in effective communication between FMs and designers?
- What types of architectural projects are more practical for the early involvement of FMs?
- What problems can occur if there is poor communication between FMs and designers during the design process?

The interviewees in this study agreed that early FM involvement in the design process benefits all of the key stakeholders, a finding that is in agreement with numerous other studies (Jaunzens et al., 2001; Duffy, 2000; Winch, 2010; Meng, 2013). During the interview process in this study, however, several benefits emerged that do not appear to have been previously discussed in the literature. One of these benefits was flexibility in design. As was discussed in Chapter Four, some of the FM interviewees emphasized that they could help in the creation of more adaptable designs by presenting realistic knowledge of building operations. For example, one interviewee described working with a designer to create a space that could be used as a café during the lunch hour and as a studio during the afternoon. Such a design would have been extremely difficult to conceptualize without a detailed knowledge of the operational procedures required to enact the transformation each day. A summary of all of the identified benefits for the early involvement of FMs in design is provided in Table 16.

Table 16. Summary of Benefits from FMs' Early Involvement in Design

	Benefits	Region in Which the Benefit Was Identified
Design	Improve Performance of Design	U.K., U.S., Middle East
	Shorter Design Process for a Project	U.K., U.S.
	Safer and Healthier Design	U.K.
	More Flexible Designs by Presenting Realistic Knowledge of Building Operations	U.K., U.S.
	More Attractive to Prospective Occupants	U.K., Middle East
	More Energy-Efficient Design	U.K., U.S., Middle East
	More Straightforward to Construct	U.S., Middle East
	Provide Lessons Learned from Previous Projects (POE)	U.K., U.S.
	Provide the Evaluation of Design Innovation from Previous Projects (POE)	U.K.
	Greater Satisfaction for Both Clients and Occupants	U.K., U.S., Middle East
	Improving Design for Future Buildings	U.K., Middle East
	Better Relationship Between Designers and Building Users	U.K., U.S.
	Emphasize the Functionality and Productivity of the Design	U.K., U.S.
Facilities Management	Reduction in Maintenance Costs	U.K., U.S., Middle East
	Reduction in the Long-Term Expenses of the Building	U.K., U.S., Middle East
	Provide the Ability to Remain Competitive in Their Field	U.K.
	Efficient Solution For Commission and Maintenance of the Building	U.K., U.S., Middle East
	Reduce The Later Need For FMs to Enact Inefficient Operational Practices and/or Expensive Infrastructure Alterations	U.K., U.S.
	More Focused on Minimizing the Building's Whole-Life Expenditures Rather Than Just the Initial Capital Costs	U.K., U.S.
	Easier to Control and Manage	U.K., U.S., Middle East
	Provide the Ability to Minimize or Avoid Maintenance Risks	U.K., U.S.
	Provide the Opportunity To Better Anticipate Contract For The Building Maintenance	U.S.

This study corroborated the findings of previous work in regard to the frequency of collaboration between FMs and designers. Erdener (2003) and Kaya (2004) observed that the link between facilities managers and designers was not sufficiently understood and was frequently ignored during briefing and design decision-making. However, more recent studies such as Meng (2013) observed that FMs' involvement in design process was increasing in the U.K., whereas Bu Jawdeh (2013) found the degree of collaboration remained nearly absent in the Middle East. In this research, 85% of all interviewees had some experience in collaborating in the design process. However, the extent to which this has taken place was very limited, occurring on an average of only 2 to 4 projects during the course of the FMs' entire career. Although it is hard to conclude that FM involvement in design has become widespread, evidence from the interviews does suggest that it is increasing, especially in the U.K. and the U.S. As mentioned in the previous section, the average number of projects in which FMs collaborated in the design process was between 1 to 3 projects in the Middle East, 2 to 4 projects in the U.K., and 4 to 8 projects in the U.S. The majority of the study participants (75% of interviewees, and 71% of survey respondents) stated that such collaboration was still an unusual practice. On average, the respondents estimated that collaboration with designers happened on around 35% of their projects.

With regard to post-occupancy relationships between designers and facility managers, a common perspective among the subjects was that very few designers ever returned to their previous projects to evaluate the outcomes of their design innovations. Only 18% of the respondents indicated that they collaborated with designers in solving

problems regularly, even though 76% agreed that having a relationship with the designer was either "very helpful for most projects" or "crucial for all projects." The most common post-occupancy collaborations between designers and FMs occurred when FMs decided to renovate a building.

The analysis of interview and survey data revealed factors associated with a higher likelihood of collaboration between FMs and designers. These were largely consistent with the conclusions of Meng (2013). One of the most important associations was between greater collaboration and the use of in-house (rather than outsourced) facility management providers. Projects in which the client planned to occupy the building themselves were also associated with a higher likelihood of collaboration—presumably because the client was more motivated to ensure a successful outcome, and thus more likely to fund the collaboration process. Many of the subjects also indicated that the chance of FM involvement in the design process depended on the size of project—larger and more complex undertakings were more likely to be seen as opportunities for effective collaboration. Furthermore, cultural differences including social obstacles and differences in perspective between designers, facility managers, and clients, were reported to affect the likelihood of collaboration between designers and FMs. These issues were more prevalent in the Middle East in comparison with the U.K. and the U.S.

There were also a number of internal factors in facility management companies that were associated with a greater likelihood of collaboration between FMs and designers. The survey analysis indicated that FMs who had a greater supervisory role

(higher number of employees reporting to them) were more likely to collaborate in design. Greater length of work experience as an FM was also associated with a higher rate of collaboration in the design process. The analysis indicated that a greater experience with previous collaboration in the design process was associated with a likelihood of future collaborations.

Finally, respondents who felt that their ideas could affect decision-making in the design process were more likely to be involved in collaborations. However, the survey analysis did not reveal any significant association for building occupant satisfaction, the use of the lean approach within facility management companies, and the level of FMs' training, in comparison the rate of collaboration in the design process. In Figure 58, a summary is presented of all identified factors that were statistically associated with greater or lesser rates of collaboration.

Figure 57. Factors Associated with Greater or Lesser Likelihood of Collaboration between FMs and Designers

6.3.Communication between FMs and Designers

This section addresses the perspectives of FMs and designers in regard to collaboration, including motivating and de-motivating factors. It addresses the following research questions:

- What are some of the communication processes that are currently in place between FMs and designers?
- How positive are designers about collaborating with FMs during the course of the design process?
- What factors can encourage designers and FMs to communicate more effectively?
- What factors prevent designers and FMs from communicating more effectively?

Given the widely recognized benefits that can emerge from the involvement of FMs in the design process, why are collaborations between designers and facilities managers not occurring more often? This study confirmed barriers previously identified by other scholars (Mohammed & Hassanain, 2010; Meng, 2013; Bu Jawdeh, 2013), and also unearthed new ones. These results are summarized in Table 17. As the table indicates, communication problems between designers and FMs was by far the most commonly reported problem.

Table 17. Summary of Identified Barriers against the Involvement of FMs in Design

Barriers	Percentage of Interviewees who Mentioned the Barrier
Communication problems between FMs and designers	85%
Underestimation of FMs' ability to contribute	55%
Concerns about the cost of involving more people in design	40%
Difficulties in explaining to clients what exactly the FMs can contribute to design	35%
Cultural differences between FMs, designers, and clients	30%
Resistance on the part of clients/owners to fund the process	30%
Lack of knowledge of clients about the prospect of collaboration	30%
Geographical distance between designers and FMs	20%

Interviewees and survey respondents were also asked number of questions about their organizational protocols, in order to better understand the existing communication activities within the facility management industry. The majority of the study participants (65% of interviews and 63% of survey respondents) stated that they meet at least once a week with their colleagues. The major participants in these meetings were FMs,

followed by heads of operation, general managers, portfolio managers, and senior assistant technicians. Sharing lessons-learned with other FMs was the most commonly stated reason for meetings in the U.K., communication and group spirit was reported as the main concern in the U.S., and efficiently distributing the workload was the most popular explanation for meetings in the Middle East. These findings suggest that the majority of facilities management organizations do have a systematic structure for sharing feedback within their own institution, even while they lack structurally integrated feedback loops and knowledge-sharing tools that would allow them to connect with other stakeholders in the building lifecycle (e.g., designers).

With regard to the facility managers' outlook on designers, one frequent complaint in the interviews was that even though designers had a limited knowledge about building operations, they were not respectful of FMs' experience and were not interested in learning from FMs about maintenance issues. Some of the interviewees also characterized designers as more concerned with the aesthetic aspects of design than with practicality and building maintainability. Eighty-six percent of the survey respondents indicated that designers' proposals need FMs' input in order to achieve a high-performance result, and 76% indicated that a relationship between FMs and designers was important. However, roughly half of the respondents indicated that they did not believe designers were positive about such collaborations. The study participants observed that communication difficulties were pervasive between the two fields and that the primary reason was simply that designers did not have an interest in communicating. Additionally, the findings show that there is a strong association between perceived

enthusiasm and actual experience in collaboration. It thus seems reasonable to suggest that collaboration is a beneficial process when it actually takes place, and that overcoming barriers could lead to an upward spiral of positive interaction.

Seventy-nine percent of the survey respondents believed that the feedback from FMs can give designers a better understanding of building users and their needs. However, FMs were less optimistic about the likelihood of this feedback being heard. Forty-one percent agreed that their feedback only "sometimes" affected decision making in the design process. In contrast, 85% of the respondents said that they felt very comfortable in sharing their opinions with their colleagues, and the data analysis indicated a correlation between this confidence and the extent to which respondents feel that their ideas can affect the decision-making process. It seems reasonable to suggest that if respondents feel that their ideas can affect decision-making in the design process, then they would be more likely to be involved in collaboration.

These results are in agreement with the findings from the interviews. Many of the disparaging outlooks that facility managers expressed about designers really boiled down to the fact that FMs did not see designers as taking their concerns seriously. The interviewees frequently brought up the idea that FMs are interested in collaboration with designers, but are not confident enough to speak up and request it. They indicated that most FMs find it difficult to engage in a dialogue with designers because they feel that their outlooks will be regarded as boring and lacking in imagination. The unbalanced power relationship between designers and FMs in the industry contributes to this apprehension. In addition to reducing the likelihood of FMs' involvement in design, the

lack of confidence was regarded as decreasing will the quality of conversation in instances where collaboration did take place. Supporting this view, 40% of interviewees mentioned that they had attended collaboration meetings in which FMs were silent for most of time or did not actively participate. However, two interviewees in the U.K. declared that over the last five years communications with designers have become significantly easier in their country, and attributed this change to the fact that FMs had become more powerful in the industry.

Some interviewees had a more cynical perspective on why FMs might not want to participate in the design process. They suggested that design problems give FMs a reason to expand their own budgets, as well as a convenient scapegoat for poor facility management results. Being involved in the design process would eliminate these conveniences. In this outlook, there was a general perception of a lack of motivation for making any kind of improvements in the quality of FM services. However, other interviewees refused this hypothesis, insisting that better collaboration can strengthen a facility management provider's competitiveness. These motivational optimists argued that stronger designs benefit everyone and that there is no end to the need for better building performance and the role of FMs in maintaining it.

One of the most commonly expressed frustrations in regard to communication between FMs and designers was simply the use of abbreviations and acronyms. The facility management industry has a unique list of shorthand terms that are known by everyone in the field, and designers have a similar playbook. However, due to a lack of historical integration and collaboration between the industries, these terminologies are

not the same between the different fields. Thus, the way in which FMs present their concerns are not readily understood by designers, and vice-versa.

6.4.How to Better Integrate FMs into the Design Process

Having answered all of the research questions, it is now possible to turn to specific recommendations for better integrating FMs into the design process. The statistical analysis of survey data revealed that higher levels of training and length of work experience are both strongly associated with the higher rate of sharing opinions within an FM organization, and that this confidence in sharing opinions is associated with a greater tendency to be involved in collaboration. Even more importantly, respondents with greater length of work experience were more likely to rate relationships with designers as a necessary step to achieve a good building performance, and this perception of necessity was also associated with higher levels of collaboration. These results suggests that simple experience and training was one of the best predictors of collaboration. It is reasonable to conclude that creating more awareness about the effectiveness of collaboration, especially among younger designers and FMs, could help to jump-start this process so that there is more enthusiasm for and experience with productive collaborations. Enhancing the training, professional development, and awareness of collaboration benefits among people who are new in the field is a crucial step in increasing the likelihood of FMs' involvement in design.

The interviews supported this interpretation, as many of the participants indicated a need for better education and training, both of designers and of FMs, in order to help

alleviate communiation problems and improve collaboration efforts. Interviewees frequently stated that FMs and designers alike have little knowledge about each others' roles and about the potential benefits of collaboration. University programs in facility management were seen as the solution to this problem, as they would not only provide better training for FMs but also allow the facility management profession to have a greater cross-fertilization with academic training programs for designers. These results also suggest that there would be a great value in developing continuing-education spheres in which designers and facility managers can have more of an interaction, such as interdisciplinary conferences and workshops.

Another finding from this study is that overall public awareness about the facilities management industry can contribute to a greater likelihood of collaboration. Thirty-five percent of the interviewees mentioned that they had difficulties in explaining to their clients what exactly FMs can contribute to design, and 30% indicated that their clients' lack of knowledge about facility management was a barrier to enacting collaboration. University programs can contribute to alleviating this general lack of knowledge about facility management, as they will broadly increase the public recognition of the industry (as well as the general recognition among individuals educated in a related field). Continuing education initiatives and direct public outreach can also contribute to a greater awareness. Some of the interview participants mentioned that these training solutions are likely to have the greatest effect in the Middle East (as compared to the U.S. and the U.K.), due to the sheer extent of unfamiliarity with facility management in the Middle East.

A related concern is the lack of software knowledge in the facility management industry. Interview respondents mentioned that this is particularly true in the U.K. and the U.S., and that it is due to the aging employee base of FMs in those countries. A lack of familiarity with contemporary software used by designers and other related professionals can be a great obstacle to collaboration. Lacking a familiarity with these tools, it is hard for FMs to effectively share their knowledge. While many FM firms maintained their own valuable databases of "lessons learned," the information in these (usually outdated) software platforms was not in a format that could readily be imported into the contemporary platforms used by designers. Again, the solution seems to be training programs—both in terms of continuing education and perhaps more importantly, university programs that would help to encourage intelligent younger individuals to consider a career in facility management. The findings in this study indicate that FM organizations and firms can help to improve the likelihood and the value of collaboration by emphasizing the need for FMs to familiarize themselves with contemporary software such as Building Information Modeling (BIM) programs. A full 25% of the interviewees brought up BIM software as having the potential to enhance the transfer of knowledge, if only FMs could become more familiar with the use of this software. These efforts could be aided by an FM lobby directed toward software creators. FMs should seek to encourage the development of contemporary design software that is more specifically tailored to incorporate the needs of the FM industry.

Another finding in this study was a significant lack of structurally integrated feedback loops between facility management firms and other stakeholders in the

building life-cycle. The interviewees agreed that establishing more robust survey tools and mechanisms for post-occupancy feedback would enhance the quality of their operations, reduce the cost of facility management, and increase customer satisfaction. It was also observed that sharing this information with designers could greatly improve the performance of buildings, although there was much pessimism about whether or not designers would actually be interested in receiving such feedback. One interesting finding in this regard was that the study did not reveal an association between the use of lean principles in an FM organization and the rate of collaboration between FMs and designers (either during the design process or following building occupancy). It was unclear whether this lack of association was due to the very low incidence of lean-principle use among the study participants, or whether the adoption of this management philosophy simply had no effect on collaboration.

The study findings indicate that FMs feel they have more in common with mechanical engineers, followed by architects, then interior designers and civil/structural engineers. For better collaboration in design process meetings, design firms and FM providers could arrange collaboration efforts to take advantage of this familiarity. Individuals could be linked based on their area of expertise to help ensure a better flow of communication and a more productive meeting (i.e., FMs could explain their perspective to mechanical engineers, who could then help explain it to the architects, etc.). Another popular recommendation from the interviews was that better communication could be established with the help of written guidelines. According to the respondents, such documents could provide a framework for all stakeholders to focus

on during the design process. Figure 59 is a summary of this study's recommendations for overcoming barriers to collaboration.

Respondents were also asked to select the phases of the design process in which they felt most confident to provide suggestions. The most common responses were the strategic planning stage and the design development stage. In general, both interviewees and survey respondents tended to emphasize that earlier involvement would lead to better results, primarily because problems are easier to solve in the early stages prior to detailed design or construction work. This finding is in agreement with previous research (Leung et al., 2003; Erdener, 2003; Kolltveit & Grønhaug, 2004; Mosey, 2009; Song et al., 2009; Meng, 2013). The study participants also provided a note of caution, however, in suggesting that the appropriate time to initiate collaboration may also depend on the type and size of the project.

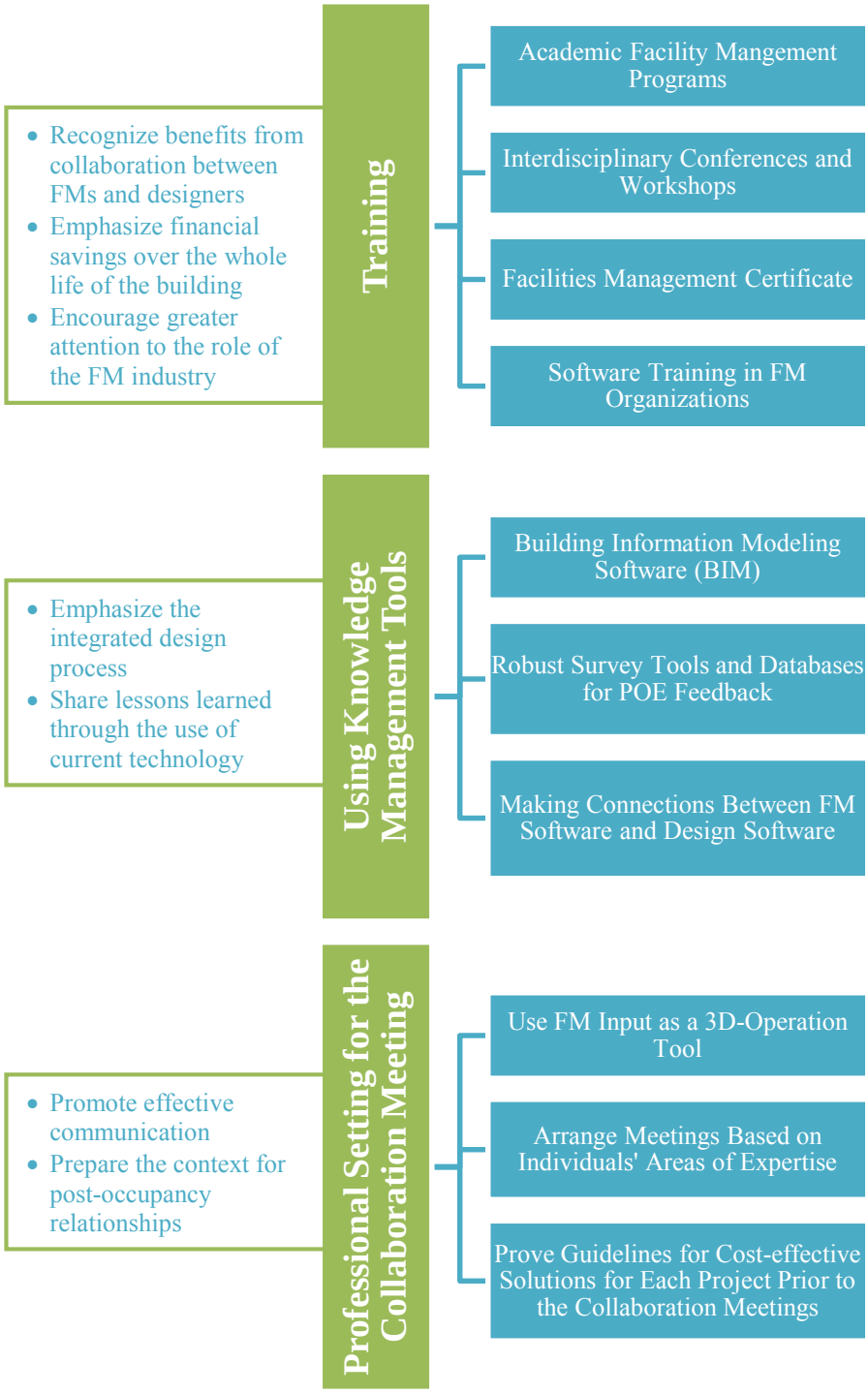


Figure 58. Model for Overcoming Barriers and Better Integrating Facilities Managers into the Design Process

The following specific contributions that FMs could make during the design process were identified in this study:

- Helping to clarify the best possible solutions to design problems
- Determining how much space needs to be allocated for various maintenance activities
- Estimating the cost of facility management based on design plans
- Identifying the best schedule for implementing a design
- Helping to create flexible-use areas, and identifying the maintenance requirements for such areas
- Analyzing a building's productivity, maintainability, and sustainability
- Formulating operational practices that would work most effectively with a particular design
- Identifying requirement for automation systems that might be used in a building
- Reviewing final design proposals from an operational point of view

Figure 60 is a proposed visual map of the route that a project could undergo during the design process in order to maximize the value that facility managers add to the project.

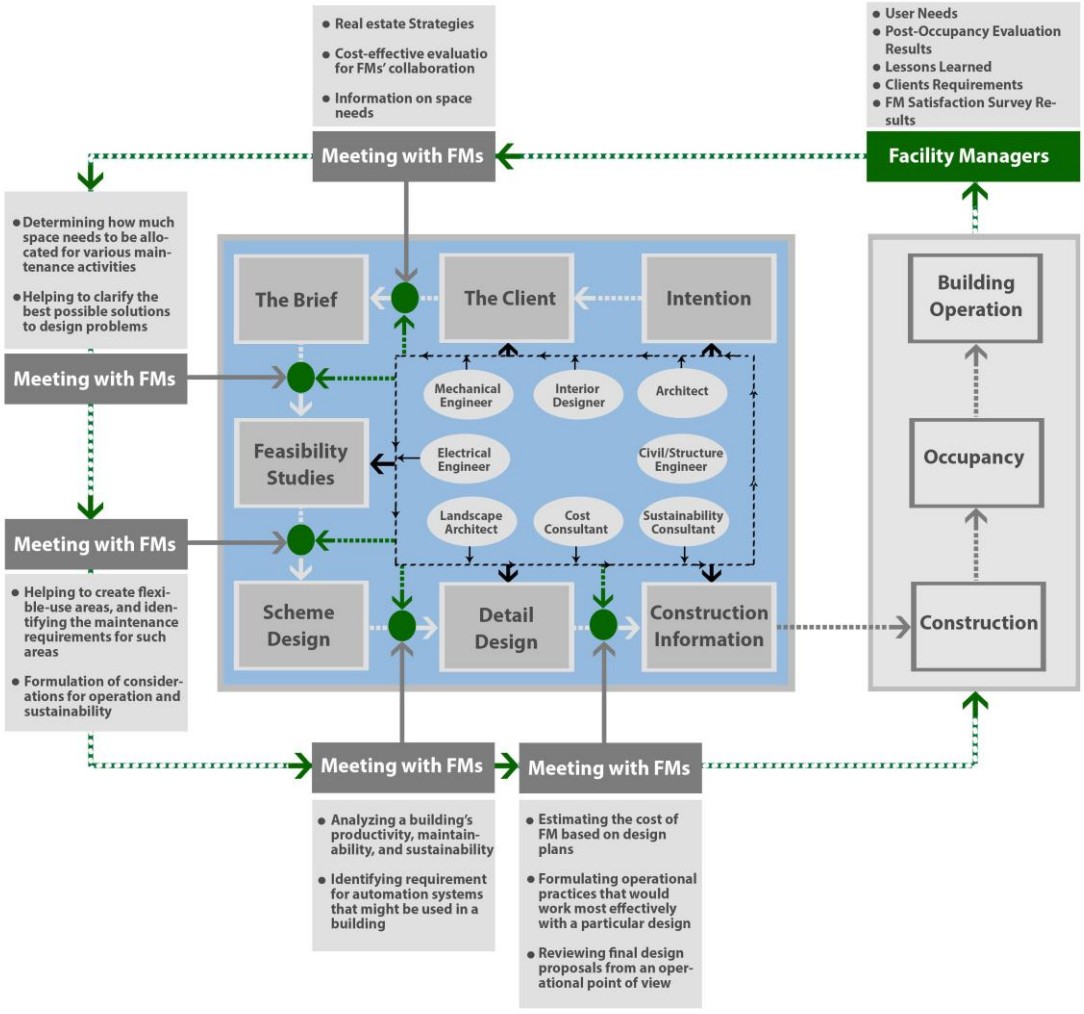


Figure 59. The Proposed Model of Collaboration to Better Integrate the Knowledge from Facilities Managers in Design Process

CHAPTER VII

CONCLUSION

7.1.Summary

This research study was an examination of collaboration between facility managers (FMs) and architectural designers. Interviews and a questionnaire survey were used to gather data from FMs in the United States, the United Kingdom, and the Middle East. In comparing these three regions, it was found that there is an increasing recognition of the importance of collaboration between FMs and designers in the United Kingdom and the United States, but this relationship is still an undiscovered area in the Middle East. The findings in the study were that the FM industry is most firmly established in the United Kingdom, followed by the United States and then, more distantly, by the Middle East. Another important finding was that in the U.S. and the Middle East there is a lack of public understanding about what exactly FMs do, as well as a scarcity of formal training programs for FMs. The varied educational programs for facility management, the differing quality of workmanship, and the level of public understanding about what exactly FMs do were among the most commonly cited pieces of evidence for the differences in the FM industry among these three regions.

In comparison with the U.K. and Middle East, the survey analysis showed that the rate of collaboration between FMs and designers was highest in the U.S. This applied both to FMs' early involvement in the design process and to post-occupancy collaborations in terms of problem-solving. The study also indicated that the number of

in-house facility management teams was greater in the U.S. as compared to the U.K. and the Middle East, with the latter countries relying more frequently on outsourcing. In addition, the study indicated that the perceived positivity of designers toward collaboration with FMs was higher in the U.S. than in the other regions studied. The factors of using in-house FMs and higher designer positivity were in general associated with higher rates of collaboration. Other factors associated with higher rates of collaboration included larger-sized projects, more complex projects, cultural affinities among the various project stakeholders (including designers, FMs, and clients), and the experience and confidence levels of FMs.

During the interview process in this study several benefits of collaboration emerged that do not appear to have been previously discussed in the literature. For example, one of these benefits was that FMs could help in the creation of more adaptable designs by presenting realistic knowledge of building operations. Additionally, barriers to collaboration were identified. The study revealed that communication problems between designers and FMs were by far the most commonly reported obstacle. Many FMs believed that designers simply did not have an interest in communicating; that they did not take FM concerns seriously and saw FM outlooks as boring and lacking in imagination. The unbalanced power relationship between designers and FMs in the industry was seen as contributing to this state of affairs. The technical aspects of knowledge-sharing also emerged as a significant concern for collaboration. Many of the study participants indicated that the language used in the different fields (facility management and design) did not overlap well, so that, for example, abbreviations used

by FMs were not recognized by designers, and vice-versa. The study findings were that the majority of facility management organizations do have a systematic structure for sharing knowledge within their own institutions, but that they lacked structurally integrated feedback loops and knowledge-sharing tools that would allow them to connect with other stakeholders in the building lifecycle. In addition, FMs tended to be unfamiliar with contemporary software used by designers and other related professionals, presenting a great obstacle to collaboration.

It is reasonable to conclude that creating more awareness about the effectiveness of collaboration, especially among younger designers and FMs, could help to create more enthusiasm for such collaborations. This enthusiasm could be enhanced with greater practical results stemming from efforts to overcome communication barriers. The study results suggest that there would be a great value in developing better training programs, greater awareness of the activities of the FM field, and continuing-education spheres in which designers and facility managers could have greater interaction (such as interdisciplinary conferences and workshops). The study also resulted in a model for specific steps that can be taken to overcome barriers to collaboration and better integrate facility managers into the design process. Based on the study findings, a visual map was created of the collaboration route that a project could undergo during the design process in order to maximize the value that facility managers add to the project.

This study indicates that the involvement of FMs in the design process could have an effect that is similar to the use of post-occupancy evaluation studies (POEs) by designers, but at a greatly reduced cost and a possibly greater effectiveness (though

further comparative studies are needed on this point). Promoting collaborations between FMs and designers can be considered as a step toward evidence-based design, as FMs possess important stores of information accumulated over long years of practice that can be of great use as feedback to designers. Much of this information is currently unutilized, especially in the international context, but this situation could be changed by taking practical steps to increase the effectiveness of collaboration and the awareness of its benefits.

7.2.Discussion of Limitations

As the case with all research, this study has some limitations. Perhaps most obviously, the study data was gathered in the United Kingdom, the United States, and the Middle East, and therefore cannot be generalized beyond those regions. Furthermore, the limited number of interviewees in the each location (U.K.=10, U.S.=5, Middle East=5) and the limited number of survey respondents (U.K.=33, U.S.=58, Middle East=80) means that some degree of caution should be maintained when using the study results. The limited number of interviewees in the U.S. and the Middle East in comparison with the U.K. may result in perspective bias, meaning that some of the identified benefits, barriers, and recommendations may be more relevant in the U.K. than in the other two regions. This bias could potentially be heightened by the fact that nine of the ten U.K. interviews were conducted face-to-face, whereas the majority of the interviews in other countries were conducted via videoconference. In regard to the survey, a lack of quantitative data from the United Kingdom (n=33) in comparison with

the U.S. (n=58) and the Middle East (n=80) may create a similar (though opposing) bias. Ideally, further research should be carried out to help minimize these potential biases and confirm the study results.

Other limitations are posed by the likely presence of confounding variables in the study. For example, in the survey data, information about the type of facilities that respondents managed and the complexity of their projects was not considered. While an effort was made to control for some of the most obvious variables, such as length work experience, the size of the FMs' organization/company, and the extent of their education, it was not practically feasible in a study of this nature to eliminate all of the potential confounding variables. In addition, this research was focused on an analysis of collaboration from the FMs' point of view. Although 10% of the interviewees and 11% of the survey respondents were designers by profession, the results mainly cover the outlook of FMs in regard to the benefits and barriers to collaboration. Thus, there may be additional topics that were overlooked or minimized due to the limited voice of designers in the study results. Further research is needed to investigate, in particular, the topic of communication problems with a greater emphasis on the perspective of designers.

7.3.Recommendation for Future Research

Topics that may be productively explored in future research include the following:

1. Further study is needed to investigate the benefits and barriers of collaboration from the perspective of designers. This is especially true in relation to communication problems between designers and FMs. The results from such a study may provide a valuable expansion and counterpoint to the FM-centered outlook that was the focus of the current research.
2. One of the results of the current study was that the software knowledge of designers and facilities managers was completely different, and that both designers and FMs have limited knowledge about each others' software. However, it was determined that using a common software was associate with higher rates of collaboration. Thus, additional research could productively explore how Building Information Modeling (BIM) programs can be adjusted to provide a common software sphere for both designers and FMs.
3. Another conclusion in the current study was that better training can improve the likelihood and effectiveness of collaboration, and enhance general knowledge about the role of FMs and the benefits of collaboration. However, this study did not include a comparison of different types of training, such as academic facility management programs, interdisciplinary conferences and workshops, facilities management certificate programs, software training conducted by FM organizations, and so forth. Further research needs to be conducted to investigate the impact of different types of training and how they might affect the collaboration process.

4. This study did not reveal an association between the use of lean principles in a facility management organization and the rate or effectiveness of collaboration between FMs and designers. It was unclear whether this lack of association was due to the very low incidence of lean-principle use among the study participants, or whether the adoption of this management philosophy simply had no effect on collaboration. Additional research might be productively undertaken to address this topic, and to determine the overall effect of lean principles in the FM industry.

7.4.Closing

This study indicates that the involvement of FMs in the design process could have a similar effect to the use of post-occupancy evaluation (POE) studies by designers. The use of POEs is an increasing interest among architectural design firms, but the in-depth experience of FMs should be considered as an even greater resource. This experience can be embraced by designers to greatly enhance the practical performance of their projects. Furthermore, the expense of collaboration is in most cases much lower than the investment required for design firms to undertake robust POE studies. Promoting collaborations between FMs and designers can be considered as a step toward evidence-based design, as FMs possess important stores of information accumulated over long years of practice. Much of this information is currently unutilized by designers. Further cost-value research is needed in order to fully compare the impact of FMs' involvement in design with other alternatives such as the use of POEs.

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APPENDIX A

IRB LETTER

DIVISION OF RESEARCH

Office of Research Compliance

TEXAS A&M UNIVERSITY

DATE: November 11, 2013

MEMORANDUM

TO: Mardelle Shepley
TAMU - College Of Architecture - Architecture

FROM: Office of Research Compliance
Institutional Review Board

SUBJECT: Initial Submission

Protocol Number: IRB2013-0693

Title: Toward an Economic Design Process: Enhancing Building Performance through Better Integration of Facility Management in the Design Process

Approval Date: 11/11/2013

Continuing Review Due: 10/01/2014

Expiration Date: 11/01/2014

Review Type: Expedite

Documents Reviewed and Approved:

Title	Version Number	Version Date	Outcome
Information Sheet Interview	Version 1.0	11/01/2013	Approved
Information Sheet Survey	Version 1.0	11/01/2013	Approved
draft interview-sk 092613	Version 1.0	10/05/2013	Approved
draft survey-sk 100313	Version 1.0	10/05/2013	Approved
final revised proposal kalantari	Version 1.0	10/05/2013	Approved
survey recruitment email	Version 1.0	10/05/2013	Approved
interviews recruitment email	Version 1.0	10/05/2013	Approved

This research project has been approved. As principal investigator, you assume the following responsibilities

1. **Continuing Review:** The protocol must be renewed by the expiration date in order to continue with the research project. A Continuing Review application along with required documents must be submitted by the continuing review deadline. Failure to do so may result in processing delays, study termination, and/or loss of funding.
2. **Completion Report:** Upon completion of the research project (including data analysis and final written papers), a Completion Report must be submitted to the IRB.
3. **Unanticipated Problems and Adverse Events:** Unanticipated problems and adverse events must be reported to the IRB immediately.
4. **Reports of Potential Non-compliance:** Potential non-compliance, including deviations from protocol and violations, must be reported to the IRB office immediately.
5. **Amendments:** Changes to the protocol must be requested by submitting an Amendment to the IRB for review. The Amendment must be approved by the IRB before being implemented.

750 Agronomy Road, Suite 2701
1186 TAMU
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Tel. 979.458.1467 Fax. 979.862.3176
http://rcb.tamu.edu

6. **Consent Forms:** When using a consent form or information sheet, you must use the IRB stamped approved version. Please log into iRIS to download your stamped approved version of the consenting instruments. If you are unable to locate the stamped version in iRIS, please contact the office.
7. **Audit:** Your protocol may be subject to audit by the Human Subjects Post Approval Monitor. During the life of the study please review and document study progress using the PI self-assessment found on the RCB website as a method of preparation for the potential audit. Investigators are responsible for maintaining complete and accurate study records and making them available for inspection. Investigators are encouraged to request a pre-initiation site visit with the Post Approval Monitor. These visits are designed to help ensure that all necessary documents are approved and in order prior to initiating the study and to help investigators maintain compliance.
8. **Recruitment**: All approved recruitment materials will be stamped electronically by the HSPP staff and available for download from iRIS. These IRB-stamped approved documents from iRIS must be used for recruitment. For materials that are distributed to potential participants electronically and for which you can only feasibly use the approved text rather than the stamped document, the study's IRB Protocol number, approval date, and expiration dates must be included in the following format: TAMU IRB#20XX-XXXX Approved: XX/XX/XXXX Expiration Date: XX/XX/XXXX.

The Office of Research Compliance and Biosafety is conducting a brief survey for the purpose of programmatic enhancements. Click here to take survey or copy and paste in a browser https://tamu.qualtrics.com/SE/?SID=SV_1CgOkLNU45QebvT

This electronic document provides notification of the review results by the Institutional Review Board.

APPENDIX B

INTERVIEW RECRUITMENT LETTER

Dear Sir/Madam,

As a member of ….. Company, you are invited to participate in a research study by a doctoral student in the College of Architecture, Texas A&M University, on **Enhancing Building Performance through Better Integration of Facility Management in the Design Process.**

I am a Ph.D. Candidate at the Center for Health Systems and Design, in College of Architecture, at Texas A&M University. As part of my doctoral dissertation, I am seeking to understand current state of facility management and provide a systematic recommendation for better integration of the facility management team with the design team with the intent of enhancing the energy performance of buildings. I would like to conduct **30 min in-person or phone interviews** with 3-5 individuals who are currently working in your company. I would appreciate if you forwarding this email to the facility managers working on international sites.

Best Regards,

Saleh Kalantari

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APPENDIX C

INTERVIEW INFORMATION SHEET

TEXAS A&M UNIVERSITY HUMAN SUBJECTS PROTECTION PROGRAM

INFORMATION SHEET

Project Title:

You are invited to take part in a research study being conducted by Dr. Mardelle Shepley, and Mr. Seyed Saleh Kalantari Hematabadi, a researcher from Texas A&M University. The information in this form is provided to help you decide whether or not to take part. If you decide you do not want to participate, there will be no penalty to you, and you will not lose any benefits you normally would have.

Why Is This Study Being Done?
The purpose of this study is to assess the role of facility managers in the design process, especially in enhancing energy efficiency of the built environment.

Why Am I Being Asked To Be In This Study?
You are being asked to be in this study because you are one of the people identified as having an experience in facility management.

How Many People Will Be Asked To Be In This Study?
Overall, a total of 50 people will be invited from FM companies and council to participate in the interview/focus groups section of this study.

What Are the Alternatives to being in this study?
The alternative to being in the study is not to participate.

What Will I Be Asked To Do In This Study?
You will be asked to complete a set of written questions on a survey document. You may be asked to participate in a group interview as well. Your participation in this study will last up to 60 minutes. The interview will be audio recorded. If you do not want to be recorded you cannot participate.

Are There Any Risks To Me?
The things that you will be doing involve no more than risks than you would come across in everyday life. Although the researchers have tried to avoid risks, you may feel that some questions/procedures that are asked of you will be stressful or upsetting. You do not have to answer anything you do not want to.

Will There Be Any Costs To Me?
Aside from your time, there are no costs for taking part in the study.

Will I Be Paid To Be In This Study?
You will not be paid for being in this study.

Will Information From This Study Be Kept Private?
The records of this study will be kept private. No identifiers linking you to this study will be included in any sort of report that might be published. Research records will be stored securely and only the researchers will have access to the records.
People who have access to your information include the Principal Investigator and research study personnel. Representatives of regulatory agencies such as the Office of Human Research Protections (OHRP) and entities such as the Texas A&M University Human Subjects Protection Program may

access your records to make sure the study is being run correctly and that information is collected properly.
Information about you and related to this study will be kept confidential to the extent permitted or required by law.

Who may I Contact for More Information?
You may contact the Principal Investigator, Dr. Mardelle Shepley, Ph.D., and Protocol Director, Mr. Seyed Saleh Kalantari Hematabadi to tell them about a concern or complaint about this research at +1 (979) 422-4950, or +1 (979) 845-7009.

For questions about your rights as a research participant; or if you have questions, complaints, or concerns about the research, you may call the Texas A&M University Human Subjects Protection Program office at +1 (979) 458-4067 or irb@tamu.edu.

What if I Change My Mind About Participating?
This research is voluntary and you have the choice whether or not to be in this research study. You may decide to not begin or to stop participating at any time. If you choose not to be in this study or stop being in the study, there will be no effect on you.
By completing the survey and/or participating in the interview, you are giving permission for the investigator to use your information for research purposes.

Thank you.

Seyed Saleh Kalantari Hematabadi, PhD Candidate

APPENDIX D

SURVEY RECRUITMENT LETTER

Dear Sir/Madam,

As a member of ….. Company, you are invited to participate in a research study by a doctoral student in the College of Architecture, Texas A&M University, on **Enhancing Building Performance through Better Integration of Facility Management in the Design Process.** Your input will inform FM industry about the challenges you face in providing optimal building performance. Your participation will also assist building designers in incorporating your recommendations in future building designs with the objective of providing better performance buildings.

In this survey, you will be asked to complete a set of written questions on a survey document which may take 20 minutes.

If you would like to inform FM communities about your recommendation and help improve the building performance through better interaction with design team, PLEASE follow this link and complete the survey document …..

I appreciate your time and attention.

Best Regards,

Saleh Kalantari

D.Arch. Candidate, M.I.D, EDAC, Certificate in Health Systems & Design
College of Architecture
Texas A&M University
College Station, TX 77843
(979)422-4950
skalant@tamu.edu
kalantari_saleh@yahoo.com

APPENDIX E

SURVEY INFORMATION SHEET

TEXAS A&M UNIVERSITY HUMAN SUBJECTS PROTECTION PROGRAM

INFORMATION SHEET

Project Title:

You are invited to take part in a research study being conducted by Dr. Mardelle Shepley, and Mr. Seyed Saleh Kalantari Hematabadi, a researcher from Texas A&M University. The information in this form is provided to help you decide whether or not to take part. If you decide you do not want to participate, there will be no penalty to you, and you will not lose any benefits you normally would have.

Why Is This Study Being Done?
The purpose of this study is to assess the role of facility managers in the design process, especially in enhancing energy efficiency of the built environment.

Why Am I Being Asked To Be In This Study?
You are being asked to be in this study because you are one of the people identified as having an experience in facility management.

How Many People Will Be Asked To Be In This Study?
Overall, a total of 500 people will be invited from FM companies and councils to participate in this survey.

What Are the Alternatives to being in this study?
The alternative to being in the study is not to participate.

What Will I Be Asked To Do In This Study?
You will be asked to complete a set of written questions on a survey document. You may be asked to participate in a group interview as well. Your participation in this study will last up to 30 minutes.

Are There Any Risks To Me?
The things that you will be doing involve no more than risks than you would come across in everyday life. Although the researchers have tried to avoid risks, you may feel that some questions/procedures that are asked of you will be stressful or upsetting. You do not have to answer anything you do not want to.

Will There Be Any Costs To Me?
Aside from your time, there are no costs for taking part in the study.

Will I Be Paid To Be In This Study?
You will not be paid for being in this study.

Will Information From This Study Be Kept Private?
The records of this study will be kept private. No identifiers linking you to this study will be included in any sort of report that might be published. Research records will be stored securely and only the researchers will have access to the records.
People who have access to your information include the Principal Investigator and research study personnel. Representatives of regulatory agencies such as the Office of Human Research Protections (OHRP) and entities such as the Texas A&M University Human Subjects Protection Program may

access your records to make sure the study is being run correctly and that information is collected properly.
Information about you and related to this study will be kept confidential to the extent permitted or required by law.

Who may I Contact for More Information?
You may contact the Principal Investigator, Dr. Mardelle Shepley, Ph.D., and Protocol Director, Mr. Seyed Saleh Kalantari Hematabadi to tell them about a concern or complaint about this research at +1 (979) 422-4950, or +1 (979) 845-7009.

For questions about your rights as a research participant; or if you have questions, complaints, or concerns about the research, you may call the Texas A&M University Human Subjects Protection Program office at +1 (979) 458-4067 or irb@tamu.edu.

What if I Change My Mind About Participating?
This research is voluntary and you have the choice whether or not to be in this research study. You may decide to not begin or to stop participating at any time. If you choose not to be in this study or stop being in the study, there will be no effect on you.
By completing the survey and/or participating in the interview, you are giving permission for the investigator to use your information for research purposes.

Thank you.

Seyed Saleh Kalantari Hematabadi, PhD Candidate

APPENDIX F

WAIVER OF DOCUMENTATION OF CONSENT

TEXAS A&M UNIVERSITY HUMAN SUBJECTS PROTECTION PROGRAM

WAIVER OF CONSENT OR DOCUMENTATION OF CONSENT FOR THE USE OF HUMAN SUBJECT RESEARCH

This form may be included with the any Application form when requesting a Waiver of Written Documentation of the Consent Process or a Waiver or Alteration of the Consent Process.

A waiver or alteration of the consent process according to 45 CFR§46.116 (c) and (d) would waive part or all of the consent process. Examples of the use of this waiver are in deception research (waiving elements of consent) or research to analyze data (waiving consent all together). A waiver of documentation of consent according to 45 CFR §46.117(c) would waive the required signature of the informed consent form and would require the use of an information sheet to provide to participants that contains all the elements of informed consent according to 45 CFR§46.116(a). Examples of the use of a waiver to documentation of consent would be for the use of internet surveys.

In order to ensure that the waiver is considered and documented appropriately, please provide a reasonable amount of detail in your responses.

I. Project Identification

Title of Project	***Toward an Economic Design Process: Enhancing Building Performance through Better Integration of Facility Management in the Design Process***
Principal Investigator	*Mardelle M. Shepley*
IRB Protocol # (if assigned)	*IRB2013-0693*

II. Waiver of Documentation of Consent - 45 CFR§46.117

Provide protocol-specific reasons and justification on how *at least one* of the following criteria are met:
That the research presents no more than minimal risk of harm to participants and involves no procedures for which written consent is normally required outside of the research context. In cases in which the documentation requirement is waived, the IRB may require the investigator to provide participants with a written statement regarding the research. **Protocol-specific explanation:** The intent is to collect minimal demographic only data and then move on to the research specific questions. If this survey could be administered via an on-line method, the same process would be followed. We anticipate confusion from our participants on any requirement for signatures on documents associated with the research.
IRB Use Only ☐ Approved ☐ Denied ☐ Portions of the study ☐ All of the study Comments:

APPENDIX G

INTERVIEW QUESTIONS

Texas A&M University
College Station, Texas
Contact: skalant@tamu.edu

Toward Economic Design Process: Study of Enhancing Building Performance through Better Integration of Facility Managements in Design Process

Interview Guide

This document is intended to guide the interview process. Each person in the focus group will fill out the survey document and the interview will follow.

Background

1. Please briefly describe about your company and your role in the company.

2. Can you explain more about your special training and background for this job?

Organization Protocols

3. I would like to understand the structure of facility management and your personal approach in this culture. Please tell me about the variation of work you are doing here, and the current state of international facility management?

4. What are the pitfalls in your management approach relating to enhance the performance of the building and in particular energy performance?

5. Do you have regular meetings? Who are the participants? How do you discuss on problems? Do you have any structure on the meetings?

Relationship with Designers

6. Is there any relationship between you and designers of the building? If yes, how do you evaluate this relationship regarding building performance? If no, what is your idea about connection of FMs and designers?

7. Please explain that in which ways this relationship can affect the performance of the design?

8. In case of sustainable design, do you have any experience of working with designers to enhance the performance of the building?

9. In which phase of design process do you think FMs can be more effective regarding better quality of final design?

10. What would be benefits for you to keep the connection with the design team after occupancy of the building?

Additional Feedback

APPENDIX H

SURVEY QUESTIONS

Texas A&M University
Doha, Qatar & College Station, Texas
Contact: skalant@tamu.edu

Toward Economic Design Process: Study of Enhancing Building Performance through Better Integration of Facility Managements in Design Process

Survey

Please take a few minutes to fill out this survey. The purpose of is to understand the role of facility management on design process, and building performance. The researchers welcome your feedback. You survey response will be anonymous. Thank you for your participation.

Background

1. What is your role in the company?

☐ General Manager (GM) ☐ Head of Operation (HOO) ☐ Portfolio Manager (PM) ☐ Senior Assistant Technician (SAT) ☐ Facility Manager (FM) ☐ Other: _____

2. What is your highest level of training/education?

☐ Technical certificate/license: _____ ☐ Some college/university classes
☐ Completed college/university ☐ Some graduate school classes ☐ Completed graduate school

3. How long have you worked in facility maintenance over your whole career?

☐ Less than 1 year ☐ 1 to 5 years ☐ 5 to 10 years ☐More than 10 years

4. How long have you worked in your current position?

☐ Less than 1 year ☐ 1 to 5 years ☐ 5 to 10 years ☐More than 10 years

5. Do you currently supervise people as a regular part of your job? How many people do you supervise?

☐ None ☐ 2-10 ☐ 11-20 ☐ More than 20

6. In which countries/areas of world do you experience of working in the realm of facility management?

☐ USA ☐ UK ☐ China ☐Middle East ☐ India ☐ Europe ☐ North Africa
☐ South America ☐ Canada ☐ South Africa ☐ Australia ☐ Other: _____

Organization Protocol

7. Please check the works that you are covering in your company.

☐ Electrical wiring and power distribution ☐ Carpentry ☐ Plumbing and water-works
☐ Operation and maintenance of HVAC ☐ Spatial Planning ☐ Civil and structural engineering
☐ Other: _____ ☐ Other: _____ ☐ Other: _____

8. How often do you have meeting with manager team?

Once in a month	Once in a week	Twice in a week	No regular schedule for meeting
☐	☐	☐	☐

9. Who are the participants in general managers' meetings?

☐ General Manager (GM)	☐ Head of Operation (HOO)	☐ Portfolio Manager (PM)	☐ Senior Assistant Technician (SAT)	☐ Facility Manager (FM)

10. Do you feel like you can freely share your opinions in the meeting?

Never	Rarely	Sometimes	Often	Always
☐	☐	☐	☐	☐

11. If you find a problem, is it easy to pass this information on to the general meeting?

Very difficult	Somewhat difficult	Neither difficult nor easy	Somewhat easy	Very easy
☐	☐	☐	☐	☐

12. How do you evaluate your company in enhancing the buildings performance by choosing the best approach?

Not Successful	Average in all projects	Successful in some of projects	Successful in all projects	Outstanding in all projects
☐	☐	☐	☐	☐

13. How often do you receive complaints about the building from people who work in the building?

Very rarely	Rarely	Sometimes	Often	Very often
☐	☐	☐	☐	☐

14. How often do you use LEAN principles in your facility management approach?

Very rarely	Rarely	Sometimes	Often	Very often
☐	☐	☐	☐	☐

15. In case of using LEAN principles in your facility management approach, please explain which principles are most practical and crucial in your field?

_____

_____

_____

16. What are the pitfalls in the current state of facility management?

17. What is the most important thing you would recommend to improve the current state of facility management?

Relationship with Designers

- Architects, interior designers, civil engineers, mechanical engineers, electrical engineers, and landscape architects are considered as "designers" for following questions.
- Relationship with designers might include any contact during the maintenance period, or any involvement in the design process of a project.

18. On which percent of your projects in the company, there is a relationship between FMs and Designers?

Less than 10%	10-30%	30-50%	50-70%	70-90%	More than 90%
☐	☐	☐	☐	☐	☐

19. How do you estimate as percent the relationship of FM companies and designers in today's international FM industry?

Less than 10%	10-30%	30-50%	50-70%	70-90%	More than 90%
☐	☐	☐	☐	☐	☐

20. In how many projects did you use designers for solving problems or taking some suggestions in your meetings?

Not at all	1-2 Project(s)	2-5 Projects	5-10 Projects	More than 10 Projects
☐	☐	☐	☐	☐

21. In how many projects were you involved with during the design process?

Not at all	1-2 Project(s)	2-5 Projects	5-10 Projects	More than 10 Projects
☐	☐	☐	☐	☐

22. With which kind of consultants you mostly contact to get feedback (Please rank them from 1-6)?

Architects	Interior Designers	Mechanical Engineers	Electrical Engineers	Civil Engineers	Landscape Designers
☐	☐	☐	☐	☐	☐

23. Do you feel you have more understandings on which of the following fields (Please rank them from 1-6)?

Architects	Interior Designers	Mechanical Engineers	Electrical Engineers	Civil Engineers	Landscape Designers
☐	☐	☐	☐	☐	☐

24. How necessary you evaluate the relationship with designers in building performance?

Not at all	Sometimes helpful, but not generally	Helpful average	Very Helpful for most of the projects	Crucial for each project
☐	☐	☐	☐	☐

25. In which phase of the design process do you think you can have more influential suggestions (you can select more than one option)?

Concepts/Principles	Sketch Design	Scheme Design	Detail Design	Construction Information	Construction
☐	☐	☐	☐	☐	☐

26. Do you feel that the relationship between designers and FMs can benefit designers to have better feedback from users?

No correlation	Barely	Sometimes	Often	Highly correlated
☐	☐	☐	☐	☐

27. Do you feel that your ideas meantime design process can affect decision making in the design process?

Never	Rarely	Sometimes	Often	Always
☐	☐	☐	☐	☐

28. How knowledgeable do you evaluate designers about building performance and facility management?

No knowledge	Minimal knowledge	Adequate knowledge	Good knowledge	Excellent knowledge
☐	☐	☐	☐	☐

29. How efficient do you evaluate designers' alternatives in solving the building problems in comparison with FMs' alternatives?

Not effective	Good ideas but not practical	Effectives, but need FM's inputs	Sometimes more effective than solutions of the FMs	Always more effective than solutions of the FMs
☐	☐	☐	☐	☐

30. In which way(s) integration of FMs in the design process can affect building performance?

31. In which way(s), in the occupancy period, designers can affect the facility management?

Additional Feedback

Please make additional comments here, if you wish.

Thank you for taking the time to fill out our survey. We rely on your feedback to help us improve building performance through better discourse between facility managers and designers. Your inputs are greatly appreciated.