

**DEVELOPMENT OF A FRAMEWORK FOR THE EFFECTIVE
IMPLEMENTATION OF BUILDING ADAPTIVE REUSE THROUGHOUT
THE PROJECT LIFE-CYCLE IN SAUDI ARABIA**

**BY
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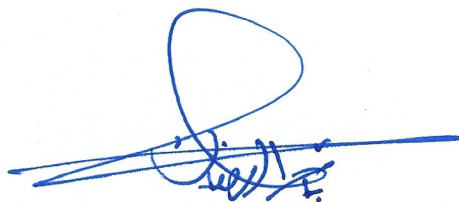
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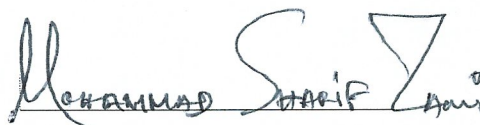


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*To my **parents, brothers and sister***

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TABLE OF CONTENTS

ACKNOWLEDGMENTS.....	v
TABLE OF CONTENTS	vi
LIST OF TABLES.....	xvi
LIST OF FIGURES.....	xviii
LIST OF SYMBOLS AND ABBREVIATIONS	xxiii
ABSTRACT.....	xxiv
ملخص الرسالة.....	xxvi
CHAPTER 1: INTRODUCTION.....	1
1.1 Overview.....	1
1.2 Background.....	1
1.3 Problem Statement	3
1.4 Research Goal	5
1.5 Research Objectives.....	5
1.6 Scope and Limitations.....	6
1.7 Research Significance	6
1.8 Research Methodology	7
1.8.1 Phase 1: Identification of the Factors Affecting the Implementation of Building Adaptive Reuse throughout the Project Life-Cycle	9

1.8.2 Phase 2: Assessment of the Identified Factors Affecting the Implementation of Building Adaptive Reuse throughout the Project Life-Cycle	12
1.8.3 Phase 3: Identification of Adaptive Reuse Functions and their Interactions across the Project Life-Cycle, Using IDEF ₀ Methodology	19
1.8.4 Phase 4: Validation of the Developed Framework for the Effective Implementation of Building Adaptive Reuse	23
1.8.5 Phase 5: Formulation of Conclusions, Recommendations and Areas for Future Research.....	27
1.9 Organization of Thesis.....	28
CHAPTER 2: REVIEW OF LITERATURE.....	31
2.1 Overview	31
2.2 The Traditional Life-cycle of Building Projects.....	31
2.2.1 Conceptual Planning and Feasibility Studies.....	32
2.2.2 Design and Engineering Phase	33
2.2.3 Construction Phase	33
2.2.4 Operation and Maintenance (O&M) Phase.....	34
2.3 Concepts of Modifications Conducted on Existing Buildings.....	34
2.3.1 Building Modernization.....	35
2.3.2 Building Rehabilitation.....	35
2.3.3 Building Renovation.....	36
2.3.4 Building Refurbishment.....	36
2.3.5 Adaptive Reuse of Building.....	36
2.4 The Practice of Adaptive Reuse of Building	37
2.4.1 Drivers and Benefits of Conducting Adaptive Reuse of Building	37
2.4.2 Barriers and Challenges of Adaptive Reuse of Buildings.....	40
2.4.3 Stakeholders Involved in the Adaptive Reuse Project.....	44
2.4.4 Practical Guidelines/Programs of Adaptive Reuse of Buildings	45

2.5 The Concept of Building Performance and Building Performance Assessment Process.....	48
2.5.1 Building Performance Concept.....	48
2.5.2 Building Performance Assessment Process	49
2.6 Previous Studies.....	51
2.7 Preliminary Identification of the Factors Affecting Building Adaptive Reuse throughout the Project Life-Cycle	56
2.7.1 Factors Related to the Phase of Conceptual Planning and Feasibility Studies	56
2.7.2 Factors Related to the Design and Engineering Phase	68
2.7.3 Factors Related to the Construction Phase.....	81
2.7.4 Factors Related to the Operation and Maintenance Phase	96
2.8 Summary and Discussion.....	125
CHAPTER 3: LOCAL PRACTICE OF BUILDING ADAPTIVE REUSE.....	127
3.1 Overview.....	127
3.2 Respondents' Demographic Information	128
3.2.1 Spatial Distribution of the Overall Respondents	128
3.2.2 Respondents' Scope of Work (Field of Work).....	129
3.2.3 Respondents' Years of Experience	132
3.2.4 Number of Adaptive Reuse Projects in which Respondents were Involved in	136
3.2.5 Types of Projects in which Respondents were Involved in.....	139
3.3 The Local Practice of Planning and Design of Adaptive Reuse Projects.....	142
3.3.1 Common Scenarios of Adaptive Reuse Projects in Saudi Arabia	143
3.3.2 A/Es' Perception about the Process of Implementing Adaptive Reuse Projects.....	144
3.3.3 Drivers/Causes of Implementing Adaptive Reuse Projects in Saudi Arabia.....	148
3.3.4 Methods Used in the Communication among the Parties during the Design and/or Documents Preparation of Adaptive Reuse Projects.....	149

3.3.5 Information and Data Needed During the Design Process and Documents Preparation of Adaptive Reuse Projects	150
3.3.6 Followed Methods for Obtaining Data and Information Needed during the Design Process and Documents Preparation of Adaptive Reuse Projects	152
3.3.7 Utilized Tools in the Design Process and Documents Preparation of Adaptive Reuse Projects	153
3.3.8 Applicable Challenges that Possibly Face A/E Professionals During the Design Process and Documents Preparation of Adaptive Reuse Projects	154
3.3.9 Systems Affected by the Requirements of the New Function in Adaptive Reuse Projects	158
3.3.10 Methods Suggested for Improving the Design Process and Documents Preparation in Adaptive Reuse Projects	159
3.3.11 Concluding Remarks of A/Es' Responses	161
3.4 The Local Practice of Constructing Adaptive Reuse Projects	163
3.4.1 Common Scenarios of Adaptive Reuse Projects in Saudi Arabia.....	164
3.4.2 Contractors' Perception about the Process of Implementing Adaptive Reuse Projects.....	165
3.4.3 Methods Used in the Communication among the Parties during the Implementation of Adaptive Reuse Projects	175
3.4.4 Information and Data Needed during the Implementation of Adaptive Reuse Projects	177
3.4.5 Followed Methods for Obtaining Data and Information Needed during the Implementation of Adaptive Reuse Projects	180
3.4.6 Extent of Work that Usually Takes Place during the Implementation of Adaptive Reuse Projects	181
3.4.7 Applicable Challenges that Possibly Face Contractors during the Implementation of Adaptive Reuse Projects.....	183
3.4.8 Methods Suggested for Improving the Implementation Process of Adaptive Reuse Projects	184
3.4.9 Concluding Remarks of Contractors' Responses.....	186
3.5 The Local Practice of Managing and Operating Adaptive Reuse Projects	188

3.5.1 Perception of FM Practitioners about the Practice of Operating Adaptively Reused Buildings	189
3.5.2 Information and Data Needed during the Operation and Maintenance (O&M) of Adaptively Reused Buildings	192
3.5.3 Followed Methods for Obtaining Data and Information Needed during the O&M Phase of the Adaptively Reused Buildings.....	195
3.5.4 Applicable Challenges that Possibly Face Facilities Management Team during the O&M of Adaptively Reused Buildings.....	196
3.5.5 Systems and Components that Frequently Require Maintenance and Repair (M&R) Works in Adaptively Reused Buildings.....	198
3.5.6 Methods Suggested for Improving the Performance of Adaptively Reused Buildings.....	200
3.5.7 Concluding Remarks of FMs' Responses	201
3.6 Summary and Discussion.....	203
CHAPTER 4: DESCRIPTION OF THE FACTORS AFFECTING BUILDING ADAPTIVE REUSE THROUGHOUT THE PROJECT LIFE-CYCLE	206
4.1 Overview.....	206
4.2 Factors Related to the Phase of Conceptual Planning and Feasibility Studies.....	208
4.2.1 Structural Integrity of the Building	208
4.2.2 Municipal Approval for the Land Use Change	209
4.2.3 The Condition of Building Components and/or Systems.....	209
4.2.4 Architectural Program of the New Function	210
4.2.5 Potential of the Building Spaces to be Adaptively Reused	210
4.2.6 Allocated Budget for the Adaptation Process	211
4.2.7 Expected Yield from the Adaptation.....	211
4.2.8 The Schedule of the Adaptation Activities	211
4.2.9 Compatibility of the Building Appearance with the Client Desired Design	212
4.3 Factors Related to the Design and Engineering Phase	212

4.3.1 Previous Experience of the Design Team with Adaptive Reuse Projects	212
4.3.2 Code Requirements for the New Occupancy	213
4.3.3 Availability and Accuracy of the Drawings and Specifications of the Existing Project	213
4.3.4 Net Area of the Adaptable Space	214
4.3.5 Layout of Spaces within the Building	214
4.3.6 Number and Layout of the Structural Columns	214
4.3.7 Layout of the Existing MEP Systems	215
4.3.8 Capacity of the Existing MEP Systems	215
4.3.9 Potential to Install Additional and/or New Systems	216
4.3.10 Site Configuration and Requirements	216
4.3.11 Sustainability and Energy Saving Measures	216
4.4 Factors Related to the Construction Phase	217
4.4.1 Previous Experience of the Contractor with Adaptive Reuse Projects	217
4.4.2 Accuracy and Completeness of the Contract Documents	217
4.4.3 Availability of Skilled Workforce	218
4.4.4 Construction Equipment and Methods	218
4.4.5 Planning and Control of the Financial Resources	219
4.4.6 Quality Assurance / Control Requirements	219
4.4.7 Complexity and Difficulties within the Project Site	219
4.4.8 Availability and Accessibility of Loading Space	220
4.4.9 Availability of Spaces for Storing the Construction Materials and Equipment	220
4.4.10 Enforcement and Management of Safety Procedures at the Project Site	221
4.5 Factors Related to the Operation and Maintenance Phase	221
4.5.1 Availability and Adequacy of the Commissioning Process for the MEP Systems	221
4.5.2 Availability of Accurate Records of the Building Assets	222
4.5.3 Efficiency of the Utilization of the Building Spaces	222
4.5.4 Compliance with Health and Safety Measures	223

4.5.5 Development and Implementation of Work Schedules for Different Maintenance Types (e.g. Planned, Unplanned).....	223
4.5.6 Potentiality of Obsolescence and/or Deterioration of Building Components and/or Systems	223
4.5.7 Control over the Operational Characteristics of the Building Components and Systems	224
4.5.8 User Satisfaction with the Layout of the Building as well as the Workflow of Activities.....	224
4.6 Summary and Discussion.....	225
CHAPTER 5: ASSESSMENT OF THE FACTORS AFFECTING BUILDING ADAPTIVE REUSE THROUGHOUT THE PROJECT LIFE-CYCLE	226
5.1 Overview.....	226
5.2 Overall Findings of the Assessment of the Factors by the Three Groups of Respondents	227
5.2.1 Factors Related to the Phase of Conceptual Planning and Feasibility Studies.....	228
5.2.2 Factors Related to the Design and Engineering Phase	228
5.2.3 Factors Related to the Construction Phase	229
5.2.4 Factors Related to the Operation and Maintenance Phase	230
5.3 Assessment of the Factors by Each Group of Respondents	235
5.3.1 Assessment of the Factors by A/Es.....	235
5.3.2 Assessment of the Factors by Contractors	239
5.3.3 Assessment of the Factors by Facilities Managers.....	242
5.4 Assessment of the Groups of Factors by Each Group of Respondents	245
5.4.1 Assessment of the Groups of Factors by A/Es.....	245
5.4.2 Assessment of the Groups of Factors by Contractors	246
5.4.3 Assessment of the Groups of Factors by Facilities Managers.....	246
5.5 Analysis of the Agreement among the Three Groups of Respondents	247
5.6 Summary and Discussion.....	248

CHAPTER 6: DEVELOPMENT OF A FRAMEWORK FOR THE EFFECTIVE IMPLEMENTATION OF BUILDING ADAPTIVE REUSE THROUGHOUT THE PROJECT LIFE-CYCLE.....	249
6.1 Overview	249
6.2 Generic Life-Cycle Framework for Effective Implementation of Adaptive Reuse Projects	250
6.2.1 Assess the Feasibility of the Adaptive Reuse Project	250
6.2.2 Design the Adaptive Reuse Project	258
6.2.3 Construct the Adaptive Reuse Project	263
6.2.4 Operate and Maintain the Adaptive Reuse Project	269
6.3 Summary and Discussion	275
CHAPTER 7: VALIDATION OF THE DEVELOPED FRAMEWORK FOR THE EFFECTIVE IMPLEMENTATION OF BUILDING ADAPTIVE REUSE THROUGHOUT THE PROJECT LIFE-CYCLE.....	278
7.1 Overview	278
7.2 Respondents' Demographic Information.....	279
7.2.1 Spatial Distribution of Respondents	279
7.2.2 Respondents' Scope of Work	280
7.2.3 Respondents' Years of Experience	281
7.2.4 Number of Adaptive Reuse Projects in which Respondents were Involved in.....	282
7.2.5 Types of Projects in Which Respondents were Involved in	283
7.3 Assessment of the Functions involved the Life-Cycle of Adaptive Reuse Projects	284
7.3.1 Feasibility Studies Phase of the Adaptive Reuse Project.....	284
7.3.2 Design Phase of the Adaptive Reuse Project	285
7.3.3 Construction Phase of the Adaptive Reuse Project.....	290
7.3.4 Operation and Maintenance Phase of the Adaptive Reuse Project	291
7.4 Summary and Discussion	291

CHAPTER 8: CONCLUSIONS, RECOMMENDATIONS AND AREAS FOR FUTURE

RESEARCH.....	293
8.1 Overview.....	293
8.2 Conclusions.....	299
8.2.1 Achievement of Objective 1	299
8.2.2 Achievement of Objective 2	303
8.2.3 Achievement of Objective 3	305
8.3 Recommendations.....	306
8.4 Areas for Future Research	307
REFERENCES	308
APPENDIX A: LIST OF ADAPTIVELY REUSED BUILDINGS IN DAMMAM METROPOLITAN	
AREA.....	321
A.1 Overview.....	321
A.2 Discussion	322
APPENDIX B: A/Es' QUESTIONNAIRE SURVEY (ARABIC AND ENGLISH)	323
APPENDIX C: CONTRACTORS' QUESTIONNAIRE SURVEY (ARABIC AND ENGLISH)	
.....	343
APPENDIX D: FACILITIES MANAGERS' QUESTIONNAIRE SURVEY (ARABIC AND	
ENGLISH).....	363
APPENDIX E: LIST OF RESPONDENTS OF THE THREE QUESTIONNAIRE SURVEYS	
.....	381
E.1 Respondents of the A/E Questionnaire Surveys	381
E.2 Respondents of the Contractors' Questionnaire Surveys.....	383

E.3 Respondents of the Contractors' Questionnaire Surveys	384
APPENDIX F: VALIDATION QUESTIONNAIRE SURVEY (ARABIC AND ENGLISH).....	387
APPENDIX G: LIST OF RESPONDENTS OF THE VALIDATION QUESTIONNAIRE SURVEY..	
.....	407
G.1 Respondents of the Validation Questionnaire Survey from the A/E Profession.....	407
G.2 Respondents of the Validation Questionnaire Survey from the Construction Profession.....	408
G.3 Respondents of the Validation Questionnaire Survey from the FM Profession	409
VITAE.....	410

LIST OF TABLES

Table 1.1: The adopted variables expressing the frequency, weights, and importance rates for all importance levels used in the assessment of the factors	17
Table 1.2: The adopted interpretation for identifying the level of correlation among paired the comparisons relaying on the calculated Spearman’s coefficients of rank correlation.....	19
Table 1.3: The adopted variables expressing the frequency, weights, and frequency rates for all levels used in the assessment of the functions’ implementation	27
Table 2.1 Drivers and benefits of conducting adaptive reuse of buildings	39
Table 2.2: Barriers and challenges of conducting adaptive reuse of buildings.....	42
Table 2.3: Brief description of stakeholders involved in the adaptive reuse project	45
Table 2.4: Steps of the adaptive reuse process of the adaptive reuse technical manual ..	47
Table 2.5: List of the identified factors and their terminology(s), definition(s)/ description and measurements/assessment method(s)	108
Table 5.1: Overall findings of the received assessment of the factors by the involved three groups of respondents.....	231
Table 5.2: Findings of the analysis of agreement among the three groups of respondents	247
Table 7.1: Overall findings of the assessment of the importance and frequency of implementing the functions involved in the processes of the developed framework	286

Table A.1: Information about the documented adaptively reused buildings in Dammam Metropolitan Area	322
Table E.1: Further information and details pertaining to the respondents of the conducted questionnaire survey on adaptive reuse practitioners from the A/E profession	381
Table E.2: Further information and details pertaining to the respondents of the conducted questionnaire survey on adaptive reuse practitioners from the construction profession	383
Table E.3: Further information and details pertaining to the respondents of the conducted questionnaire survey on adaptive reuse practitioners from the FM profession	385
Table G.1: Further information and details pertaining to the respondents of the validation questionnaire survey from the A/E profession	407
Table G.2: Further information and details pertaining to the respondents of the validation questionnaire survey from the construction profession.....	408
Table G.3: Further information and details pertaining to the respondents of the validation questionnaire survey from the FM profession.....	409

LIST OF FIGURES

Figure 1.1: The adopted design of the research methodology	8
Figure 1.2: The adopted IDEF ₀ standard for representing the relation and interaction of functions and their input, controls, outputs and mechanism	22
Figure 2.1: The traditional life cycle of building projects	32
Figure 2.2: Types of modification works performed on existing building.....	35
Figure 2.3: The concept of building performance	49
Figure 2.4: Building performance evaluation (BPE) process model	50
Figure 3.1: Spatial distribution of the respondents	128
Figure 3.2: Scope of work of the involved practitioners in the A/Es' questionnaire survey..	130
Figure 3.3: Scope of work of the involved practitioners in the contractors' questionnaire survey	131
Figure 3.4: Scope of work of the involved practitioners in the FMs' questionnaire survey	132
Figure 3.5: Ranges of years of experience of the practitioners involved in the A/Es' questionnaire survey.....	133
Figure 3.6: Ranges of years of experience of the practitioners involved in the contractors' questionnaire survey.....	134
Figure 3.7: Ranges of years of experience of the practitioners involved in the FMs' questionnaire survey	135

Figure 3.8: Range of number of adaptive reuse projects in which respondents of the A/Es' questionnaire survey were involved in.....	136
Figure 3.9: Range of number of adaptive reuse projects in which respondents of the contractors' questionnaire survey were involved in.....	137
Figure 3.10: Range of number of adaptive reuse projects in which respondents of the FMs' questionnaire survey were involved in	138
Figure 3.11: Types of projects in which respondents of the A/Es' questionnaire survey were involved in	139
Figure 3.12: Types of projects in which respondents of the contractors' questionnaire survey were involved in	140
Figure 3.13: Types of projects in which respondents of the FMs' questionnaire survey were involved in	141
Figure 3.14: A/Es' responses to the common scenarios of adaptive reuse projects in Saudi Arabia	143
Figure 3.15: A/Es' responses to the drivers/causes of Implementing adaptive reuse projects in Saudi Arabia	148
Figure 3.16: A/Es' responses to the methods used in the communication among the parties during the design and documents preparation of adaptive reuse projects	149
Figure 3.17: A/Es' responses to the information and data needed during the design process and documents preparation of adaptive reuse projects.....	151

Figure 3.18: A/Es’ responses to the followed methods for obtaining data/information needed during the design process and documents preparation of adaptive reuse projects	152
Figure 3.19: A/Es’ responses to the utilized tools in the design process and documents preparation of adaptive reuse projects	154
Figure 3.20: A/Es’ responses to the applicable challenges that possibly face the design process and documents preparation of adaptive reuse projects.....	156
Figure 3.21: A/Es’ responses to the systems affected by the requirements of the new function in adaptive reuse projects	158
Figure 3.22: A/Es’ responses to the methods suggested for improving the design process and documents preparation in adaptive reuse project	160
Figure 3.23: Contractors’ responses to the common scenarios of adaptive reuse projects in Saudi Arabia.....	164
Figure 3.24: Contractors’ responses to the methods used in the communication among the parties during the implementation of adaptive reuse projects	176
Figure 3.25: Contractors’ responses to the information and data needed during the implementation of adaptive reuse projects	178
Figure 3.26: Contractors’ responses to the followed methods for obtaining data and information needed during the implementation of adaptive reuse projects	180
Figure 3.27: Contractors’ responses to the extent of work that usually takes place during the implementation of adaptive reuse projects	182

Figure 3.28: Contractors’ responses to the applicable challenges that possibly face the process of implementing of adaptive reuse projects	183
Figure 3.29: Contractors’ responses to the methods suggested for improving the implementation process of adaptive reuse projects	185
Figure 3.30: FMs’ responses to the information and data needed during the operation and maintenance (O&M) of adaptively reused buildings	193
Figure 3.31: FMs’ responses to the followed methods for obtaining data and information needed during the O&M phase in adaptively reused buildings.....	196
Figure 3.32: FMs’ responses to the applicable challenges that possibly face facilities management team during the O&M of adaptively reused buildings.....	197
Figure 3.33: FMs’ responses to the systems and components that frequently require maintenance and repair (M&R) works in adaptively reused buildings....	199
Figure 3.34: FMs’ responses to the methods suggested for improving the performance of adaptively reused buildings	200
Figure 4.1: List of the identified factors that affect the building adaptive reuse throughout the project life-cycle	207
Figure 6.1: Generic framework for the processes involved in the life-cycle of adaptive reuse projects	252
Figure 6.2: Node P1 ‘assess the feasibility of the adaptive reuse project’	253
Figure 6.3: Node P2 ‘design the adaptive reuse project’	260
Figure 6.4: Node P3 ‘construct the adaptive reuse project’	265
Figure 6.5: Node P4 ‘operate & maintain the adaptive reuse project’	270

Figure 7.1: Spatial distribution of the respondents involved in the validation questionnaire survey	279
Figure 7.2: Scope of work of the involved practitioners in the validation questionnaire survey	280
Figure 7.3: Ranges of years of experience of the practitioners involved in the validation questionnaire survey	281
Figure 7.4: Range of number of adaptive reuse projects in which respondents of the validation questionnaire survey were involved in	282
Figure 7.5: Types of projects in which respondents of the validation questionnaire survey were involved in	283
Figure A.1: Random documentation of adaptively reused buildings in Dammam Metropolitan Area	321

LIST OF SYMBOLS AND ABBREVIATIONS

A	Always
A/E	Architect/Engineer
AEC/FM	Architecture, Engineering, Construction and Facilities Management
ARP	Adaptive Reuse Potential
Avg. RIIs	Average of Relative Importance Indices
BIM	Building Information Modeling
BOQ	Bill of Quantities
BPE	Building Performance Evaluation
CAD	Computer-Aided Design
DDS	Decision Support System
DMA	Dammam Metropolitan Area
EI	Extremely Important
F	Frequently
FI	Frequency Index
FM	Facilities Management
FMs	Facilities Managers
HVAC	Heating, Ventilation, and Air Conditioning
I	Important
IDEF₀	Integration Definition for Function Modeling
IT	Information Technology
IEQ	Indoor Environmental Quality
LCC	Life Cycle Costs
MEP systems	Mechanical, Electrical, and Plumbing Systems
M&R	Maintenance and Repair
NLA	Net Lettable or Usable Space
N	Never
<i>n</i>	Number of responses/respondents/sample size
<i>n₀</i>	First estimate of sample size
NI	Not Important
MoMRA	The Ministry of Municipal and Rural Affairs
O&M	Operations and Maintenance
OH&S	Occupational Health and Safety
<i>p</i>	Spearman's Coefficient of Rank Correlation
POE	Post-Occupancy Evaluation
RII	Relative Importance Index
S	Seldom
SBS	Saudi Building Code
SI	Somewhat Important
ST	Sometimes
TFA	Total (gross) floor area
VI	Very Important

ABSTRACT

Full Name : Mohammad Basel Hamida

Thesis Title : Development of a Framework for the Effective Implementation of Building Adaptive Reuse throughout the Project Life-Cycle in Saudi Arabia

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Adaptive reuse of building is among the practices that started to take place in Saudi Arabia, as well as in different places around the world, since the 20th century. Such practice provides sustainable outcomes to communities, due to its potential to fulfill environmental, social and economic benefits. On the other hand, this practice undergoes different kinds of challenges that could face the project stakeholders, including legal, functional, financial, cultural and technical challenges. Thus, previous studies focused on developing decision-making tools, to improve the judgment on the feasibility and potential of the adaptive reuse. The review of the relevant literature indicated that there is a gap on the integrated knowledge and applicable guidelines within the context of adaptive reuse life-cycle. Accordingly, this research aimed to develop a life-cycle-oriented framework for the effective implementation of adaptive reuse projects in Saudi Arabia. Three objectives were formulated and followed in order to achieve this goal, namely (1) *“to identify and evaluate the factors affecting the implementation of adaptive reuse of buildings throughout the project life-cycle”*, (2) *“to develop a framework of the process of adaptive reuse of buildings throughout the project life-cycle”*, and (3) *“to validate the developed framework through conducting interviews with a selected sample of design professionals, contractors and facilities managers in the Eastern Province of Saudi Arabia”*.

To achieve the first objective, a literature review and pilot study were conducted to identify the factors. Thirty-eight factors were identified and categorized in a life-cycle oriented classification as follows: factors related to the ‘conceptual planning and feasibility studies’, ‘design and engineering’, ‘construction’, and ‘operation and maintenance (O&M)’ phases. Three questionnaire surveys were developed and conducted on thirty architects /engineers (A/E), thirty contractors and thirty facilities managers. The questionnaire surveys aimed to reveal the local practice of building adaptive reuse, and assess its influential factors. Findings indicated that the top-five influential factors on the life-cycle of adaptive reuse projects are: ‘structural integrity of the building’, ‘municipal approval for the land use change’, ‘enforcement and management of safety procedures at the project site’, ‘compliance with health and safety (H&S) measures’, and ‘accuracy and completeness of the contract documents’.

Regarding the second objective, a life-cycle-oriented framework model was developed based on the knowledge obtained from the literature review, as well as findings of the three questionnaire surveys. The developed framework consists of twenty-two sequential functions listed under four sequential processes, namely: “assess the feasibility of the adaptive reuse project”, “design the adaptive reuse project”, “construct the adaptive reuse project”, and “operate and maintain the adaptive reuse project”. Integration Definition for Function Modeling (IDEF₀) methodology was employed for a schematic representation of the developed framework.

The third objective was fulfilled through conducting face-to-face validation questionnaire survey on one-third of the respondents’ sample of the first three questionnaire surveys. Therefore, ten A/Es, ten contractors and ten facilities managers were interviewed, to assess the importance and the implementation of the function included in the framework. Overall, findings of the validation questionnaire survey indicated that the framework functions received high importance rates, with acceptable frequencies of implementation. Feedbacks obtained from the interviewees indicated that adopting the developed framework has the potential to enhance the practice of building adaptive reuse in Saudi Arabia.

ملخص الرسالة

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عنوان الرسالة: تطوير إطار للتنفيذ الفعال لإعادة الاستخدام المتكيف للمباني طوال دورة حياة المشروع في المملكة العربية السعودية

التخصص: الهندسة المعمارية

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تعد إعادة الاستخدام المتكيف للمباني من بين الممارسات التي بدأت تنتشر في المملكة العربية السعودية وكذلك في أماكن مختلفة حول العالم منذ القرن العشرين. توفر هذه الممارسة نتائج مستدامة للمجتمعات بسبب قدرتها على تحقيق فوائد بيئية واجتماعية واقتصادية في آن واحد. من ناحية أخرى تواجه هذه الممارسة أنواعاً مختلفة من التحديات ، بما في ذلك الصعوبات القانونية والوظيفية والمالية والثقافية والتقنية التي قد تواجه الأطراف المعنية بالمشاركة في هذا النوع من المشاريع ؛ ولذلك ركزت العديد من الدراسات السابقة على تطوير أدوات لصنع القرار من أجل تحسين الحكم على جدوى وإمكانية تنفيذ مشاريع إعادة الاستخدام المتكيف للمباني. أظهرت مراجعة الأدبيات ذات الصلة بهذا السياق إلى أن هنالك فجوة في المعرفة والأدوات المتكاملة المتعلقة بدورة حياة مشاريع إعادة الاستخدام المتكيف. ولذلك يهدف هذا البحث إلى تطوير إطار دورة حياة للتنفيذ الفعال لمشاريع إعادة الاستخدام المتكيف للمباني في المملكة العربية السعودية، حيث تمت صياغة ثلاثة أهداف واتباعها من أجل تحقيق هذا الهدف ، وهي "أولاً تحديد وتقييم العوامل التي تؤثر على تنفيذ إعادة الاستخدام المتكيف للمباني طوال دورة حياة المشروع" ، "ثانياً تطوير إطار لعملية إعادة الاستخدام المتكيف للمباني طوال دورة حياة المشروع" ، "ثالثاً التحقق من صحة الإطار الذي تم تطويره من خلال إجراء مقابلات مع عينة مختارة من ممارسي مهنة التصميم والمقاولات وإدارة المنشآت في المنطقة الشرقية بالمملكة العربية السعودية".

لتحقيق الهدف الأول تم إجراء مراجعة للأدبيات ودراسة تجريبية مع مجموعة من الخبراء ؛ لتحديد العوامل حيث تم تحديد ثمان وثلاثون عاملاً وتصنيفها في أربعة مجموعات في سياق دورة الحياة وهي "العوامل المرتبطة بمرحلة التخطيط المفاهيمي ودراسات الجدوى" ، "العوامل المرتبطة بمرحلة التصميم الهندسي" ، "العوامل المرتبطة بمرحلة التشييد" ، و "العوامل المرتبطة بمرحلة التشغيل والصيانة". تم تطوير وإجراء ثلاثة استبيانات استقصائية على ثلاثون مهندس إستشارات هندسة و ثلاثون مقاولاً و ثلاثون ممارساً لمهنة إدارة المنشآت ؛ للكشف عن الممارسة المحلية لمشاريع إعادة الاستخدام التكميلية وتقييم العوامل المؤثرة عليها. أظهرت النتائج إلى أن أهم خمسة عوامل مؤثرة في دورة حياة مشاريع إعادة الاستخدام المتكيف تشمل كلاً من "السلامة الأنشائية للمبنى" ، و "موافقة البلدية على تغيير استخدام الأرض" ، و "تطبيق وإدارة إجراءات السلامة في موقع المشروع" و "الامتثال لتدابير الصحة والسلامة " و "دقة واكتمال وثائق العقد".

فيما يتعلق بالهدف الثاني لهذا البحث فقد تم تطوير نموذج إداري في سياق دورة الحياة استناداً إلى المعرفة التي إكتسبها من مراجعة الأدبيات ونتائج الدراسات الاستقصائية الثلاثة. يتكون الإطار المطور من اثنين وعشرون وظيفة متسلسلة تم إدراجها في أربع عمليات متتابعة وهي: "تقييم جدوى مشروع إعادة الاستخدام المتكيف" ، "تصميم مشروع إعادة الاستخدام المتكيف" ، "تشيد مشروع إعادة الاستخدام المتكيف" ، و "تشغيل وصيانة مشروع إعادة الاستخدام المتكيف". تم استخدام منهجية تعريف التكامل لنموذج الوظيفة (IDEF₀) لتمثيل الإطار المطور في سياق تخطيطي.

تم تحقيق الهدف الثالث من خلال إجراء استبيان استقصائي وجهاً لوجه على ثلث عينة الإستبيانات الإستقصائية الثالثة الأولى التي أجريت من أجل تقييم العوامل ، حيث تمت مقابلة عشرة مهندسي إستشارات هندسية و عشرة مقاولين و عشرة ممارسين لمهنة إدارة المنشآت ؛ وذلك لتقييم وظائف الإطار من ناحية أهميتها وتنفيذها في الممارسة المهنية لمشروعات إعادة الاستخدام المتكيف للمباني. بشكل عام أظهرت نتائج هذا الاستبيان إلى وجود معدلات أهمية كبير للوظائف التي يحتويها الإطار بالإضافة إلى معدلات مقبولة من الناحية التنفيذية. كما أظهرت ردود المجيبين على إستبيان التحقق من الصحة إلى أن لاعتماد الإطار قدرة على تحسين ممارسة مشاريع إعادة الاستخدام المتكيف للمباني بالمملكة العربية السعودية.

CHAPTER 1:

INTRODUCTION

1.1 Overview

This chapter covers the background, problem statement, research goal and objectives, scope and limitations, and research significance. In addition, this chapter also explains the research methodology followed in this thesis. Finally, the organization of the thesis is explained in end of this chapter.

1.2 Background

Building adaptive reuse is referred to the concept of “Adaptation”, which means “change of use” of the original function of an existing structure and its fabric, so that extending its useful life (Wilkinson et al., 2014). Adaptive reuse can be considered as the process of converting the use of a building, to fulfill a change in its function, according to the requirements of new or current owner. The changes might consist of refurbishment and/or full renovation of the building/structure (Bullen, 2007). There are three levels of building adaptation, namely: adaptation with the same use (i.e. no change in the original use), adaptation with mixed use (i.e. additional functions will be added while keeping the current use as it is) and adaptation with a totally new use (i.e. a substantial change in the original use of the building) (Mİsİrlİsoy and Günçe, 2016).

Previous studies on adaptive reuse of building have focused on potentiality, measuring the adaptability, and modeling the knowledge for decision-making process (Agha and Kamara, 2017; Arge, 2005; Bullen and Love, 2011a, 2011c; Conejos et al., 2013; Langston et al., 2008; Mİsİrİlİsoy and Günçe, 2016). These studies indicated that adaptive reuse of buildings presents an effective strategy for sustaining and leveraging the heritage, historic, abandoned, vacant, and obsolete buildings (Bullen and Love, 2009, 2011b; Conejos et al., 2016, 2013; Li and Tsai, 2017b, 2017a; Mİsİrİlİsoy and Günçe, 2016; Petković-Grozdanovića et al., 2016; Riggs and Chamberlain, 2018; Sofiana et al., 2015; Sugden, 2017; Tam et al., 2016; Wilkinson, 2012b; Zivkovic et al., 2016).

Different issues could be addressed as well as several acquired advantages could be realized through the implementation of building adaptive reuse, including: economic, environmental, and social benefits (Remøy and Voordt, 2007). The economic advantages of adaptive reuse could be achieved in different ways. For instance, reusing an existing facility is cheaper than the cost of constructing a new building (Velthuis and Spennemann, 2007). In term of the environmental benefits, advantages can be realized in the scale of the building as well as the community. This can be seen in the amount of the possible saving in the use of the other types of project resources, where adaptive reuse of building requires less consumption of materials, energy and transportation (Bullen and Love, 2011c). For the social benefits, there are several positive outcomes of building adaptive reuse can be reflected on the societies (Remøy, 2010). For example, adaptive reuse offers the opportunity to preserve the identity of the old cities and revive them, through converting the use of their current buildings to another attractive uses (Sofiana et al., 2015; Zivkovic et al., 2016).

However, the review of the published literature revealed the gap in the knowledge about the building adaptive reuse within the context of the project life-cycle. There is a lack on the documentation of all necessary activities, information and tools in the planning, design, construction, and operation and maintenance of adaptive reuse projects. In addition, an understanding of the relation among the different parties involved the adaptation process was lacked in the literature (Heidrich et al., 2017). Accordingly, this study aimed to respond to all these research gaps.

1.3 Problem Statement

Building are viewed as long-term investments by their owners (Alexander, 2013). During their service life, buildings may become obsolete due to a decline in their usefulness to carry out their original functions, or in their market value. Further, buildings could also be redundant because of the changes in market demand (Langston and Lauge-Kristensen, 2002). Adaptive reuse of existing buildings to different uses could provide an opportunity to building owners to revive the value of their investments (Rayman et al., 2017; Shen and Langston, 2010). Adaptive reuse is the process of renovating, or rehabilitating, an existing building, to fulfill an alteration in its functional context, so that introducing a totally new use within its fabric (Agha and Kamara, 2017; Bullen and Love, 2011a). This process involves the development of new design, as well as the execution of that design according to the requirements demanded for the new use (Kurul, 2007; Wilkinson et al., 2014). The practice of adaptive reuse of buildings in Saudi Arabia has been taking place over the last 3 decades (examples are listed in **Appendix A**), in the absence of technical frameworks that can be used to guide the various stakeholders of these projects on their effective implementation (Al-ghamdi, 2011; Elbelkasy et al., 2015; Orbasli, 2009).

Therefore, a set of the influential factors needs to be identified and considered during the different phases of the life-cycle of the adaptive reuse projects (Bullen and Love, 2011c; Hong and Chen, 2017; Wilkinson et al., 2014). The life-cycle of adaptive reuse projects is similar to that of new building projects (Manewa et al., 2016; Webb et al., 2015), as it encompasses the various phases of planning, design, construction (execution), and operation and maintenance. Knowledge about the factors influencing the process of building adaptive reuse, during the various project phases, will contribute effectively towards their successful implementation (Alauddin, 2014; Nwachukwu et al., 2017; Remøy and Voordt, 2007).

The review of the published literature indicated that the factors influencing the process of implementing building adaptive reuse, throughout the project life-cycle, have not been identified and assessed in a holistic manner. The review of literature revealed that various research outputs that addressed these factors have focused on particular phases within the life-cycle of adaptive reuse projects, namely the planning phase (Bullen and Love, 2011c); the design phase (Arge, 2005; Conejos et al., 2016); the construction phase (Ernest et al., 2016; Hein and Houck, 2008; Kincaid, 2002; Watson, 2009); and the operation and maintenance phase (Al-obaidi et al., 2017; Fournier and Zimmnicki, 2004). This gap necessitates the need for identifying and assessing the significance of these factors, so that planners, design professionals, contractors and facilities managers will gain the benefits of timely completions, controlled expenditures, and enhanced quality.

Moreover, the findings of the reviewed literature, as well as observed current practice have demonstrated the need for practical guidelines and that guide the project stockholders, including planners, design professionals, contractors and facilities managers, on the

effective implementation of the building adaptive reuse throughout the project life-cycle. Therefore, this thesis aims to develop a generic framework focus on the comprehensive process of building adaptive reuse during the various phases of their life-cycle. The framework would serve to identify the activities that needs to be performed at each phase, the data necessary to perform these activities and the constraints controlling the activities.

1.4 Research Goal

The goal of this research is to develop a generic framework that guides the professionals involved in the different phases of the life-cycle of the adaptive reuse project, namely: conceptual planning and feasibility studies, design and engineering, construction, and operation and maintenance (O&M) phases.

1.5 Research Objectives

The objectives of the research are as follows:

1. To identify and evaluate the factors affecting the implementation of adaptive reuse of buildings throughout the project life-cycle.
2. To develop a framework of the process of adaptive reuse of buildings throughout the project life-cycle.
3. To validate the developed framework through conducting interviews with a selected sample of design professionals, contractors and facilities managers in the Eastern Province of Saudi Arabia.

1.6 Scope and Limitations

Scope and limitations of this research were formulated as the following:

- The assessment of the factors influencing the implementation of building adaptive reuse, as well as the interviews with AEC/FM (architecture, engineering, contradiction and facilities management) practitioners, was limited those practicing in the Eastern Province of Saudi Arabia.
- The development of the framework for the effective implementation of building adaptive reuse throughout the project life-cycle was limited to the knowledge obtained from the literature as well as the observed local practices.

1.7 Research Significance

The research significance stems from the follows:

- The study has the potential to support the effective implementation of building adaptive reuse, through identifying the factors that have an impact on it throughout its life-cycle.
- The study provides a framework that has the potential to guide the various stakeholders involved in the life-cycle of adaptive reuse projects.
- The study has the potential to offer the various stakeholders of adaptive reuse projects, with the benefits of timely completions, controlled expenditures, and enhanced quality.

1.8 Research Methodology

In order to achieve the research objectives, the adopted design of the research methodology comprises five main phases as shown in **Figure 1.1**. These phases were organized as follows:

1. Identification of the factors affecting the implementation of building adaptive reuse throughout the project life-cycle.
2. Assessment of the identified factors affecting the implementation of building adaptive reuse throughout the project life-cycle.
3. Identification of adaptive reuse functions and their interactions across the project life-cycle, using IDEF₀ methodology.
4. Validation of the developed framework for the effective implementation of building adaptive reuse.
5. Formulation of conclusions, recommendations and areas for future research.

Each phase served to accomplish a milestone of the research. Thus, *Phase 1* and *Phase 2* served to achieve the first objective of the research. *Phase 3* served to achieve the second research objective. *Phase 4* and *Phase 5* served to achieve the third research objective. Each phase employed a set of activities that were needed for accomplishing its relevant objective (**Figure 1.1**).

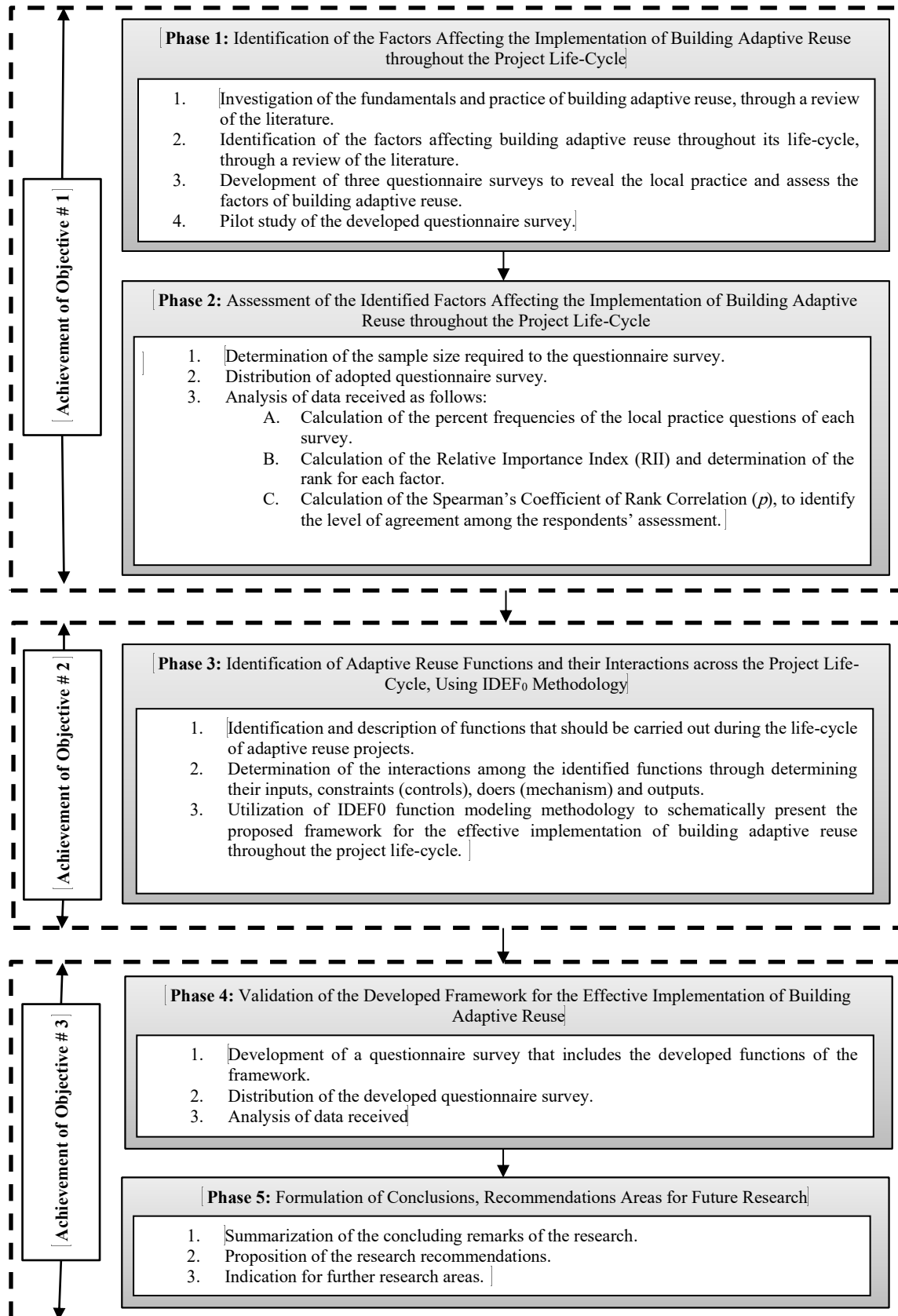


Figure 1.1: The adopted design of the research methodology

1.8.1 Phase 1: Identification of the Factors Affecting the Implementation of Building Adaptive Reuse throughout the Project Life-Cycle

This phase was intended to identify the factors influencing the building adaptive reuse throughout the phases of the project life-cycle, namely: planning, design, construction (execution), operation and maintenance (O&M) phases. The accomplishment of this phase was achieved through performing the following activities:

1.8.1.1 Investigation of the Fundamentals and Practice of Building Adaptive Reuse, through a Review of the Literature

A literature review on concepts, terminologies and practice of building adaptive reuse and their relevant practices was carried out, to comprehend the theoretical backgrounds of the research. It covered a review of research papers, proceedings textbooks, guidelines and handbooks pertaining to the theories and practice of building adaptive reuse.

1.8.1.2 Identification of the Factors Affecting Building Adaptive Reuse throughout its Life-Cycle, through a Review of the Literature

Based on the conducted review of literature, a preliminary identification of the factors affecting building adaptive reuse throughout the project life-cycle was carried out. The selected grouping and terms of the factors was based on the performed review of literature as well. The factors were grouped in a phase-based categorization of the traditional building life-cycle. Hence, they were categorized under four main groups, namely: factors related to the conceptual planning and

feasibility studies, design and engineering, construction, and operation and maintenance (O&M) phases.

1.8.1.3 Development of Three Questionnaire Surveys to Reveal the local Practice and Assess the Factors of Building Adaptive Reuse

Based on the investigated terminologies and practice of building adaptive reuse as well as the identified factors, three questionnaire surveys were developed for the three groups of professionals who are usually involved in the adaptive reuse life-cycle. These groups included the architect/engineer (A/E), contractors and facilities managers. Each questionnaire survey comprised four sections, namely: *Section (A)*, *Section (B)*, *Section (C)* and *Section (D)*, respectively (See **Appendices B - C**).

Section (A): Included an overview of the survey as well as demographic questions regarding the general information of the respondents. These demographic questions asked each respondent about his/her name, organization, organization address, phone, email address, number of years of experience and position/job title.

Section (B): included a set of questions aimed to reveal the local practice of building adaptive reuse. In each of the three questionnaire surveys, his section offered an open question that asked the respondents to express his/her experience in adaptive reuse questions. The rest of this section included multiple-answer questions. The purpose of these multiple-answer questions was to quantify the proportion of the frequency of all possible determinants of different considerations surrounding the practice of building adaptive reuse. These considerations covered the information needed in adaptive reuse projects within the respondent's scope of work, applicable

challenges, building systems and components that are usually influenced in these projects, methods and/or techniques to enhance the practice of these projects in the respondent's professional domain, and other considerations related to the involved parties and source of information gathering.

Section (C): Included the list of the factors that were identified and formulated based on the carried-out review of literature. Further, the factors were listed in accordance with the adopted categorization which was in the sequence of the four phases of the traditional life-cycle, namely: conceptual planning and feasibility studies phase, design and engineering phase, construction phase, and operation and maintenance (O&M) phase. This section asked the respondents to rate the importance level of each factor, based on a 5-point Likert scale rating system, as follows: "Extremely Important", "Very Important", "Important", "Somewhat Important" and "Not Important". This section also allowed respondents to mention additional factors under each phase or independently in the end of the developed list.

Section (D): This section was an optional part that enabled the respondents to add any remarks that would benefit the researcher, or any additional comments about the developed questionnaire survey.

1.8.1.4 Pilot Study of the Developed Questionnaire Survey

A pilot study was conducted on the established three questionnaire survey through the consultation of fifteen practitioners from three professional domains, five practitioners from each domain, as follows: five Architectural/Engineers (A/E), five contractors, and five facilities managers. The pilot study was conducted with the practitioners who had at least five years of experience, as previous experience on adaptive reuse projects or major remodeling projects. The pilot study aims at:

- Ensuring the adequacy of questions
- Identifying and removing any ambiguities
- Improving the clarity of the factors and enhancing their readability
- Adding more relevant factors and removing redundant factors
- Determining the time needed to answer the survey

1.8.2 Phase 2: Assessment of the Identified Factors Affecting the Implementation of Building Adaptive Reuse throughout the Project Life-Cycle

This phase was intended to process and analyze the received data, and present the results of the assessment obtained from the conducted questionnaire surveys. The results comprised findings of the local practice questions as well as the factors evaluation. The accomplishment of this phase was achieved through the performing following activities:

1.8.2.1 Determination of the Sample Size Required to the Questionnaire Surveys

The sample size required to respond to the questionnaire survey was calculated for the three professional domains, namely: Architectural/Engineering (A/E) organizations, construction organizations, and facilities management (FM) organizations. Data on the registered organizations in each professional domain was obtained from Asharqia Chamber of Commerce (the chamber of commerce and industry in the Eastern Province of Saudi Arabia).

Kish (1995) formulas (**Equations 1.1 and 1.2**) were applied to estimate the sample size of each of the three professional domains, as follows: (Kish, 1995)

$$n_o = \frac{(p \times q)}{(V^2)} \dots\dots\dots \textbf{(Equation 1.1)}$$

$$n = \frac{n_o}{[1+(n_o/N)]} \dots\dots\dots \textbf{(Equation 1.2)}$$

Where:

n_o: First estimate of the size sample

p: Population of the characteristic being measured in the target population

q: Completion of *p* or 1-*p*

V: Maximum percentage of allowable standard error (10% for this study)

n: Sample size

N: Population size

Note: To maximize the sample, both *p* and *q* are each set at 0.5

The below are the performed calculations for determining the required sample size of each professional domain:

A. Determining the required sample size from the A/E domain

According to Asharqia Chamber of Commerce, the total number of registered A/E organizations is 50. Data and information of the 50 A/E organizations are available. Thus, the required sample size of respondents from the A/E domain was determined as follows:

$$\text{First estimate of sample size } (n_0) = \frac{(p \times q)}{(V^2)} = n_0 = \frac{(0.5 \times 0.5)}{(0.1^2)} = 25 \text{ respondents}$$

$$\text{Sample size } (n) = \frac{n_0}{[1 + (n_0/N)]} = \frac{25}{[1 + (25/50)]} = 16.66 \approx 17 \text{ respondents}$$

However, the research aimed at collecting and analyzing 30 ($n = 30$) valid responses from the A/E domain, for more reliability.

B. Determining the required sample size from the construction domain

According to Asharqia Chamber of Commerce, the total number of registered construction organizations is 609. Out of the 609 construction organizations, data and information on 200 of these organizations are available. Thus, the required sample size of respondents from the construction domain was determined as follows:

$$\text{First estimate of sample size } (n_0) = \frac{(p \times q)}{(V^2)} = n_0 = \frac{(0.5 \times 0.5)}{(0.1^2)} = 25 \text{ respondents}$$

$$\text{Sample size } (n) = \frac{n_0}{[1 + (n_0/N)]} = \frac{25}{[1 + (25/200)]} = 22.22 \approx 23 \text{ respondents}$$

However, the research aimed at collecting and analyzing 30 ($n = 30$) valid responses from the construction domain, for more reliability.

C. Determining the required sample size from the facilities management (FM) domain

According to Asharqia Chamber of Commerce, the total number of registered building O&M organizations is 519. Out of the 519 building O&M organizations, data and information on 200 of these organizations are available. Thus, the required sample size of construction domain was determined as follows:

$$\text{First estimate of sample size } (n_o) = \frac{(p \times q)}{(V^2)} = n_o = \frac{(0.5 \times 0.5)}{(0.1^2)} = 25 \text{ respondents}$$

$$\text{Sample size } (n) = \frac{n_o}{[1 + (n_o/N)]} = \frac{25}{[1 + (25/200)]} = 22.22 \approx 23 \text{ respondents}$$

However, the research aimed at collecting and analyzing 30 ($n = 30$) valid responses from the building O&M domain, for more reliability.

1.8.2.2 Distribution of the Adopted Questionnaire Survey

The distribution and collection of the questionnaire surveys were conducted among the three main professional domains, located in the Eastern Province of Saudi Arabia. Most of the questionnaire surveys were conducted through holding face-to-face-based interview sessions with the respondents. However, some questionnaire surveys were conducted through phone calls. **Appendix E** illustrates the list of respondents who have participated in the conducted questionnaire surveys.

1.8.2.3 Analysis of Data Received

The data received from the conducted questionnaire surveys were analyzed in this activity. This activity was performed through conducting the following processes:

A. Calculation of the percent frequencies of the local practice questions of each survey

The calculation of the percent frequency of each choice included in the multiple-answer questions, for all local practice questions in the three questionnaire surveys, was carried out. The purpose of this process was to quantify the proportion of the frequency of all given choices in the multiple-answer questions. The utilized software for calculating the percent frequency was Microsoft Excel 365 (Version 2016). **Equation 1.3** was used to calculate the percent frequency of each choice (Anderson et al., 2015).

$$\text{Percent frequency} = \frac{\text{Frequency of the class}}{n} \times 100 \dots\dots\dots (\text{Equation 1.3})$$

Where:

Frequency of the class: Number of responses of each choice

n: Total number of respondents

B. Calculation of the Relative Importance Index (RII) and determination of the rank for each factor

The calculation of the Relative Importance Index (RII) was carried out to determine the significance of the assessed factors based on the respondents' feedback. The utilized software for calculating the RII was Microsoft Excel 365 (Version 2016). **Equation 1.4** was applied to achieve this step (Dominowski, 1980).

$$\text{Relative Importance Index (RII)} = \frac{\sum_{i=0}^4 (a_i)(x_i)}{(4 \sum x_i)} \times 100 \dots\dots\dots (\text{Equation 1.4})$$

Where:

i : Response category index where $i = 0,1,2,3,4$

a_i : Weight given to i response where $i = 0,1,2,3,4$

x_i : is the variable expressing the frequency of i

Each importance level has been given a variable expressing its frequency (x_i), to indicate its significance. A specific weight (a_i) for each importance level was given as well (**Table 1.1**). Thus, the identification of the importance rate of each factor was based on the received RII value, as well as the adjusted scale presented in **Table 1.1**.

The identification of the rank of each factor was based on the calculated RII as well. The factors were ranked in a descending order, relying on the calculated RIIs. This implies that the factor with highest RII was ranked first, and so on for the rest of factors.

Table 1.1: The adopted variables expressing the frequency, weights, and importance rates for all importance levels used in the assessment of the factors

Importance Level	Variables Expressing the Frequency (x_i)	Weight (a_i)	Importance Rate
“Extremely Important”	x_0	4	87.5 - 100%
“Very Important”	x_1	3	62.5 -< 87.5%
“Important”	x_2	2	37.5 -< 62.5%
“Somewhat Important”	x_3	1	12.5 -< 37.5%
“Not Important”	x_4	0	0 -< 12.5 %

C. Calculation of the Spearman's Coefficient of Rank Correlation (p)

Spearman's coefficient of rank correlation was calculated to determine the level of agreement among the involved three groups of respondents, in term of the correlation among the ranks of the factors received in the three questionnaire surveys. In order to have a comprehensive analysis of the agreement among the three groups of respondents, the calculation of the Spearman's coefficient of rank correlation was carried out on the following paired comparisons: A/E and contractors, A/E and FM, and Contractors and FM. **Equation 1.5** was used to calculate the Spearman's coefficient of rank correlation (Fellows and Liu, 2015).

$$p = 1 - \frac{6 \sum D^2}{N(N^2-1)} \dots\dots\dots \textbf{(Equation 1.5)}$$

Where:

p : Spearman's coefficient of rank correlation

$\sum D^2$: Sum of the squared differences in ranks of the paired comparisons

N : Number of parameters for which the ranking in made

A subjective interpretation of the level of correlation was adopted from a previous research, to identify the level of correlation of each paired comparison. **Table 1.2** illustrates the adopted interpretation for identifying the level of correlation among paired the comparisons relaying on the calculated Spearman's coefficients of rank correlation (Mukaka, 2012).

Table 1.2: The adopted interpretation for identifying the level of correlation among paired the comparisons relaying on the calculated Spearman’s coefficients of rank correlation

Interpretation	Size of Correlation
“Very High Positive Correlation”	0.90 to 1.00
“High Positive Correlation”	0.70 to 0.90
“Moderate Positive Correlation’	0.50 to 0.70
“Low Positive Correlation”	0.30 to 0.50
“Negligible Correlation”	0.00 to 0.30
“Negligible Correlation”	-0.30 to 0.00
“Low Negative Correlation”	-0.50 to - 0.30
“Moderate Negative Correlation’	-0.70 to - 0.50
“High Negative Correlation”	-0.90 to - 0.70
“Very High Negative Correlation”	-1.00 to - 0.90

1.8.3 Phase 3: Identification of Adaptive Reuse Functions and their Interactions across the Project Life-Cycle, Using IDEF₀ Methodology

This phase was intended to develop a framework for the effective implementation of building adaptive reuse throughout the project life-cycle. Thus, the identification of the functions and their interaction was the core of this phase, in addition to the determination of the inputs, controls, mechanisms and outputs of each function. The development of the framework was accomplished in line with the knowledge obtained from the reviewed literature, investigated local practice and findings of the factors’ assessment. The accomplishment of this phase was achieved through performing the following activities:

1.8.3.1 Identification and Description of Functions that should be Carried Out during the Life-Cycle of Adaptive Reuse Projects

The identification and formulation of the description of all functions involved in the framework were carried out in this activity. The identification and description of the processes and framework functions included in the framework were carried out, according to the findings of the review of literature and results of the two sections of included in the questionnaire surveys, namely: local practice questions and factors assessment.

1.8.3.2 Determination of the Interactions among the Identified Functions through Determining their Inputs, Constraints (Controls), Doers (Mechanism) and Outputs

The determination of the relationships and interactions among the identified functions was carried out in this activity. The fulfillment of this activity was performed based on three considerations, namely: knowledge gained from the reviewed literature, findings revealed from the conducted questionnaire surveys, and the four determinants of any function represented in the IDEF₀ (Integration Definition for Function Modeling) methodology. The four determinants are: *inputs*, *constraints (controls)*, *outputs* and *doers (mechanism)* was a substantial process. The follows are brief descriptions of the four elements of an IDEF₀ function (FIPS OUP 183, 1993):

- Inputs: Include data and/or objects that are converted by the function into outputs.
- Controls: Include conditions that are needed to produce the correct outputs.
- Output: Include data and/or objects that are produced by a function.
- Mechanism: Include means that are utilized to perform a function.

1.8.3.3 Utilization of IDEF₀ Function Modeling Methodology to Schematically Present the Proposed Framework for the Effective Implementation of Building Adaptive Reuse throughout the project Life-Cycle

The schematic modeling of the proposed framework was carried out in this activity. In this regard, IDEF₀ methodology was utilized for the schematic representation of the identified framework functions, comprising their interactions.

Figure 1.2 presents the adopted IDEF₀ standard for representing the relation and interaction between functions and their input, controls, outputs and mechanism (FIPS OUP 183, 1993). The follows are the main rules of developing an IDEF₀ model (FIPS OUP 183, 1993; Šerifi et al., 2009):

1. Each function should be presented in a syntax box, where the box should be rectangular as well as illustrates the title and code/number of the function.
2. All function determinants, namely: inputs, controls, outputs and mechanism, should be represented in the standard arrow system of the IDEF₀.

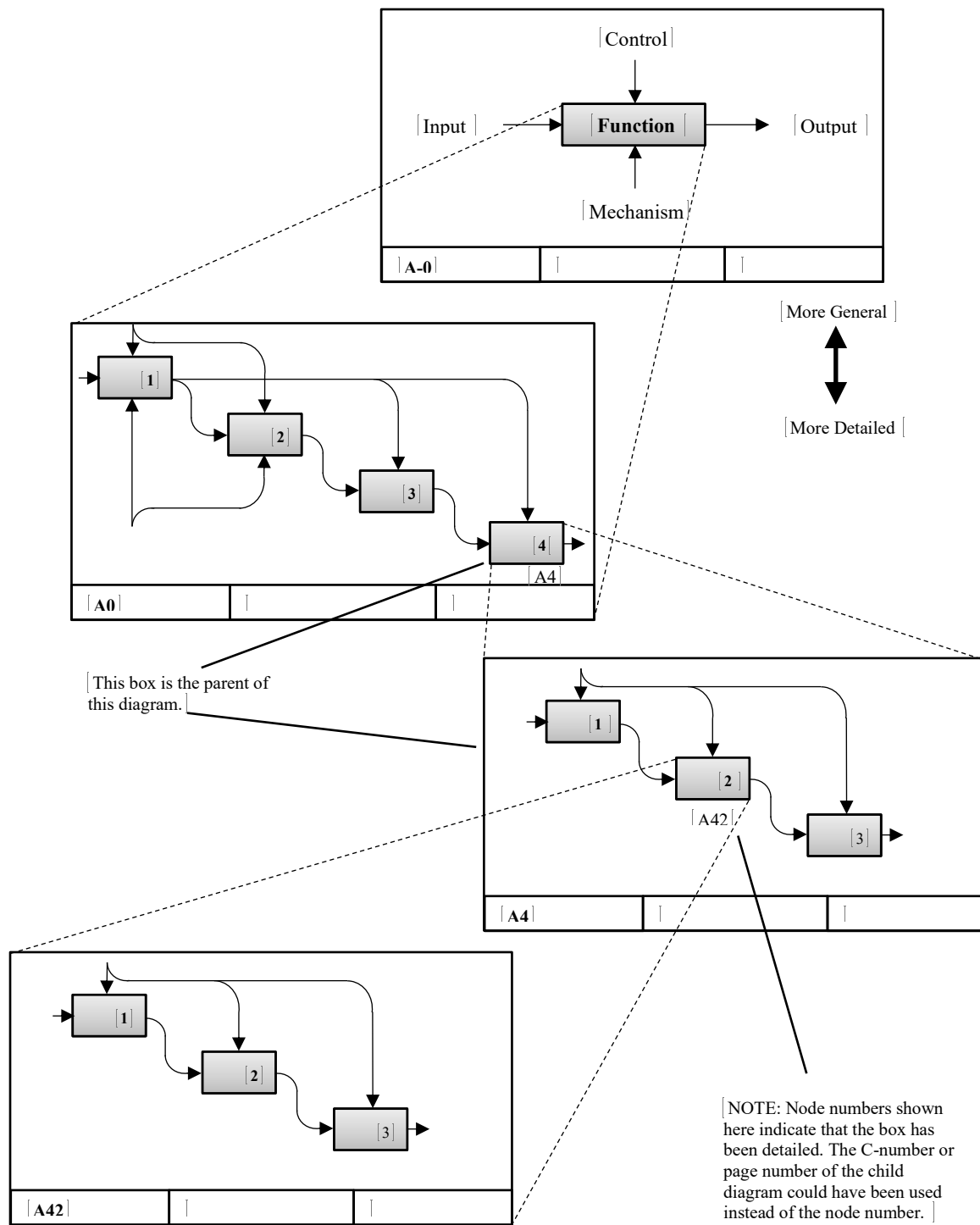


Figure 1.2: The adopted IDEF₀ standard for representing the relation and interaction of functions and their input, controls, outputs and mechanism

Source: Federal Information Processing Standards Publication: Integration Definition for Function Modeling (IDEF₀) (FIPS OUP 183, 1993).

3. Inputs' arrows should be perpendicular to the box from the left side.
4. Controls' arrows should be perpendicular to the box from the upper side.
5. Outputs' arrows should be going out from the right side of the syntax box, in a perpendicular and horizontal manner.
6. Mechanisms' arrows should be drawn in an upward direction, and perpendicular to the syntax box from the bottom side.
7. All sequenced syntax boxes should be connected through a curved arrow.
8. The horizontal and vertical segments of the curved arrows should be drawn in a 90° degree angle.
9. The curve of the curved arrows should be also drawn as arc, with an angle of 90° degree.
10. Number of connected functions/processes (syntax boxes) should not be more than six, as well as not less than three boxes.

1.8.4 Phase 4: Validation of the Developed Framework for the Effective Implementation of Building Adaptive Reuse

This phase was intended to check the validity of the developed framework for the effective implementation of building adaptive reuse across the project life-cycle. The accomplishment of this phase was achieved through performing the following activities:

1.8.4.1 Development of a Questionnaire Survey that Includes the Developed Functions of the Framework

The development of a questionnaire survey, for validating the developed framework, was carried out in this activity. For a comprehensive validation, the developed questionnaire survey aimed to assess the importance rate as well as frequency of implementing all identified functions. The validation questionnaire survey consisted of four sections, (A), (B) (C), and (D), respectively (**Appendix F**).

Section (A): Included s summary of the questionnaire survey, as well as demographic questions pertaining to the general information of the respondents' profile. These questions covered the respondent name, organization, organization address, phone, email address, number of years of experience and position/job title.

Section (B): Included the list of the identified functions of the proposed framework, where they were ordered according to the phases of the traditional life-cycle of building projects. This section aimed to assess the importance rate as well as the frequency of implementing each function involved in the developed framework. Thus, the assessment of the rate of importance and implementation frequency was accomplished through the adoption of a 5-point Likert scale rating technique. For the assessment of the importance, respondents were asked to rate the importance of each function, as such as done in the assessment of the factors. Thus, each respondent was asked to choose one of the following rates for each function: "Extremely Important", "Very Important", "Important", "Somewhat Important" and

"Not Important". Regarding the assessment of the frequency of implementation, respondents were asked to rate the level carrying out each function involved in the framework, according to their professional practice of building adaptive reuse. In this regard, each respondent was asked to choose one of the following rates for each function: "Always", "Frequently", "Sometimes", "Seldom" and "Never"

Section (C): Included the list of the schematically developed IDEF₀ diagrams for the framework. The purpose of this section was to enable the respondents to have an insight on the identified functions and their interactions and related elements. Further, it enabled the respondents to propose further improvements on the developed framework.

Section (D): Included a blank page, optional part, that enabled the respondents to add any further remarks that would benefit the researcher, or any additional comments about the developed questionnaire survey.

1.8.4.2 Distribution of the Developed Questionnaire Survey to Determine the Importance and Practicality of the Framework Functions

The distribution and collection of the questionnaire survey were carried out among a selected sample of 30 of adaptive reuse practitioners, working at architecture, engineering, construction and facilities management (AEC/FM) professions in the Eastern Province of Saudi Arabia. All questionnaire surveys were conducted through holding face-to-face-based interview sessions with the respondents. **Appendix G** illustrates the list of respondents who have participated in the validation questionnaire survey.

1.8.4.3 Analysis of Data Received

The data received from the conducted validation questionnaire surveys were analyzed in this activity. This activity was performed through carrying out the following processes:

A. Calculation of the Relative Importance Index (RII) for each function

The calculation of the Relative Importance Index (RII) for each function was carried out in this process, as performed in the assessment of the importance of the factors in phase 2 (see section 1.8.2.3). **Equation 1.4** was employed to calculate the RII for each function. The interpretation of the importance rate of each function was performed according to the illustrated adjustments in **Table 1**.

B. Calculation of the Frequency Index (FI) for each function

The calculation of the Frequency Index (FI) was carried out in this process, to determine the frequency rate of implementing each function involved in the developed framework. Microsoft Excel 365 (Version 2016) was employed for calculating the FI for each function involved in the framework. **Equation 1.6** was applied to achieve this step (Dominowski, 1980).

$$\text{Frequency Index (FI)} = \frac{\sum_{i=0}^4 (a_i)(X_i)}{(4 \sum X_i)} \times 100 \dots\dots\dots \text{(Equation 1.6)}$$

Where:

i: Response category index where $i = 0,1,2,3,4$

a_i: Weight given to *i* response where $i = 0,1,2,3,4$

x_i: is the variable expressing the frequency of *i*

Each frequency level has been given a variable expressing its frequency (x_i), to indicate its rate of implementation in the profession. A specific weight (a_i) for each frequency level was given as well (**Table 1.3**). Thus, the identification of the frequency of implementing each function was based on the received FI value, as well as the adjusted scale presented in **Table 1.3**.

Table 1.3: The adopted variables expressing the frequency, weights, and frequency rates for all levels used in the assessment of the functions' implementation

Frequency Level	Variables Expressing the Frequency (x_i)	Weight (a_i)	Frequency Rate
"Always"	x_0	4	87.5 - 100%
"Frequently"	x_1	3	62.5 -< 87.5%
"Sometimes"	x_2	2	37.5 -< 62.5%
"Seldom"	x_3	1	12.5 -< 37.5%
"Never"	x_4	0	0 -< 12.5 %

1.8.5 Phase 5: Formulation of Conclusions, Recommendations and Areas for Future Research

This phase was intended to state the conclusions, recommendations and areas for future research. The accomplishment of this phase was achieved through performing the following activities:

1.8.5.1 Summarization of the Concluding Remarks of the Research

Summarization of the findings in a form of concluding remarks that answer the research objective was performed in this activity. This implies that concluding remarks were formulated and presented in a sequential manner according to the followed research methodology.

1.8.5.2 Proposition of the Research Recommendations

Proposition of research recommendations was performed in this activity. The recommendations were proposed based on the formulated concluding remarks. These recommendations were directed to the literature, professional domains and entities concerned in the practice of adaptive reuse projects.

1.8.5.3 Indication for Further Research Areas

Indication for further research areas was performed in this activity. This was based on the limitation of the study, review of literature and research findings.

1.9 Organization of Thesis

The adopted organization of this thesis comprised eight chapters which was in line with the sequence of the research objectives and methodology. These chapters were developed as follows:

Chapter 1: Introduction

This chapter covers a research background, problem statement of the research, research goal and objectives, scope and limitation, research significance, research methodology, and organization of thesis.

Chapter 2: Review of Literature

This chapter covers theoretical background regarding to fundamentals and terminologies of this research. It covers the following topics: traditional building life-cycle, concepts of modifications conducted on existing buildings, the practice of adaptive reuse of building,

and the concept of building performance and building performance assessment process. It also covers a review of previously published studies that are relevant to this research. Based on the reviewed topics and studies, the chapter presents a preliminary identification of the factors affecting building adaptive reuse throughout the project life-cycle.

Chapter 3: Local Practice of Building Adaptive Reuse

This chapter presents the pattern of the practices of adaptive reuse of buildings in Saudi Arabia, in terms of the planning, design, construction and operation of these projects.

Chapter 4: Description of the Factors Affecting Building Adaptive Reuse throughout the Project Life-Cycle

This chapter presents a description of the identified factors that influence the building adaptive reuse throughout the phases of the project life-cycle, including the planning, design, construction (execution) and O&M phases.

Chapter 5: Assessment of the Factors Affecting Building Adaptive Reuse throughout the Project Life-Cycle

This chapter presents the analysis of data received from the questionnaire surveys that were conducted on the three professional domains, namely: A/E, contactors, and facilities managers.

Chapter 6: Development of a Framework for the Effective Implementation of Building Adaptive Reuse throughout the Project Life-Cycle

This chapter presents the established framework that contributes to the effective implementation of building adaptive reuse throughout the project life-cycle.

Chapter 7: Validation of the Developed Framework for the Effective Implementation of Building Adaptive Reuse throughout the Project Life-Cycle

This chapter presents the process of validating the developed framework by local practitioners who were involved from the A/E, construction and facilities management domains.

Chapter 8: Conclusions, Recommendations and Areas for Future Research

This chapter covers concluding remarks, recommendations and areas for future researches.

CHAPTER 2:

REVIEW OF LITERATURE

2.1 Overview

This chapter covers a literature review on the fundamentals, theoretical background and previous studies that are relevant to the context of building adaptive reuse. Four relevant topics are presented in this chapter, namely: the traditional building life-cycle, concepts of modifications conducted on existing buildings, the practice of adaptive reuse of building, and the concept of building performance and building performance assessment process. The chapter also presents a review of a set of previously published studies that are in the context of building adaptive reuse. Based on the presented fundamentals, theoretical background and previous studies, the chapter presents a preliminary identification of the factors affecting building adaptive reuse throughout the project life-cycle. Finally, the chapter concludes with a summary and discussion on the reviewed literature.

2.2 The Traditional Life-cycle of Building Projects

The implementation of building projects is considered to be among the complex processes in the built-environment. The appropriate integration the project life-cycle is required to reduce the propagation of the unexpected conflicts (Pryke et al., 1997). There are many classifications of the phases of the life-cycle of building projects been documented before. For example, the general pattern of implementing building projects undergoes the following sequence of steps: initiation, execution/development and project termination

(Pinto and Prescott, 1988). Overall, the traditional life-cycle of a building projects is typically consisted of four sequential phases, namely: conceptual planning and feasibility studies, design and engineering, construction, and operation and maintenance (O&M) (Kartam, 1996). During these phases, various parties are involved during these phases, including: designers, engineers, clients and contractors and other stakeholders (Zavadskas et al., 2001). **Figure 2.1** illustrates the traditional life-cycle of building projects (Kartam, 1996).

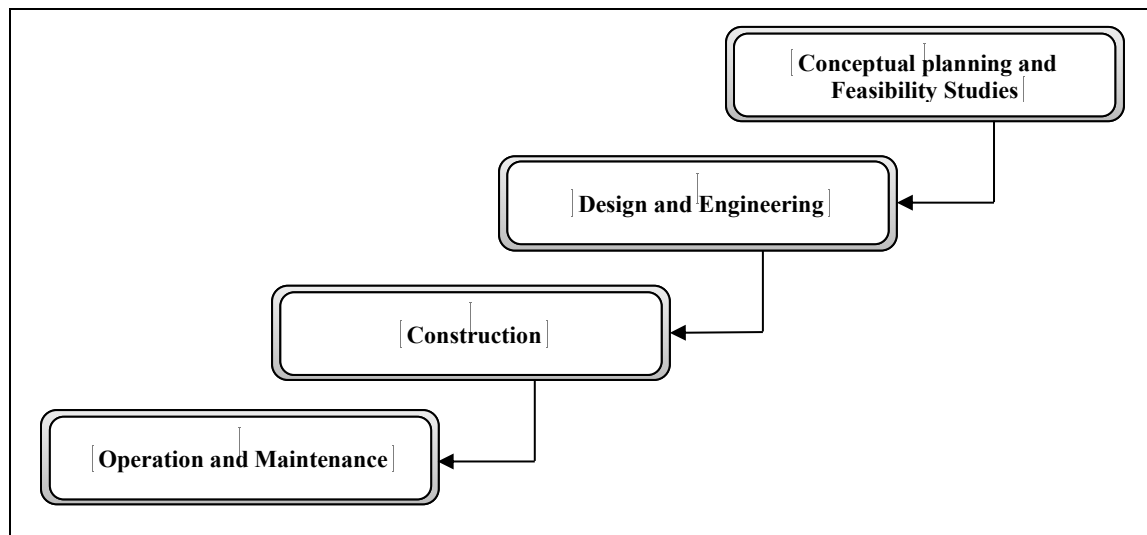


Figure 2.1: The traditional life cycle of building projects

Source: Making effective use of construction lessons learned in project life cycle (Kartam, 1996)

2.2.1 Conceptual Planning and Feasibility Studies

This phase includes a conceptual planning of the building layout (Kartam, 1996). It is considered to be the initial phase of the project, where the feasibility analysis and formulation of the design concept are conducted during this phase (Graham, 2003). Thus, economic, functional and physical constraints are tested in a rigorous manner, in order to improve the solutions and outcomes of this phase. Based on findings these tests, effective

possible design options will be proposed for the subsequent phase (Best and Valence, 2013; Evbuomwan and Anumba, 1998).

2.2.2 Design and Engineering Phase

The development of the architectural, structural, and mechanical, electrical and plumbing systems (MEP) design solutions is carried out in this phase (Evbuomwan and Anumba, 1998). Different parties are involved in this phase, including: client, architects and engineers (Bowen and Edwards, 1996). A set of information and data is needed to be provided in this phase, including client needs, construction site, costs, and requirements of codes and standards (Augenbroe, 1992). Nowadays, advanced tools are used in this phase, such as the computer-aided design (CAD) as well as building information modeling (BIM) (Azhar, 2011).

2.2.3 Construction Phase

The construction phase is mainly concerned with the implementation processes of the building project, including the contractual and executorial operations. The construction of building projects might be carried out directly by the owner, or by a contractor based on an officially signed agreement on the execution services (Nunnally, 2014). Agreements on the executorial services are known as the procurement systems that describe the way of which the project will be established (Dakhli et al., 2017). The construction phase requires the provision and issuance of different types of information, such as the technical blueprints and specifications (Tan et al., 2018). Different parties are involved during the construction phase of building projects, including the contractors, owners, architects, engineers, material dealers, and other suppliers and service providers (Clough et al., 2005). The construction of building projects comprises different field activities, including:

mobilization, site clearing, excavation, and establishment of the structural skeleton (Hinze, 2012). In these activities, several resources need to be managed and efficiently consumed, including labor force, material, equipment and project budget (Froese, 1996).

2.2.4 Operation and Maintenance (O&M) Phase

Operation and maintenance (O&M) phase starts after the completion of the building construction (Kartam, 1996). The O&M phase is typically including all day-to-day activities needed for keeping the performance of the building and its systems in the recommended condition (Ihsan and Alshibani, 2018). Several information and data are needed for in this phase including as-built drawings, manuals of systems, work orders and occupancy information (Tan et al., 2018; Wordsworth, 2001). Facilities managers, occupants and clients are the main parties who are involved in this phase. The adoption of a maintenance strategy is critical action in all modern buildings, for ensuring an efficient management of the available resources (Hassanain et al., 2011). This phase has a vital role in the effectiveness of the life-cycle costs (LCC) of the building, since the implementation of maintenance activities on all systems would enhance their reliability (Wu et al., 2006).

2.3 Concepts of Modifications Conducted on Existing Buildings

There are different types of alterations performed on existing buildings, and mentioned by different terminologies in the literature (Wilkinson et al., 2009). There is an overlap in comprehending and differences among these types of works in a clear manner (Egbu, 1994). Generally, these works are conducted to serve several purposes, such as increasing the efficiency of the resource consumption in of the facility (Máte, 2011). This section explains the common types of the modifications that are conducted on the existing buildings. **Figure 2.2** illustrates the types of modification performed on existing buildings.

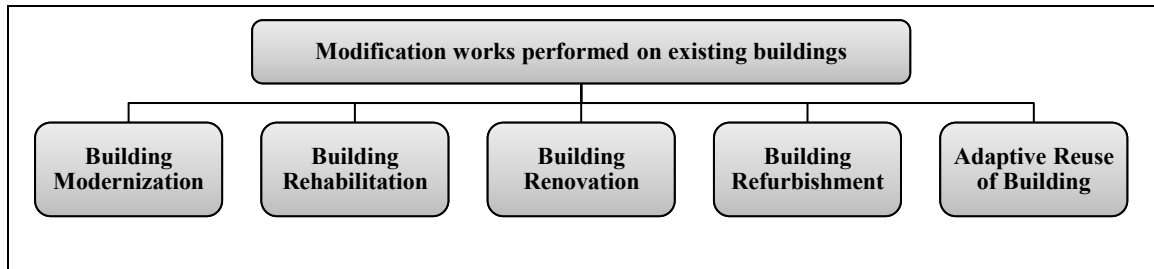


Figure 2.2: Types of modification works performed on existing building

2.3.1 Building Modernization

Building modernization is the process of making the building new in terms of its style and condition. A replacement of the building systems by new items that have the same performance features will be carried out in this context (Downs Jr., 1980). Thus, this process has the potential to enhance the performance and reliability of the built facilities (Adhikary, 2014). Further, implementing this process is also correlated with issues regarding the users' and market demands (Szarejko and Trocka-Leszczynska, 2007).

2.3.2 Building Rehabilitation

Building rehabilitation is the process of renewing the materials, surfaces, equipment in a building, so that it may include the correction of the deteriorated elements without changing the building basic plan (Downs Jr., 1980). Thus, this process is essential to be conducted in old buildings, for the purpose of maintaining their functionality, safety condition and environmental comfort (Carvalho et al., 2015; Highfield, 1987). Hence, implementing rehabilitation can increase the capital value of the buildings (Hui et al., 2008).

2.3.3 Building Renovation

Building renovation is known as the process of repairing or replacing parts within an existing building, in order to recover and/or improve its performance to the original condition or better (Jensen and Maslesa, 2015). Therefore, renovating an old building can enhance the performance of the building, and thus, be operated in a contemporary condition (Jakučionis and Ustinovičius, 2000). Hence, this can lead to improvements in the energy efficiency, indoor environmental quality (IEQ) and the building impact on the environment (Gelfand and Duncan, 2012).

2.3.4 Building Refurbishment

Building refurbishment is the process of modifying the design of a building, through: improving the facilities, rearranging the layout of the internal spaces, and increasing the life-span of the structure by repairing the skeleton (Egbu, 1994). Refurbishment is a sustainable process that can be conducted to rationalize the consumption of resources. It consumes less amount of materials comparing to the process of constructing a new building (Artés et al., 2017; Baker, 2009). It is conducted for many reasons, including repairing damages of disasters, change the building use and expanding the available space in the building (Doran et al., 2009).

2.3.5 Adaptive Reuse of Building

Adaptive reuse is referred to the concept of adaptation, means the “change of use” (Wilkinson et al., 2014). Adaptive reuse is the practice of converting the use of a built-facility, or part of it, into a new use that has a totally different purpose from original one (Iselin and Lemer, 1993). Thus, adaptive reuse may require the implementations of refurbishment and/or full renovation works on the building (Bullen, 2007). It is considered

as a sustainable practice, due to its vital role in maintaining the continuity of the building life-cycle, as well as preventing the destruction of the existing buildings (Mohamed and Alauddin, 2016). Building conversion must be implemented based on an accurate cost estimation, a survey of the new function, as well as an identification of the remodeling activities (Frey, 1979). There are three options of building adaptive reuse, namely: adaptation with the same use, adaptation with a mixed use and adaptation with a totally new function (Mİsİrİlİsoy and Günçe, 2016).

2.4 The Practice of Adaptive Reuse of Building

Adaptive reuse of buildings become a global practice that are taking place in different places around the world (Conejos et al., 2013). Thus, this necessitates the need of comprehending the pattern of the adaptive reuse practices (Wilkinson, 2014). In fact, the context of adaptive reuse of buildings is in line with the concept of sustainable development (Bullen, 2007; Rayman et al., 2017). As a practice, adaptive reuse of buildings contains of a set of drivers, benefits, barriers and challenges that affect its decision-making process (Lardner et al., 2013). These variables are surrounded by different constraints, namely: economic, physical, spatial, legal, social, functional and environmental determinants (Wilkinson et al., 2014). Consequently, this section discusses the issues correlated with the practice of adaptive reuse of buildings.

2.4.1 Drivers and Benefits of Conducting Adaptive Reuse of Building

There are many benefits of building adaptive reuse that drive to its practice in the built environment. They are mainly can be classified into four groups, namely: economic, environmental and social benefits (Kohler and Yang, 2007; Langston, 2012; Wilkinson et

al., 2014). **Table 2.1** illustrates the drivers and benefits of implementing adaptive reuse of buildings, according to the reviewed literature.

Under the economic benefits, there are several drivers affecting the decision of implementing building adaptive reuse projects. One of the economic drivers for implementing these projects is that the cost of converting an existing building is less than the cost of constructing new one (Aigwi et al., 2018; Wilkinson and Reed, 2011). In addition, many investors realize that old buildings have an economic value in the market. Thus, the conversion of these buildings can increase their market value and profitability (Downs Jr., 1980; Frey, 1979). Hence, adaptive reuse is a substantial alternative for vacant facilities (Petković-Grozdanovića et al., 2016; Remøy and Voordt, 2007).

Regarding the environmental benefits, adaptive reuse is a strategy that is in line with the context of sustainable development, due to its potential to protect the stability of the environment and economy, concurrently (Langston, 2008). Adaptive reuse of buildings supports the trend of reducing the emissions of greenhouse gasses, since the built environment is one of the largest consumers of energy (Conejos, 2013b). In another word, adaptive reuse is a sustainable practice to the environment, due to its vital role in reducing the consumption of materials and transportation during the construction of new building projects (Bullen and Love, 2011a).

Under the social benefits, adaptive reuse of building provides the chance to communities for keeping their traditional buildings (Shehata et al., 2015; Wilkinson et al., 2014). In addition, adaptive reuse is a strategy to stimulate the demand of the redundant historic buildings (Velthuis and Spennemann, 2007). It also contributes for reclaiming the

redundant cities (Ball, 2002; Yung et al., 2014). Accordingly, different programs and initiatives were launched to support the practice of building adaptive reuse, such as the City of Los Angeles Adaptive Reuse Program (Behdad, 2006; Bullen and Love, 2009).

Table 2.1 Drivers and benefits of conducting adaptive reuse of buildings

Category	Benefit/Driver	Brief description	References
Economic	Increase yield	Achieve more profits through the new function.	(Downs Jr., 1980; Frey, 1979; Remøy and Voordt, 2014; Wilkinson et al., 2014)
	Save the cost of constructing a new building	Cost of converting an existing building is cheaper than constructing a new building.	(Frey, 1979; Hoxha, 2019; Langston et al., 2008; Wilkinson et al., 2014)
	Reduce the cost of the consumption of resources (money, manpower, etc.)	Adapting an existing building requires less consumption of resources, namely: man, money, material and machine.	(Bullen, 2007; Langston et al., 2008; Wilkinson et al., 2014)
Environmental	Reduce the consumption materials	Quantity of materials needed for converting a building is less than that in the construction of new facility.	(Bullen, 2007; Bullen and Love, 2011c; Wilkinson et al., 2014)
	Reduce the amount greenhouse emissions	Converting an existing building consumes fewer construction materials, and thus, this will lead to fewer greenhouse emissions.	(Bullen, 2007; Bullen and Love, 2011c; Conejos, 2013b; Langston, 2012; Wilkinson, 2012b; Wilkinson et al., 2014)
	Reduce the use of transportation	Resources transported to the site of adaptive reuse projects are less comparing to that of new building projects.	(Bullen, 2007; Bullen and Love, 2011c; Wilkinson et al., 2014)
Social	Maintain the cultural buildings	Ensuring the protection of the identity of the historic buildings.	(Bottero et al., 2019; Bullen and Love, 2009, 2011b; Mİsİrİlİsoy and Günçe, 2016; Shehata et al., 2015; Wilkinson and Remøy, 2018; Wilkinson et al., 2014)
	Stimulate the attractiveness to the vacant heritage buildings	Increase the attraction and demand of the heritage buildings, through the new function.	(Bullen and Love, 2009, 2011b; Eshrati et al., 2017; Hasnain and Mohseni, 2018; Petković-Grozdanovića et al., 2016; Velthuis and Spennemann, 2007; Wilkinson et al., 2014)
	Reclaim redundant and vacant cities	Increase the attraction and demand of the redundant and vacant cities.	(Aigwi et al., 2019; Ball, 2002; Bullen and Love, 2009, 2011b; Clarke et al., 2019; Niu et al., 2018; Sugden, 2017; Wilkinson et al., 2014)

2.4.2 Barriers and Challenges of Adaptive Reuse of Buildings

Although building adaptive reuse offers a set of economic, environmental and social benefits, there are several barriers and challenges facing the practice (Mehr and Wilkinson, 2018; Wilkinson et al., 2014). They can be divided into five categories, namely: legal, financial, technical, functional and cultural challenges and barriers (Remøy and Voordt, 2014). **Table 2.2** illustrates barriers and challenges of implementing adaptive reuse of buildings, according to the reviewed literature.

Legal challenges and barriers include all possible difficulties and obstacles of complying the adaptive reuse project with the requirements stated in building codes, standards, regulations, guidelines and municipal legislations (Bullen, 2007). Approval on the land use change is among the common legal challenges for implementing adaptive reuse projects. This is due to the fact that land use change has an impact on the zoning policies of the municipal organizations (Wilkinson et al., 2014). Additionally, design codes are a barrier for implementing adaptive reuse projects, since health and safety requirements differ in all types of occupancy (Aigwi et al., 2018; Cantell, 2005; Conejos et al., 2016).

Financial challenges and barriers include all possible difficulties and obstacles related to economic constraints, (Conejos et al., 2016). Under this category, several aspects are challenging the decision on the adaptation feasibility, such as lack of funding source, as well as high cost of adaptation and maintenance (Ernest et al., 2016).

Technical challenges and barriers include all possible difficulties and obstacles that are correlated with the physical and environmental aspects of the building. Different issues are considered in this context, such as building configuration, energy consumption, IEQ,

O&M, thermal performance, and other issues (Conejos, 2013a). Installation of high efficiency equipment in old buildings is one of the common technical challenges for implementing adaptive reuse projects (Mehr and Wilkinson, 2018). During the construction phase, many technical challenges could face the contractor of adaptive reuse projects, such as lack of site accessibility, limited space of workers, and poor enforcement of safety measures (Hein and Houck, 2008). Further, availability of accurate information and drawings of the building is also a challenge that face the stakeholders of adaptive reuse projects (Conejos et al., 2016).

Functional challenges and barriers include all possible difficulties and obstacles that are correlated with the spatial considerations of the building and users' needs. They include the aspects pertaining to the of the layout and sizes of the building spaces, and how they can efficiently serve the new function (Remøy and Voordt, 2014). Under this category, several challenges face stakeholders of the adaptive reuse projects, including: existing layout of the floor plan(s), number of columns and walls, and layout of the structural system (Conejos et al., 2016). While the adaptive reuse requires the development of a new program, the configuration of both uses, new and old, need to be considered simultaneously (Eyüce and Eyüce, 2010; Yaldiz and Asatekin, 2013).

Cultural challenges and barriers include all possible difficulties and obstacles correlated with the social and historical aspects, also how to maintain the daily life of people after the implementation of adaptive reuse (Conejos et al., 2016). Although adaptive reuse has social benefits for keeping the identity of the historic cities and buildings, implementing this kind of protecting strategies is a challenge. This is due to the fact that providing contemporary

services in a heritage building without compromising its historic identity would need innovative solutions (Eshrati et al., 2017; Wilkinson et al., 2014).

Table 2.2: Barriers and challenges of conducting adaptive reuse of buildings

Category	Barriers/Challenges	Brief description	References
Legal	Health and safety requirements	Requirements of fire safety and health measurements of the new occupancy classification.	(Aigwi et al., 2018; Bullen and Love, 2011c; Cantell, 2005; Hein and Houck, 2008; Mehr and Wilkinson, 2018; Wilkinson et al., 2014)
	Legal authorizations	Licenses and approvals of the adaptation documents, including the land use and design documents.	(Elsorady, 2018; Kincaid, 2002; Mehr and Wilkinson, 2018; Remøy and Voordt, 2014; Wilkinson et al., 2014)
	Parking and site configuration	Requirements of the site planning, including the parking and other services.	(Z. Ali et al., 2018; Bullen and Love, 2011c; Cantell, 2005; Olivadese et al., 2017)
	Code requirements	Code requirements of the new use, including spatial and technical performance requirements.	(Bullen and Love, 2011a; Conejos et al., 2016; Ernest et al., 2016; Olivadese et al., 2017)
	Heritage regulatory requirements	Guidelines and regulations of the heritage preservation.	(Aigwi et al., 2018; Mehr and Wilkinson, 2018; Wilkinson et al., 2014)
Financial	Feasibility of the adaptation	Viability of the yield of implementing the adaptive reuse	(Aigwi et al., 2018; Arge, 2005; Bullen and Love, 2011a; Conejos et al., 2016; Frey, 1979)
	Adaptation cost	Cost of the implementing the adaptive reuse.	(A. Ali et al., 2018; Arge, 2005; Conejos et al., 2016; Ernest et al., 2016; Haroun et al., 2019; Oppong and Masahudu, 2014; Shipley et al., 2006)
	Cost of materials	Cost of the materials used in implementing the adaptive reuse project.	(Aigwi et al., 2018; Oppong and Masahudu, 2014; Rodrigues and Freire, 2017; Wilkinson et al., 2014)
	Cost of maintenance and reforms	Cost of restoring the building condition, and repairing all defects and deteriorations.	(Bullen and Love, 2011a; Conejos et al., 2016; Ernest et al., 2016)

Table 2.2: Barriers and challenges of conducting adaptive reuse of buildings (Cont.)

Category	Barriers/Challenges	Brief description	References
Technical	Structural integrity of the building	Physical strength of the structural elements in the building.	(Aigwi et al., 2018; Conejos, 2013a; Hein and Houck, 2008; Wilkinson et al., 2014)
	Installation of new building systems	Ease of installing efficient services systems and equipment in the building.	(Ernest et al., 2016; Hein and Houck, 2008; Mehr and Wilkinson, 2018)
	Accuracy and availability of the original document of the building	Clarity and completeness of the original design documents and specifications of the building	(Conejos et al., 2016; Oppong and Masahudu, 2014; Wilkinson et al., 2014)
	Site accessibility	Accessibility of transporting to the building site.	(Z. Ali et al., 2018; Cantell, 2005; Conejos, 2013a; Ernest et al., 2016; Hein and Houck, 2008; Mehr and Wilkinson, 2018)
	Methods and tools of construction	Procedures and equipment used in implementing the change of use of the building.	(Hein and Houck, 2008; Mehr and Wilkinson, 2018; Olivadese et al., 2017; Oppong and Masahudu, 2014)
	Adequacy of loading space	Availability of space for loading the material and equipment during the construction.	(Hein and Houck, 2008; Wilkinson et al., 2014)
	Energy efficiency and IEQ measures	Issues of the quality of the energy consumption and the indoor environment.	(Bullen and Love, 2011b; Conejos et al., 2016; Mehr and Wilkinson, 2018)
	Availability of skilled tradesmen	Lack of expertise and workers who are able to implement the adaptive reuse project.	(Bullen and Love, 2011c; Conejos, 2013a; Conejos et al., 2016)
Functional	Size of spaces and rooms	Effectiveness and adequacy of the dimensions and areas of the spaces in the building.	(Al-obaidi et al., 2017; Oppong and Masahudu, 2014; Watson, 2009)
	Layout of spaces	Distribution and shape of the spaces in the building.	(Bullen and Love, 2011a; Conejos et al., 2016)
	Number and size of columns	Number and dimensions of the structural columns within the floor plan.	(Conejos et al., 2016; Mehr and Wilkinson, 2018)
	Architectural programming	Development of adequate architectural program of the new function.	(Beck, 2014; Eyüce and Eyüce, 2010; Wilkinson et al., 2014)

Table 2.2: Barriers and challenges of conducting adaptive reuse of buildings (Cont.)

Category	Barriers/Challenges	Brief description	References
Cultural	Sustaining the historic authenticity	Keeping the historical attributes on the appearance of the old buildings.	(Bullen and Love, 2011b; Eshrati et al., 2017; Hein and Houck, 2008; Mehr and Wilkinson, 2018)
	Maintaining the daily life of the community	Maintaining the lifestyle of the community in which the building is located.	(Bullen and Love, 2011b; Muldoon-Smith and Greenhalgh, 2016)
	The fit of the building appearance with the function	Matching the building appearance with the new function.	(Conejos, 2013a; Wilkinson, 2012a; Wilkinson et al., 2014)
	Acceptance to sustainability measures	Stockholders' awareness and acceptance of the measures of sustainability.	(Conejos et al., 2016; Mehr and Wilkinson, 2018)

2.4.3 Stakeholders Involved in the Adaptive Reuse Project

The decision of implementing building adaptive reuse could be initiated by the existing user or a new one (Bullen and Love, 2011b). Hence, stakeholders involved in decision-making of the adaptive reuse projects are divers from a project into another. In general, they include six participants, namely: investors, procedures, marketeers, regulators, users and developers (Kincaid, 2002; Wilkinson et al., 2014). **Table 2.3** illustrates a brief description of the stakeholders who are involved in the adaptive reuse project. Each individual stockholder has an impact on the process of implementing adaptive reuse projects (Kurul, 2007). In the adaptive reuse projects of heritage buildings, legal entities become the most impactor party, due to their cultural promotion for sustaining and reusing the heritage facilities (De Silva et al., 2019). In the adaptive reuse of commercial facilities, policy makers also become one of the main important parties which have an influence on the this practice (J. Chen et al., 2016). In summary, set of stakeholders is involved in adaptive reuse projects, where the impact of each party is manly depends on the project.

Table 2.3: Brief description of stakeholders involved in the adaptive reuse project

Stockholder	Brief description
Investor	Investors are those parties who supply the project with the financial resources, independent investors for example.
Producer	Producers are those professional parties who design, implement and manage the adaptive reuse projects, including architects, contractors and facilities managers.
Marketer	Marketers are those who work to find a user for the adaptively reused buildings, such as sales managers in a real estate organization.
Regulator	Regulators are the local authorities which states the rules.
Policy marketer	Policy makers are the government, whether local or state government.
Developer	Developers are that organizations that merge all sectors in a partial manner or in an integrated one body, including the investment, production and marketing
Users/occupant	Users or occupants are the end user of the building, whether large organization or individuals.

Source: Sustainable Building Adaptation: Innovations in Decision-Making (Wilkinson et al., 2014)

2.4.4 Practical Guidelines/Programs of Adaptive Reuse of Buildings

Recall that the legal aspects are among the issues challenging the adaptive reuse practice. In fact, municipalities can be a motivator and regulator of the adaptive reuse of heritage buildings in many situation, to manage the redevelopment of the old cities (Shipley et al., 2006). However, there is a gap in the guidelines of building conversion that regulates the implementation of this practice in a holistic manner, including the type, construction methods and architectural aspects (Olivadese et al., 2017). The author found few technical guidelines/programs of building adaptive reuse. The followings are some of the guidelines/programs of building adaptive reuse found in the reviewed literature:

2.4.4.1 City of Los Angeles Adaptive Reuse Program

The city of Los Angeles Adaptive Reuse Program was launched in 1999 (Behdad, 2006). This program aims to protect and revive the heritage buildings, built before 1974, located within the city of Los Angeles, California, USA. The program allows the developers to change the use of the buildings into different uses, including condos, apartments, live/work units, and hotels. The program offers a set of guidelines that facilitate the process of getting the approval of implementing the change of use. The guidelines cover different design and technical criteria, such as dimensions, health and safety, parking and space functions of the different types of uses mentioned above.

2.4.4.2 Historic Preservation Guidelines of Lancaster County

The main aim of the Historic Preservation Guidelines of Lancaster County is to preserve the historic buildings and sites within the Lancaster County, Pennsylvania, USA (Grof et al., 2009). The guidelines were formulated in form of plans that covers the follows: a plan of the management and balance of housing growth, strategic tourism development plan, and cultural heritage plan. Aspects of the adaptive reuse of the heritage buildings are emphasized and mentioned in the cultural heritage plan. This part offers a procedure to developers to follow in case of developing a design proposal for adaptive reuse project of historical facilities. it covers many technical and design aspects for such kind of projects. Thus, this procedure facilitates the legal process of assessing and regulating all alteration proposals.

2.4.4.3 Adaptive Reuse Technical Manual

The adaptive reuse technical manual is considered to be interpretations of the adaptive reuse guidelines stated in the California Building Standard Code. (LBDS, 2014). The manual was developed by the Long Beach Development Services. It aims to clarify the applicability of implementing adaptive reuse of buildings that are located in specified zones within the City of Long Beach, California, USA. Moreover, the manual mentions 7 steps for the process of implementing building adaptive reuse. These steps were summarized in **Table 2.4**.

Table 2.4: Steps of the adaptive reuse process of the adaptive reuse technical manual

Step	Brief description
(1) Due Diligence	Review and investigation of the property ownership, utilities and infrastructure of the existing building.
(2) Conceptual Review	Develop the conceptual design of the project.
(3) Determination of Adaptive Reuse	Determine the adaptive reuse zoning, building official and fire official.
(3) Site Plan Review	Review the site by the site plan review committee according to the Long Beach Maniple Code.
(4) Plan Check	Check the compliance of the project plan with the Long Beach Standard Code.
(5) Construction and Inspection	Conduct frequent inspirations and communications with the inspectors during the construction process.
(6) Certificate of Occupancy	Issue the certificate of occupancy that enable the adaptively reused building to accommodate the new function

Source: Adaptive Reuse Technical Manual (LBDS, 2014)

In summary, several practical programs/guidelines of building adaptive reuse have been launched in different places. Most of these programs focus on the adaptive reuse of heritage buildings. Nevertheless, there is a lack in the technical guidelines concerned with the life-cycle of the adaptive reuse projects in the presented programs. Further, it was noted that there no practical guidelines for adaptive building reuse have been developed in Saudi Arabia, even for historic buildings.

2.5 The Concept of Building Performance and Building Performance Assessment Process

2.5.1 Building Performance Concept

The building performance concept is shown in **Figure 2.3**. This concept was developed by Preiser et al (1988), in which it is the basic of the post-occupancy evaluation (POE). The concept is basically the act of assessing the performance of the building through comparing the results of performance measurements conducted on a building with the performance criteria. The conclusion of that assessment is a description of the building success in its compliance with the recommended criteria. The assessment end with the formulation of recommendations for performance improvements. Thus, the building performance is a process that is based on a structured collection of building data of both, quantitative and qualitative (Wilkinson et al., 2014).

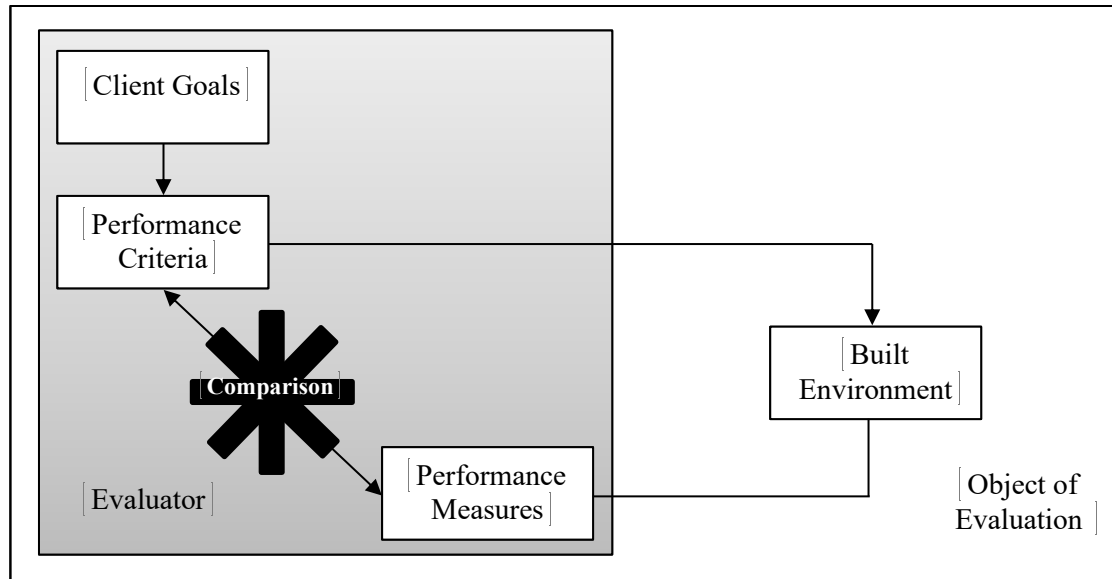


Figure 2.3: The concept of building performance

Source: Post Occupancy Evaluation (Preiser et al., 1988)

2.5.2 Building Performance Assessment Process

Recall that the building performance concept is the basic of (POE). The process model of the building performance assessment was developed in line with the concept of building performance. **Figure 2.4** presents the process model of building performance evaluation (BPE), developed by Preiser and Schramm (2005). This model consists of six phases, namely: (1) strategic planning phase, (2) programming phase, (3) design phase, (4) construction (execution) phase, (5) occupancy (O&M) phase, (6) adaptive reuse/recycling phase. Between each two phases, there is an internal loop. The concept states that BPE is conducted in these loops. Thus, effectiveness review is the first loop, which occurs between the strategic planning and programming phases. Programming review is the second loop, which occurs between the programming and design phases. The design review is the third loop, which occurs subsequently after the accomplishment of the design and before the initiation of the construction phase. Commissioning is the fourth loop, which is conducted

after the construction completion and before the transformation to the occupancy phase. After performing the commissioning, occupancy activities will be started to take place in the building. Between the occupancy and the adaptive reuse/recycling phases, POE procedures are conducted to evaluate the performance of the building, and thus, POE become the fifth loop in the BPE process model. After implementing the reuse or recycling of the building, the whole life-cycle will be repeated after analyzing the needs/ market, which is the sixth loop. In conclusion, the concept indicates that the performance of buildings can be assessed in different milestones of the building life-cycle. The methods of assessing the performance is different from a milestone into another. The milestones in this model are called “loops”.

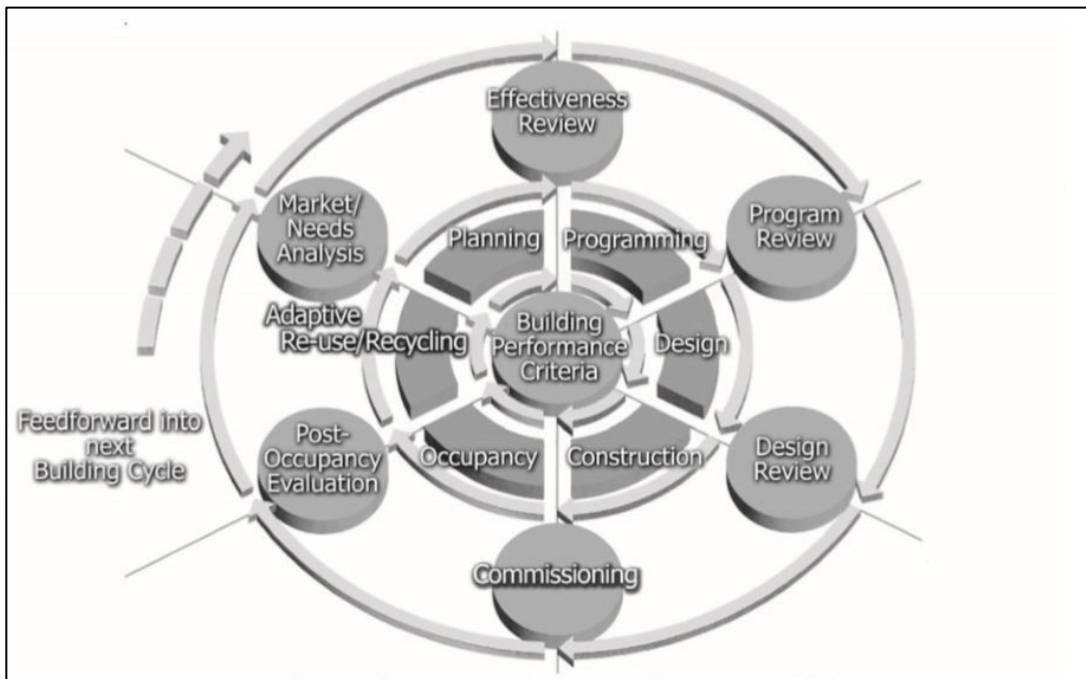


Figure 2.4: Building performance evaluation (BPE) process model

Source: Assessing Building Performance (Preiser and Schramm, 2005)

2.6 Previous Studies

Arge (2005) conducted a theoretical review and comparative case studies on the adaptability of office buildings in Norway. The study aimed to explore and implement measures of adaptive reuse potential in these facilities. The theoretical part covered concepts and definitions of adaptability according to the Norwegian Building Research Institute. The comparative case studies included an assessment of the achievement of the building adaptability by 11 real estate developers in Norway. These developers were categorized under three groups of developers, namely: (1) group who develops the business for their core usage, (2) group who develops the business for leasing the properties, and (3) group who develops the business for selling the properties. The case study covered an assessment of 16 measures of adaptability. Findings of the theoretical review concluded that adaptability as concept includes three correlated determinants, namely: generality, flexibility, and elasticity. The author described these determinants as follows: (1) generality is the ability of a building to meet users'/owner's needs without any change on the property, (2) flexibility is the ability of a building to meet the users'/owner's needs through implementing minor changes on the property, and (3) elasticity is the ability of a building to be expanded/divided according to change(s) of the users'/owner's needs. These determinants comprise 15 variables of building adaptability. Findings of the case studied indicated the follows: (1) buildings of first group were the most adaptable buildings (66% of adaptability measures were fulfilled), (2) buildings of the second group were satisfying only 50% of adaptability measures, and (3) buildings of the third group were the least adaptable buildings (33% of adaptability measures were satisfied).

Al-obaidei et al (2017) assessed the performance of two adaptively reused heritage buildings in Kuala Lumpur, Malaysia. The two buildings were converted from shophouses to hotels. Triangulation approach was used in the performance assessment of the case study buildings. It comprised interviews with users, physical survey of the building, measurements of the IEQ and occupant satisfaction survey. Based on the findings of the assessment, the study revealed that building adaptive reuse has the potential to meet the indoor environmental requirements of the new occupancy. Further, the study concluded that the practice of building adaptive reuse is in accordance with the concepts of sustainable development.

Kurul (2007) developed a process mapping approach for the planning and design phases of adaptive reuse projects. The mapping aimed to explore and document all processes involved in adaptive reuse design. The approach was developed based on four case studies that were conducted on four adaptively reused buildings in London, UK. Triangulation approach for the data collection was applied, to achieve the research objective. The study revealed that the process of adaptive reuse projects is complex, due to the differentiation and interdependence of such practice. Further, it indicated that developer groups' attributes have an impact in defining the differentiation in each phase of the project. Moreover, there was a direct relation between the project risks, complexity and competent management. Thus, the study recommended the need for innovative approaches to control and monitor the adaptive reuse projects, considering an appropriate level of flexibility. The study concluded with the identification of several challenges that face the establishment of such kind of tools, including: (1) extremely labor intensive and time consuming on data

processing, (2) data exchange between software tools, and (3) poor automated visual outputs.

Bullen (2007) investigated the viability of adaptive reuse of commercial buildings in Western Australia, as well as its influence on the built-environment. The study focused on exploring the owners' views toward the followings: adaptive reuse, improving sustainability and key issues surrounding adaptive reuse of the current commercial building in the Western Australia. The followed methodology of the research was survey-based, in addition to a literature review that was in the context of adaptive reuse of commercial buildings. In summary, the study revealed the follows: (1) there was a support from the building owners for the concept of adaptation, (2) there was a strong perception of that adaptive reuse can serve the concepts sustainable development, and (3) building owners were considering adaptive reuse as viable option for redeveloping the built-environment.

Bullen and Love (2011a) developed a model for the decision-making process of implementing building adaptive reuse. The main purpose of the model was to assist the practitioners in the decision on whether to demolish or reuse an existing facility. The development of the model was based on an interpretive research approach that has covered about 81 in-depth interviews conducted with a variety of the stakeholders of adaptive reuse. This approach aimed to understand the issues confronting the stakeholders when considering building adaptive reuse, including: demolish, reuse and sustainability. The interviews revealed that there were three principle criteria used in the decision-making process of adaptive reuse implementation, namely: capital investment, condition of asset, and regulation. Further. development and construction costs, and regulatory requirements were other criteria that were considered in this context. However, social, economic and

environmental issues were considered as well, but in a lower priority. The model was represented according to these findings.

Langston et al (2008) developed a decision-making model, called Adaptive Reuse Potential model (ARP-Model). The model was subsequently applied on a set of buildings on Hong Kong. The concept of the model was to establish a sustainable decision-making tool that contributes to support the industry in identifying the ability of the existing buildings to be adaptively reused. The ARP-Model requires the evaluation of all types of building obsolescence, namely: physical, economical, functional, technological, social, and legal obsolescence. The purpose of this assessment is to identify the useful life of the building. By determining the useful life of the building, effective useful life and the ARP of the building can be determined, accordingly. The research revealed that the developed and applied model offered a sustainable and comprehensive decision-making tool for the adaptive reuse stakeholders.

Alauddin (2014) developed a knowledge and expert-based framework, entitled “Intellectual Capital Framework for Successful Adaptive Re-use Projects”. The concept of the model was to provide a tool for capturing and transferring the knowledge and skills from previous-successful adaptive reuse projects. The development of the framework was based on a qualitative approach, which covered about 14 in depth interviews, and two case studies on successful adaptive reuse projects. Both methods of investigation were performed to comprehend and explore the follows: (1) importance of adaptive reuse projects, (2) components of the knowledge of the problem solving, (3) context of knowledge transfer, and (4) relation between successful project components and key components of creating and transferring the knowledge in the process of the problem

solving. Hence, the developed model contains six elements, namely: trust, supportive attitude, communication, skills, appreciation and collaboration. The framework undergone refinement process. After the implementation of the refinement process, eleven components were incorporated into the framework, namely: “trust, collaboration, communication, skills, past experience, project team actions, sources of information, similar project team, effectiveness and efficiency mode, generating new skills and knowledge, and developing new solutions”.

Conejos et al in (2013) developed a model called (*adaptSTAR* - Model). The model was developed to assist designers and developers to predict the adaptability of future buildings during the design phase. The establishment of the model was based on the basis of the ARP-model. The model is basically a rating tool that comprised of 7-weighted groups of criteria, namely: physical (long life), economic (location), function (loose fit), technological (low energy generation and consumption), social (sense of place), legal (quality standard) and political (context). Under each of these groups, set of weighted criterial are listed. The total number of criteria is 51. The research concluded that *adaptSTAR* model has the potential to improve the adaptability as well as the sustainability of the future buildings, due to its holistic coverage of the weighted criteria.

Mısırlısoya and Günc (2016) developed a holistic process model for determining adaptive reuse strategies for the heritage premises. The concept of the model was to assist the decision-makers involved in the selection of the adaptive reuse options of historic buildings. The process of the model development was started by identifying the factors influencing the decision-making of adaptive reuse. The factors were identified based on a review of literature as well as content analysis. Subsequently, the model was developed,

accordingly. The model consisted of several factors that are critical to be taken into account in a holistic manner during the decision-making process. The model was formulated in approach of 5 phases, namely: (1) definition of actors in decision-making, (2) analysis of existing fabric, (3) decision on conservation actions, (4) definition of adaptive reuse potential, and (5) definition of functional changes. Each phase involved a set of analytical tasks that facilitate the overall decision-making process.

2.7 Preliminary Identification of the Factors Affecting Building Adaptive Reuse throughout the Project Life-Cycle

This section presents a preliminary identified of the factors based on performed review of literature in this chapter. Based on the presented review of literature, 38 factors were identified. The factors were categorized in a life-cycle-oriented classification. They were categorized under the following four groups: factors related to the phase conceptual planning and feasibility studies, design and engineering phase, construction, and operation and maintenance phases. This categorization is a life-cycle-oriented grouping. **Table 2.5** presents the list of the identified factors and their references.

2.7.1 Factors Related to the Phase of Conceptual Planning and Feasibility

Studies

This group includes the factors affecting adaptive reuse projects during the phase of the conceptual planning and feasibility studies. Under this group, nine factors were identified based on the review of literature, namely: structural integrity of the building, municipal approval for the land use change, the condition of building components and/or systems, architectural program of the new use, potential of the building spaces to be adaptively

reused, allocated budget for the adaptation process, expected yield from the adaptation, the schedule of the adaptation activities, and compatibility of the building appearance with the client desired design.

2.7.1.1 Structural Integrity of the Building

Structural integrity of the building is one of the issues that need to be considered during the decision-making process for implementing building adaptive reuse (Aigwi et al., 2018; Bullen, 2007). Several terminologies expressed the structural integrity of the building in the literature, using different terms as shown in **Table 2.5**. Five terms of the structural integrity were found in the reviewed literature, namely: “structural integrity” (Douglas, 2006), “building structural integrity”(Aigwi et al., 2018), “structural integrity of the building” (Bullen, 2007; Hein and Houck, 2008; Wilkinson et al., 2014), “structural condition” (Wilkinson et al., 2014), “structural strength and stability” (Naidu, 2008), and “deterioration of the structure and fabric of the buildings” (Bullen and Love, 2011c). As indicated above, there are a diversity in the terminologies of this factor.

As shown above, there is a diversity in the terms used to express the impact of the structural integrity on the decision-making process for implementing building adaptive reuse. However, “structural integrity” was the mostly frequent term found in the reviewed literature, which was repeated twice. Accordingly, “structural integrity of the building” can be the appropriate term for expressing this factor, and thus, it was adopted to be used in this research.

Structural integrity of the building can be described as the ability of the structure of an existing building for catering future uses and loads (Wilkinson et al., 2014).

2.7.1.2 Municipal Approval for the Land Use Change

Municipal requirements of the planning authorities is one of the factors that are considered during the decision-making process for implementing the building adaptive reuse (Mİsİrlİsoy and Günçe, 2016). Based on the reviewed literature, several terminologies were used to describe this factor (**Table 2.5**), namely: “legal constraints” (Conejos et al., 2016), “planning and regulatory approval” (Kincaid, 2002), “regulations defined by planning and local authorities” (Mİsİrlİsoy and Günçe, 2016), “legal consideration in term of the building classification” (Wilkinson et al., 2014), and “municipal zoning plans” (Remøy and Voordt, 2007).

As shown above, there was no unified term used to expresses the impact of the planning authorities’ approval on the decision-making process for the adaptive reuse implementation. Thus, ‘municipal approval for the land use change’ was formulated and adopted, to reflect the literature’s terminologies in a broader context.

Based on the reviewed literature, there was no definition formulated to define this factor. However, according to Conejos et al. (2016), this factor can be described as the compliance with requirements of the local authorities, in terms of their planning guidelines and licensing procedures.

2.7.1.3 The Condition of Building Components and/or Systems

The physical condition of the building systems and components is one of the major factors that affect the decision-making for implementing building adaptive reuse (Wilkinson et al., 2014). Many terminologies were found in the literature to indicate this factors, using different terms (**Table 2.5**), namely: “building condition” (Al-obaidi et al., 2017), “condition of external fabric and finishes” (Bullen and Love, 2011c), “depreciation of the buildings fabric and systems” (Bullen and Love, 2011c), “architectural integrity of the building” (Mehr and Wilkinson, 2018), “poor performing envelopes and inadequate energy systems” (Mehr and Wilkinson, 2018), “physical condition of building”, (Wilkinson et al., 2014), “physical deterioration and building obsolescence” (Wilkinson et al., 2014), “technical state” (Wilkinson et al., 2014), “physical obsolescence” (Langston et al., 2008), “technological obsolescence” (Langston et al., 2008), and existing physical condition of the building (Misiřliřoy and Gönçe, 2016).

As shown above, there was no unified and clear terminology indicates the impact of the condition of building system and components on the decision-making phase of adaptive reuse projects. Hence, ‘the condition of building components and/or systems’ was formulated and adopted to express this factor in an adequate and broader manner. This term is more comprehensive, because it covers the physical and performance conditions of the system and components in the building, whether if they are obsolete or not.

However, physical obsolescence can be defined as “*the accelerated deterioration leads to reduced physical performance and obsolescence of the building*”, where technological obsolescence can be defined as “*the change in owner objectives and needs leads to possible functional change from the purpose for which a building was originally designed*” (Langston et al., 2008).

In order to define the formulated and adopted term in a direct and clear manner, ‘the condition of building components and/or systems’ was defined therefore as the current state of the physical and performance capacities of the building components and systems.

2.7.1.4 Architectural Program of the New Function

The architectural programming of the new function is one of the important tasks that needs to be carried out in adaptive reuse projects (Yaldiz and Asatekin, 2013). Based on the reviewed literature, different terminologies were used by different researchers to indicate this factor from the perspective of building adaptive reuse (**Table 2.5**), namely: “programming requirements” (Beck, 2014), “programmatic needs” (Beck, 2014), “new program requirements” (Eyüce and Eyüce, 2010), “new program and new functional requirements” (Eyüce and Eyüce, 2010), “reprogramming process” (Yaldiz and Asatekin, 2013), “programming of the new function” (Yaldiz and Asatekin, 2013), “change of architectural program” (Yaldiz and Asatekin, 2013), “functional programme” (Wilkinson et al., 2014), and “programme of requirements” (Wilkinson et al., 2014).

As mentioned above, several terminologies were used to indicate the aspects pertaining to the architectural program and programming in the context of building adaptive reuse. In order to illustrate the term of “architectural program” in context of building adaptive reuse, the term ‘architectural program of the new function’ was formulated and adopted to be used in this research in order to express this factor in a clear manner.

Architectural program is defined as *“the document in which the identified values, goals, facts, and needs are presented”* (Hershberger, 2015). The process of developing the architectural program is known as “architectural programming” or “programming”. Yaldiz and Asatekin (2013) defined the programming as *“the analytic stage of analysis design and information collection which includes observation and measurement as well”* (Yaldiz and Asatekin, 2013). Further, Hershberger (2015) defined the architectural programming as *“the first stage of the architectural design process in which the relevant values of the client, users, architects, and society are identified, important project goals articulated, facts about the project are uncovered, and facility needs made explicit”*.

From the presented definitions, it was concluded that there was no definition formulated yet to describe the architectural program from the perspective of building adaptive reuse. In order to describe the formulated term in a clear manner, ‘architectural program of the new function’ was defined as the group of information and data gathered during the planning of adaptive reuse projects, including the goals and needs of the new function.

2.7.1.5 Potential of the Building Spaces to be Adaptively Reused

The potential of the building for the change of use is a key factor that is taken into account during the decision-making process regarding the assessment of the adaptive reuse feasibility (Wilkinson et al., 2014). Many terminologies were found in the reviewed literature indicating this factor, using different terms (**Table 2.5**), namely: “adaptable buildings” (Arge, 2005), “adaptability of the space” (Bullen and Love, 2011c), “adaptive reuse potential” (ARP) (Langston et al., 2008), “potential of the building for ‘alterations’ adaptation” (Wilkinson et al., 2014), “adaptability” (Arge, 2005; Heidrich et al., 2017; Kincaid, 2000; Pinder et al., 2017; Wilkinson et al., 2014), “adaptability potential” (Kincaid, 2000), “re-use potential” (Ball, 2002), and “convertibility” (Conejos et al., 2011; Wilkinson et al., 2014).

As mentioned above, there is a diversity in the terminologies that express the factor of the potential of implementing building adaptive reuse. In order to simplify the statement expressing this factor, ‘potential of the building spaces to be adaptively reused’ was formulated and adopted to be used in this research. This is due to the fact that the formulated term is simple to be used in a questionnaire survey.

Based on the reviewed literature, different definitions were stated by many authors to describe this factor. Wilkinson et al. (2014) defined the adaptive reuse potential as (ARP) *“the propensity of an asset to be ‘recycled’ to perform a significantly different function while keeping the basic attributes of the asset in place”*. Adaptability was defined by Heidrich et al. (2017) as *“the inherent properties in a building that gives it the ability to change, or the relative ease with which it can be*

changed through some external intervention". Furthermore, Wilkinson et al. defined the convertibility as *"ease of conversion to other use and costs associated with the conversion"*.

As mentioned above, several definitions were stated to describe this factor, while all of them indicate the same meaning. However, in order to simplify the definition of the formulated term, 'potential of the building spaces to be adaptively reused' was defined as the ability of the building spaces to be functionally converted in an easy manner.

2.7.1.6 Allocated Budget for the Adaptation Process

The financial aspects is one of the key factors that has a direct bearing on the decision-making process for implementing building adaptive reuse (Bullen and Love, 2011c). Based on the reviewed literature, several terminologies expressed this factor, using different terms (**Table 2.5**), namely: "costs of adapting a building" (Bullen and Love, 2011b), "project budget" (Kincaid, 2002), "budget estimate" (Wilkinson et al., 2014), "budget estimate" (Wilkinson et al., 2014), "capital budgeting criteria" (Wilkinson et al., 2014), "construction cost" (Bullen and Love, 2011a; Langston et al., 2008), "cost of financing" (Langston et al., 2008), and "adaptation cost" (Wilkinson et al., 2014).

As mentioned above, different terminologies were used in the literature to indicate the impact of the allocation of budget in the planning phase of the adaptive reuse projects. Additionally, there was no unified term used to describe this factor in a clear manner. Accordingly, 'allocated budget for the adaptation process' was

formulated and adopted to be used in this research, to have a term that reflects the literature terminologies in a broader context.

However, Langston (2011) defined the budgeting as *“the disciplined pre-determination of cost, and such is a significant element of planning and control for any business or project”*. Yadollahi and Zin (2011) mentioned that *“budget allocation is a complex process with too many contradictions in form of criteria or attributes*. Farther, such authors mentioned that the process is concerning about *“how to allocate and utilize the limited resources to all administrative issues in a reasonable way”*.

From the reviewed definitions, the formulated term ‘allocated budget for the adaptation process’ was be defined as the determined client budget that will be spent in the whole process of the adaptive reuse project.

2.7.1.7 Expected Yield from the Adaptation

The economic viability, in term of the yields from the adaptation, is one of the main attributes in the decision-making process for implementing building adaptive reuse (Wilkinson et al., 2014). Based on the review of literature, several terminologies expressed this factor, using different terms (**Table 2.5**), namely: “capital investment” (Bullen and Love, 2011a), “cost-benefit analysis” (Bullen and Love, 2011b), “introduce financial incentives to provide income” (Bullen and Love, 2011c), “financial incentives” (Bullen and Love, 2011c), “financial and technical perceptions” (Conejos et al., 2016), “yields” (Wilkinson et al., 2014), “total estimated yield” (Wilkinson et al., 2014), “anticipated yield performance”

(Kincaid, 2002), “investment in adaptive reuse” (Kincaid, 2002), and “profits from market demand” (Mİsİrİlİsoy and Günçe, 2016).

As mentioned above, there was no unified term used to express the factor of the economic viability in the literature. In order to have a clear term expressing the mentioned terminologies, ‘expected yield from the adaptation’ was formulated and adopted to be used in this research. It was also adopted to facilitate comprehending of the factor by the participants involved in the questionnaire survey.

In addition, all the mentioned terminologies indicate the impact of the yield on the decision-making process of regarding the adaptive reuse implementation. However, there was no direct definition describing this factor. According to the Oxford Wordpower dictionary, yield is “*the amount that is produced*” (OXFORD, 2011).

Consequently, the formulated term ‘expected yield from the adaptation’ was defined as the probable amount that might be returned from the new function of the adaptive reuse project.

2.7.1.8 The Schedule of the Adaptation Activities

Changes and interventions that will be performed in adaptive reuse projects are major concerns during decision-making process (Mİsİrİlİsoy and Günçe, 2016). Therefore, activities associated with the adaptation process need to be considered in the feasibility assessment process (Douglas, 2006). Based on the reviewed literature, several terminologies were used to express the impact of the adaptation activities on the potential and feasibility of the conversion (**Table 2.5**), namely: “renovation activities” (Hein and Houck, 2008), “construction activities” (Hein and

Houck, 2008), “planning and constructing an adaptive reuse project” (Hein and Houck, 2008), “construction schedule” (Hein and Houck, 2008), “refurbishment activities” (Kincaid, 2002), “planning activities” (Kincaid, 2002), “traces of activities and processes” (Lardner et al., 2013), “management plan” (Lardner et al., 2013), “main adaptation work being carried out on a building” (Watson, 2009), “adaptation work” (Douglas, 2006), and “necessary interventions that will be applied” (Mısırlısoy and Günçe, 2016).

As mentioned above, there was no unified term that can express the terminologies found in the literature in a generic context. Thus, ‘the schedule of the adaptation activities’ was formulated and adopted to be used in this study, to express the other terminologies in a broader context.

However, construction activities can be defined as *“anything that must be accomplished (whether by the owner, contractor, subcontractor, inspector, or other party) in order for the project to be completed may warrant inclusion in the network”* (Hinze, 2012). Nunnally (2014) stated that *“schedule is nothing more than time-phased plan which used as a guide during the performance of an operation in order to control the pace of activities and to permit completion of the operation at the desired or required time”*. Further, Douglas (2006) stated that *“adaptation is considered as work accommodating change in use or size or performance of a building which may include alterations, extensions, improvements, and other works modifying it in some way”*.

As shown above, there was no general definition expresses this factor in a clear and direct manner. Thus, ‘schedule of the adaptation activities’ was defined as the time schedule of the works required to execute the adaptive reuse project.

2.7.1.9 Compatibility of the Building Appearance with the Client Desired Design

The building appearance is one of the crucial factors that affect the planning success in adaptive reuse projects (Kincaid, 2002). Based on the reviewed literature, several terminologies were used to express this factor, using different terms (**Table 2.5**), namely: “building appearance” (Kincaid, 2002; Wilkinson and Reed, 2011), “external appearance” (Kincaid, 2002), “ability to aesthetically fit streetscape” (Bullen and Love, 2011b), “aesthetics” (Watson, 2009; Wilkinson et al., 2014), “high architectural merit including pleasing aesthetics and compatibility with its surrounding streetscape” (Wilkinson et al., 2014), and “construction form, envelop, shape and height” (Wilkinson, 2012b).

As mentioned above, there was no unified term used to express the impact of the building appearance on the planning and feasibility phase of the adaptive reuse project in a broader and clear context. Accordingly, ‘compatibility of the building appearance with the client desired design’ was formulated and adopted to express the literature terminologies of this factor in a broader and clear context.

Based on the reviewed literature, there was no clear definition formulated to describe this factor in a clear manner. However, Wilkinson et al. (2014) mentioned that esthetics indicates “*architectural beauty, good appearance, proportion, etc.*”. Further, Wilkinson (2012b) mentioned that “*premium buildings are that reflecting*

contemporary and modern appearance of the stock and current perceptions of what is aesthetically pleasing". According to the Oxford Wordpower dictionary, Compatible means that "*suitable to live together or to be used together*" (OXFORD, 2011).

Consequently, the formulated term 'compatibility of the building appearance with the client desired design' was defined as the suitability of the appearance of the building that will be adaptably reused with desired design outputs from the client.

2.7.2 Factors Related to the Design and Engineering Phase

This group includes the factors affecting adaptive reuse projects during the design and engineering phase. Under this group, eleven factors were identified based on the review of literature, namely: previous experience of the design team with adaptive reuse projects, code requirements for the new occupancy, availability and accuracy of the drawings and specifications of the existing project, net area of the adaptable space, layout of spaces within the building, number and layout of the structural columns, layout of the existing MEP systems, capacity of the existing MEP systems, potential to install additional and/or new systems, site configuration and requirements, and sustainability and energy saving measures.

2.7.2.1 Previous Experience of the Design Team with Adaptive Reuse Projects

Previous experience of the design team with the adaptive reuse projects is one of the influential factors on the successful accomplishment of the project (Alauddin, 2014). Based on the reviewed literature, several terminologies were used to express this factor, using different terms and contexts that imply the same concept (**Table**

2.5), namely: “lack of previous experience in the new form of building and construction” (Al-ghamdi, 2011), “knowledge and experienced” (Al-ghamdi, 2011), “limited skilled labor and experienced specialists in the field” (Al-ghamdi, 2011), “past experience” (Alauddin, 2014), “skills and experience of project team’s member” (Alauddin, 2014), and “experience and judgment of specialist consultants” (Wilkinson et al., 2014).

As mentioned above, there was no unified term used to express this factor in a specified way. Accordingly, ‘previous experience of the design team with adaptive reuse projects’ was formulated and adopted to be used in this research. This term was formulated to express the impact of previous knowledge and skills of the design team on the project implementation, in a clear and specified context.

Kincaid (2002) stated that *“engineering consultants should have experience with the unique type of work required for each project”*. However, Alauddin (2014) defined the past experience as *“the practically-oriented knowledge that accumulates from past projects and the intervening period in a time series scenario”*.

In order to have a simplified and specified definition for the formulated term, ‘previous experience of the design team with adaptive reuse projects’ was defined as the knowledge and skills of the design professionals, that were gained from former adaptive reuse projects.

2.7.2.2 Code Requirements for the New Occupancy

Code requirements of the new function is one of the major legal factors that affect the design process in adaptive reuse projects (Yaldiz and Asatekin, 2013). Based on the reviewed literature, this factor was stated in different terminologies (**Table 2.5**), namely: “compliance with building codes” (Bullen and Love, 2011b), “building codes and regulations/legal constraints” (Conejos et al., 2016), “regulations” (Lardner et al., 2013), “occupational health and safety regulations” (Lardner et al., 2013), “legal attributes” (Wilkinson et al., 2014), “building codes” (Wilkinson et al., 2014), “fire codes” (Wilkinson et al., 2014), “health and safety issues” (Wilkinson et al., 2014), “legal inputs” (Yaldiz and Asatekin, 2013), and “certain requirements of the new function” (Yaldiz and Asatekin, 2013).

As shown above, there is a diversity in the terminologies used in the literature to express this factor, while there was no unified term was used to express it in a unified manner. Accordingly, ‘code requirements for the new occupancy’ was formulated and adopted to be used in this research, to express the literature terminologies in a broader and clear context.

According to the International Building Code (IBC), code requirements can be described as “*the minimum requirements to safeguard the public health, safety and general welfare through structural strength, means of egress facilities, stability, sanitation, adequate light and ventilation, energy conservation, and safety to life and property from fire and other hazards attributed to the built environment and to provide safety to fire fighters and emergency responders during emergency*”

operations” (IBC, 2018). Conejos et al. (2016) described the impact of this factor on the adaptive reuse design through the following statement “*compliance with current building codes, regulations, conservation guidelines, licensing and planning requirements”* (Conejos et al., 2016).

In order to define this factor from the perspective of building adaptive reuse, the formulated term ‘code requirements for the new occupancy’ was defined as the legal and design requirements of the new function, that are stated in the applicable building codes and standards.

2.7.2.3 Availability and Accuracy of the Drawings and Specifications of the Existing Project

Accuracy of the building documents, including the drawings and other related information, is one of the major factors that affect the adaptive reuse design (Conejos et al., 2016). Based on the reviewed literature, this factor was mentioned in different terminologies and contexts (**Table 2.5**), namely: “inaccuracy of information and drawings” (Conejos et al., 2016), “background information on the building lacked accuracy” (Oppong and Masahudu, 2014), and “risk of inaccurate drawings and differing construction” (Wilkinson et al., 2014).

As mentioned above, there was no unified and clear terminology was used to express this factor in a clear and broader manner. Accordingly, ‘availability and accuracy of the drawings and specifications of the existing project’ was adopted and formulated to be used in this research. This term has the potential to express the factor in a direct and broader manner.

Conejos et al. (2016) described this factor as *“the lack of accurate information and drawings for heritage buildings (includes defects or dimensional and material inconsistencies)”*. In addition, Wilkinson et al. (2014) stated that *“measurements and materials used do not always correspond to the construction drawings”*.

However, Conejos’s description was formulated within the knowledge area of building adaptive reuse. However, it focuses on the context of adaptive reuse of heritage buildings, since it is not considering the other types of change of use projects. Thus, the formulated term ‘availability and accuracy of the drawings and specifications of the existing project’ was defined as potential to obtain an accurate drawings and specifications of the building that are recently updated to be identical to the current situation of the building.

2.7.2.4 Net Area of the Adaptable Space

Space availability of the new functions is a major factor that affects the design process in adaptive reuse projects (Yaldiz and Asatekin, 2013). Based on the reviewed literature, this factor was mentioned in different terminologies implying the same meaning (**Table 2.5**), namely: “size and shape of the building” (Al-obaidi et al., 2017), “a plot size of area” (Oppong and Masahudu, 2014), “floor area” (Kincaid, 2002; Wilkinson et al., 2014), “gross floor area” (Wilkinson et al., 2014), “floor size” (Wilkinson et al., 2014), “lower-grade space available” (Wilkinson et al., 2014), “total floor area” (Kincaid, 2002), “areas that are required for people’s activities” (Yaldiz and Asatekin, 2013), and “areas for the various human activities in the adaptation to the new function” (Yaldiz and Asatekin, 2013).

As mentioned above, there was no unified term used to express this factor in specified manner. According to the International Building Code (IBC 2009), “net area” is mostly close to the context of architectural design, more than the “gross area”. Consequently, ‘net area of the adaptable space’ was formulated and adopted to be used in this research. This term enabled for expressing the aspects of the availability of area and space in a specific and clear context.

According to the International Building Code (IBC 2009), gross floor area is defined as *“the floor area within the inside perimeter of the exterior walls of the building under consideration, exclusive of vent shafts and courts, without deduction for corridors' stairways, closets, the thickness of interior walls, columns or other features”*. Further, net floor area is defined as *“the actual occupied area not including unoccupied accessory areas such as corridors, stairways, toilet rooms, mechanical rooms and closets”* (IBC, 2018).

From the above definitions, the formulated term ‘net area of the adaptable space’ was defined as total area of the occupied spaces in the building, which can be adaptively reused.

2.7.2.5 Layout of Spaces within the Building

The arrangement of the spaces in the building is one of the major factors that affect the building adaptability and the design process (Bullen and Love, 2011a, 2011c). Based on the reviewed literature, several terminologies were used to express this factor, using different terms (**Table 2.5**), namely: “building form or organization of space” (Arge, 2005), “functional organization” (Arge, 2005), “layouts and space

plans” (Arge, 2005), “building layout” (e.g. space efficiencies)” (Bullen and Love, 2011a, 2011c), “internal layout (space plan)” (Bullen and Love, 2011a), “physical restriction” (Conejos et al., 2016), “shape of floor plate” (Wilkinson et al., 2014), and “service core location” (Wilkinson et al., 2014).

As mentioned above, there is a diversity of the definitions in the used expressions for this factor. Accordingly, ‘layout of spaces within the building’, was formulated and adopted to be used in this research, to express this factor in a broader context, so that reflecting the literature terminologies.

This factor was described by Wilkinson et al. (2014) as *“the restrictions due to existing floor layouts, number of columns/walls and structural system layouts”*.

2.7.2.6 Number and Layout of the Structural Columns

The structural characteristics of the building, in terms of the columns’ layout and dimensions, is a major factors that affect the design process in adaptive reuse projects (Conejos et al., 2016). Several terminologies were used to express this factor, using different terms, in previous research (**Table 2.5**), namely: “number of columns/walls and structural system layouts” (Conejos et al., 2016), “difference in column sizing” (Hein and Houck, 2008), “column spacing and floor heights” (Hein and Houck, 2008), “distance between columns” (Wilkinson et al., 2014), “internal layout (columns)” (Wilkinson et al., 2014), “structural grid and section dimensions” (Kincaid, 2002), and “technical grid/module” (Arge, 2005).

However, there was no term used to express this factor in a unified and clear manner as shown above. Therefore, ‘number and layout of the structural columns’ was formulated and adopted to be used in this research, to express the terminologies of the literature in a broader and clear context.

This factor was described by Wilkinson et al. (2014) as *“the technical grid, or the distance between the structural columns on the floor plate”*.

2.7.2.7 Layout of the Existing MEP Systems

The existing services and systems are one of the major influences on the design judgments in adaptive reuse projects (Wilkinson et al., 2014). Based on the reviewed literature, several terminologies were used to express this factor, using different terms (**Table 2.5**), namely: “technical grid/module” (Arge, 2005), “complexity and technical difficulties” (Conejos et al., 2016), “vertical service location” (Wilkinson et al., 2014), “building services” (Wilkinson et al., 2014), “service ducts and corridors” (Wilkinson et al., 2014), “vertical circulation” (Wilkinson et al., 2014), “service elements” (Wilkinson et al., 2014), “utilities and existing building infrastructure” (LBDS, 2014), “location of vertical services” (Wilkinson and Reed, 2011), “building services and equipment” (Wilkinson and Reed, 2011), “building service designs” (Halvitigala and Reed, 2015), and “HVAC systems, electrical systems, lighting and water supply systems” (Halvitigala and Reed, 2015).

As mentioned above, there was no unified term used to express this factor in a clear manner. Accordingly, ‘layout of the existing MEP systems’ was formulated and

adopted to be used in this research, to express this factor in a broader context, so that reflecting the literature terminologies.

- Wilkinson et al. (2014) described this factor as the criterion that concerned with *"service ducts and corridors: vertical circulation, service elements, raised floors, etc."*.

However, the mentioned description is not adequate to explain the formulated factor in a simple manner. Accordingly, the formulated factor 'layout of the existing MEP systems' was defined as the design and distribution of the currently available MEP systems in the building.

2.7.2.8 Capacity of the Existing MEP Systems

Capacity of the building services systems is one of the important factors that need to be considered during the design of building adaptive reuse (LBDS, 2014). Based on the reviewed literature, this factor was mentioned in previous research in different terminologies (**Table 2.5**), namely: "reduced levels of amenity and service" (Bullen and Love, 2011c), "condition of mechanical, plumbing and electrical systems and their capacity for modification" (Bullen and Love, 2011a), "capacity of the electrical, water, gas, and sewer services" (LBDS, 2014), "services to meet new use requirements" (Wilkinson and Reed, 2011), "outdated building services" (Wilkinson and Reed, 2011), "additional operational requirements" (Halvitigala and Reed, 2015), "buildings extra capacity" (Conejos et al., 2016), and

“characteristics of a potential use and the related performance requirements can be matched” (Kincaid, 2002).

As mentioned above, there was no unified term used to express this factor in a direct and clear manner. However, all the mentioned terminologies and phrases indicate that there is an impact of the new function on the demand of the building services and systems. In order to express this factor in a broader and clear context, ‘capacity of the existing MEP systems’ was formulated and adopted to be used in this research.

However, this factor was also described in previous research and other sources in an undirect context. Halvitigala and Reed (2015) described issues correlated with this factor as follows “*the additional operational requirements caused by space-use intensification*”. It was mentioned also in the LBDS manual that “*existing buildings may also be limited as far as the capacity of the electrical, water, gas, and sewer services*” (LBDS, 2014). Further, Conejos et al. (2016) stated that “*buildings extra capacity must be considered for future servicing and insulation*”.

Accordingly, the formulated factor ‘capacity of the existing MEP systems’ was described as the operational size of the currently available MEP systems in the building.

2.7.2.9 Potential to Install Additional and/or New Systems

Potential of installing new systems is one of the factors that need to be considered during the design of adaptive reuse projects, especially when the building is old (Mehr and Wilkinson, 2018). Based on the reviewed literature, several

terminologies were used to express this factor, using different terms (**Table 2.5**), namely: “install new services that would be required to reduce resource consumption” (Bullen and Love, 2011a), “installing mechanical air conditioning to improve indoor air quality and meet user expectations” (Mehr and Wilkinson, 2018), “installation of electrical equipment and lighting” (Mehr and Wilkinson, 2018), “installation of electrical equipment and lighting” (Mehr and Wilkinson, 2018), “installation of telecommunications equipment” (Mehr and Wilkinson, 2018), “flexibility” (Arge, 2005; Halvitigala and Reed, 2015), “installations” (Wilkinson et al., 2014), and “potential technical difficulties” (Kincaid, 2002).

As mentioned above, there was no unified term used to express this factor in a direct and clear manner. Accordingly, ‘potential to install additional and/or new systems’ was formulated and adopted to reflect the literature terminologies, and express this factor in a broader context.

Moreover, the reviewed literature indicated that there was no specific description and/or definition was stated to explain this factor. However, Arge (2005) stated that flexibility means that *“a building has built-in possibilities to rearrange, take away or add elements and systems, when the needs of the users change”*. Wilkinson et al. (2014) stated that *“parts of the installation works had technical issues relating to latent conditions”*. In addition, Wilkinson et al. (2014) described the issue of installation flexibility as *“the impossible to fit vertical ventilation shafts”*.

According to the mentioned definition and descriptions of the installation flexibility, the formulated term ‘potential to install additional and/or new systems’

was defined as the possibility to install new and/or extra services systems to the building in an easy way.

2.7.2.10 Site Configuration and Requirements

The characteristics and requirements of the site of adaptive reuse projects are major determinants that need to be considered during the design phase (Kincaid, 2002). Based on the reviewed literature, many terminologies were used to express this factor, using different terms (**Table 2.5**), namely: “onsite contamination” (Conejos et al., 2016), “site access” (Conejos et al., 2015; Kincaid, 2002), “parking provision” (Kincaid, 2002), “site amenity” (Kincaid, 2002), “locational and site characteristics” (Kincaid, 2002), “site orientation” (Wilkinson et al., 2014), “spatial configuration” (Wilkinson et al., 2014), “car parking” (Wilkinson et al., 2014), “locational and land use attribute” (Wilkinson et al., 2014), “location and site” (Wilkinson et al., 2014), “plot size and site plan” (Wilkinson et al., 2014), “spatial formation” (Yaldiz and Asatekin, 2013), “spatial organization” (Yaldiz and Asatekin, 2013), and “spatial requirements” (Yaldiz and Asatekin, 2013).

As mentioned above, there was no unified term used to adequately and clearly express the impact of the site characteristics and requirements on the design of adaptive reuse projects. To respond to this issue, ‘site configuration and requirements’ was formulated and adopted to be used in this research.

However, site access can be defined as “*the proximity or link to access roads, parking and communal facilities, etc.*” (Conejos et al., 2015; Wilkinson et al., 2014). Kincaid (2002) mentioned that locational and site characteristics are the

physical attributes include five variables, namely: “*site access, boundary condition, parking provision, site density, site amenity*”.

Based on the information mentioned by Kincaid (2002), the formulated term ‘site configuration and requirements’ was therefore defined as the characteristics and legal provisions concerned with the size, accessibility, parking, amenities, neighboring areas considerations, and arrangement of the site of adaptive reuse projects.

2.7.2.11 Sustainability and Energy Saving Measures

Building adaptive reuse is in line with the context of sustainability, and sustainable development (Remøy, 2010; Yoon and Lee, 2019). In addition, sustainability and energy saving measures concepts are among the factors that affect the design of adaptive reuse projects (Al-obaidi et al., 2017; Wilkinson et al., 2014; Yaldiz and Asatekin, 2013). Based on the reviewed literature, several terminologies were used to express this factor, using different terms (**Table 2.5**), namely: “principle of sustainability” (Al-obaidi et al., 2017), “sustainable design approach” (Al-obaidi et al., 2017), “promote energy efficiency” (Al-obaidi et al., 2017), “environmental sustainability and reduce energy consumption” (Mehr and Wilkinson, 2018), “sustainable strategies” (Mehr and Wilkinson, 2018), “requirements of sustainable development” (Wilkinson et al., 2014), “sustainability measures” (Wilkinson et al., 2014), “ensure the sustainability” (Yaldiz and Asatekin, 2013), and “energy-saving measures” (Wilkinson et al., 2014).

As mentioned above, there was no unified term used to express this factor in a direct manner. Accordingly, 'sustainability and energy saving measures' was formulated and adopted to be used in this research, to express this factor directly, and reflect the literature terminologies in a broader context.

Based on the reviewed literature, there was no unified term used to express the formulated term directly. Wilkinson et al. (2014) stated that *"sustainability is explored within the context of social, economic and environmental paradigms"*. However, sustainability can be defined as *"the ability to meet the needs of the current generation without compromising the ability of future generations to meet their needs"* (Foster, 2017). Further, sustainable design is referred to *"the principle that recognizes resources are finite, and the intelligent design and construction can mitigate the impact of building on the environment"* (Kalin et al., 2010). According to Cambridge Dictionary (2019), energy-saving of a product or systems implies that *"use as little electricity, gas, etc. as possible"* (Cambridge Dictionary, 2019).

Relying on the above definitions and information, the formulated term 'sustainability and energy saving measures' was defined as the actions concerned with the principles of environmental sustainability and energy conservation in the building.

2.7.3 Factors Related to the Construction Phase

This group includes the factors affecting adaptive reuse projects during the construction phase. Under this group, ten factors were identified based on the review of literature, namely: previous experience of the contractor with adaptive reuse projects, accuracy and

completeness of the contract documents, availability of skilled workforce, construction equipment and methods, planning and control of the financial resources, quality assurance / control requirements, complexity and difficulties within the project site, availability and accessibility of loading space, availability of spaces for storing the construction materials and equipment, and enforcement of construction safety procedures.

2.7.3.1 Previous Experience of the Contractor with Adaptive Reuse Projects

The experience of the contractor in implementing adaptive reuse projects is important factor that needs to be considered during the contractor selection process. This due to the fact that considering this factor contributes to achieve the successful accomplishment of the adaptive reuse (Kincaid, 2002). Based on the reviewed literature, many terminologies were used to express this factor (**Table 2.5**), namely: “inventive architects and engineers experienced with older buildings” (Hein and Houck, 2008), “availability of materials and lack of skilled tradesmen” (Conejos et al., 2016), “experience remaining private to the individual firms involved” (Kincaid, 2002), “experienced project manager” (Kincaid, 2002), “expert practitioners” (Kincaid, 2002), and “contractors experienced in the type of use proposed and in the level of specification intended” (Kincaid, 2002).

As mentioned above, there was no unified term used to express this factor in a direct and clear manner. Consequently, ‘previous experience of the contractor with adaptive reuse projects’ was formulated and adopted to express this factor directly in this research.

Based on the reviewed literature, there was no definition/ description formulated yet to explain this factor specifically. Hein and Houck (2008) quoted the following statement *“Inventive architects and engineers experienced with older buildings can recognize and take advantage of design opportunities presented by the existing building as well as devise cost-effective solutions to structural constraints that are certain to materialize”*. Further, Conejos et al. (2016) described this factor as the *“compatibility of new materials with existing materials, as well as the availability of local expertise and tradesmen capable of implementing conservation works”*.

Accordingly, the formulated term ‘previous experience of the contractor with adaptive reuse projects’ was defined as the former knowledge and skills of the construction organization in implementing adaptive reuse projects.

2.7.3.2 Accuracy and Completeness of the Contract Documents

The accuracy and clarity of the contract documents is a major part that needs to be considered for successful accomplishment of the adaptive reuse projects (Fournier and Zimnicki, 2004). Based on the reviewed literature, several terms were used to express this factor, using different synonyms (**Table 2.5**), namely: “inaccuracy of information and drawings” (Conejos et al., 2016), “construction documents and specifications” (Fournier and Zimnicki, 2004), “construction documents” (Hein and Houck, 2008), “construction drawings” (Wilkinson et al., 2014), “costs, quantities and specification details” (Wilkinson et al., 2014), “durable specification and design details” (Wilkinson et al., 2014), “specification” (Kincaid, 2002), “project specification” (Kincaid, 2002), “building specification” (Kincaid, 2002),

“material specification” (Kincaid, 2002), “level of specification” (Kincaid, 2002), “level of specification appropriate to the project proposed” (Kincaid, 2002), and “level of specification intended” (Kincaid, 2002).

As mentioned above, there was a diversity in the terms used to express the impact of the accuracy and completeness of the contract documents on the construction process of the adaptive reuse projects. Further, there was no unified term used to express this factor in a generic context. Accordingly, ‘accuracy and completeness of the contract documents’ was formulated and adopted to be used in this research, to express this factor in a generic and comprehensive context.

However, Conejos et al. (2016) described this factor described as *“the lack of accurate information and drawings for heritage buildings (includes defects or dimensional and material inconsistencies)”*(Conejos et al., 2016). Fournier and Zimnicki (2004) stated that *“Construction documents, representing the methods used to achieve the design intent, are included in the standard design drawings and specifications, but integrated systems drawings and supporting documents should also be developed as part of any adaptive reuse project”*. In addition, Further, Fournier and Zimnicki (2004) also stated that *“specifications work hand in hand with the construction drawings to provide information that cannot be effectively illustrated, or that requires special procedural or component emphasis”*. Kalin et al. (2010) mentioned that the contract documents (which are also known as construction documents) consist of five components, namely: *“agreement, condition of contracts, drawings, specifications and modifications”*. Fournier and Zimnicki (2004) stated that *“typical design documentation includes the*

construction drawings, specifications, and any change orders that materialize during construction and commissioning”.

Relying on the above definitions and information, the formulated term ‘accuracy and completeness of the contract documents’ was defined as the availability of exact and adequate construction documents which include: agreement, contractual conditions, modifications, and drawings and specifications of the building and its systems.

2.7.3.3 Availability of Skilled Workforce

Availability of skilled workforce is among the factors that affect the execution process of any project that comprises refurbishment works (Doran et al., 2009; Egbu, 1994). While the adaptive reuse projects usually include refurbishment works (Bullen, 2007), the human resourcing aspect is intervening in the execution process (Kincaid, 2002). Based on the reviewed literature, several terminologies were used to express this factor, using different phrases (**Table 2.5**), namely: “worker and space efficiencies” (Bullen and Love, 2011c), “workmanship” (Heidrich et al., 2017; Wilkinson et al., 2014), “material durability and workmanship” (Wilkinson et al., 2014), “human resourcing” (Kincaid, 2002), “poor quality of construction materials and workmanship” (Hui et al., 2008), “workforce development” (Rayman et al., 2017), “selection and recruitment of workforce” (Egbu, 1994), “shortage of skilled workforce” (Egbu, 1994), and “training and experience of the work force” (Doran et al., 2009).

As shown above, there was no consistency in the terms used to express the factor of the skills of the workers involved in the execution adaptive reuse projects. In order to have a term expressing the literature terminologies in a broader and clear context, ‘availability of skilled workforce’ was formulated and adopted in this research.

On the other hand, there was no stated definition, or even description, that describes this factor from the perspective of building adaptive reuse. However, Wilkinson et al. (2014) described the criterion of the workmanship as “*the quality of craftsmanship of structure and finishes*”. According to the Oxford Wordpower dictionary, workman is defined as “*a man who works with his hands especially at building or making things*”. Also, workmanship is defined as “*a skill that a workman needs or uses to do or make sth well*”. Moreover, workforce is defined as “*total number of people who work in a company, factory, etc.*” (OXFORD, 2011).

Accordingly, the formulated term ‘availability of skilled workforce’ was defined as the potentiality to have skillful workers who are capable to execute the adaptation process successfully.

2.7.3.4 Construction Equipment and Methods

Construction methods and equipment are among the key factors that need to be considered during the execution of adaptive reuse projects (Hein and Houck, 2008). Based on the reviewed literature, many terminologies were used to indicate this factor, using different terms (**Table 2.5**), namely: “construction methods” (Hein and Houck, 2008), “construction equipment and methods” (Hein and Houck, 2008),

“complexity and technical difficulties” (Conejos et al., 2016), “construction techniques” (Mehr and Wilkinson, 2018; Olivadese et al., 2017), and “construction practices” (Oppong and Masahudu, 2014).

As mentioned above, there was no unified term used to express this factor among the researchers. However, the term ‘construction equipment and methods’ that were used by Hein and Houck (2008) seems to be a broad term that can be used to clearly express this factor. Accordingly, it was adopted to be used in this research.

Based on the reviewed literature, there was no stated definition explains the adopted term in a broad expression. However, Conejos et al. (2016) stated that *“refurbishment techniques, technical installations and innovative solutions for the adaptive reuse of heritage buildings”* are among the challenges of the adaptive reuse. Construction equipment is referred to as the "group of machines" used in the construction process, such as "excavator, trucks, dozer, roller, etc." (Peurifoy et al., 2011). Tatum (1988) defined the construction methods as *“means of achieving construction”*. In addition, Tatum (1988) describe the construction methods as *“the means used to transform resources into constructed products. They define how construction applies resources”*.

According to the mentioned definitions and descriptions, the adopted term ‘construction equipment and methods’ was defined as the construction means and machines used in the execution process of building projects (e.g. adaptive reuse project).

2.7.3.5 Planning and Control of the Financial Resources

Although it is important to consider the technical and human resources during the implementation of adaptive reuse projects, financial resources are also a critical factor that needs to be considered in this context (Kincaid, 2002). Based on the reviewed literature, several terms were used to express this factor (**Table 2.5**), namely: “financial investigations” (Hein and Houck, 2008), “financing” (Kincaid, 2002), “reducing financing costs and risk (Kincaid, 2002), “financial and professional services” (Kincaid, 2002), “costing and project financial analysis” (Kincaid, 2002), “financial factor” (Shehada et al., 2015), “total financial implications” (Shehada et al., 2015), “overrun budgets” (Wilkinson et al., 2014), “cost plan” (Wilkinson et al., 2014), and “cost control process” (Wilkinson et al., 2014).

As mentioned above, there was no unified term used to express the impact of the financial aspects on the construction of adaptive reuse project in a direct manner. Therefore, the term ‘planning and control of the financial resources’ was formulated and adopted to be used in this research. This term clearly expresses this financial factor, with the reflection of the literature terminologies.

Similarly, there was no definition/description available yet that directly explains the formulated term. However, Nunnally (2014) stated that “*financial management of a construction company is equally as important to company success as is its technical management*”. In addition, Nunnally (2014) described the financial planning for a construction project as the process that “*includes cost estimating*

prior to bidding or negotiating a contract, forecasting project income and expenditure (or cash flow), and determining the amount of work that a construction firm can safely undertake at one time”. Further, such author described the project cost control as the process that *“involves the measurement and recording of project costs and progress and a comparison between actual and planned performance”*.

Relying on the above descriptions, the formulated term ‘planning and control of the financial resources’ was defined as the processes that are concerned in estimating, forecasting, defining and managing the expenditures (cash flow) of the project, against to the execution activities.

2.7.3.6 Quality Assurance / Control Requirements

Execution quality of the adaptive reuse projects must be maintained as such as performed in the other building projects (Wilkinson et al., 2014). Based on the reviewed literature, the factor of the execution quality was stated in different synonyms, using different terms (**Table 2.5**), “quality control methods” (Hein and Houck, 2008), “quality of local amenities” (Kincaid, 2002), “preference to quality of project” (Kincaid, 2002), “quality of renovation” (Al-ghamdi, 2011), “quality of adaptive reuse” (Al-ghamdi, 2011), “quality” (Wilkinson et al., 2014), “quality of construction” (Wilkinson et al., 2014), “building quality” (Wilkinson et al., 2014), “inadequate quality assurance” (Glew et al., 2017), and “adequate quality control” (Douglas, 2006).

As mentioned above, there was a diversity in the terms that were used to express the importance and impact of the quality management on the adaptive reuse

construction. Accordingly, ‘quality assurance/control requirements’ was formulated and adopted to express this factor in a clear and simple context.

Regarding the concepts of quality management, Nunnally (2014) stated that *“the terms quality management (QM) and quality assurance (QA) have been adopted to include all aspects of producing and accepting a construction project which meets all required quality standards”*. Such author stated that *“quality control (QC) is primarily concerned with the process control function. Since the contractor has the greatest control over the construction process, it has been found that quality control is most effective when performed by the contractor”*. Regarding the parties concerned in conducting the quality management procedures, also Nunnally (2014) stated that *“the construction contractor is primarily responsible for construction quality. Quality assurance inspections and tests performed by an owner’s representative or government agency provide little more than spot checks to verify that some particular aspect of the project meets minimum standards”*. However,

Nunnally’s descriptions are comprehensive, in which it was concluded both, QC and QA, are carried out during the construction phase. Thus, they have been considered as adequate definitions that can be adopted in this research to describe the formulated term of the factor.

2.7.3.7 Complexity and Difficulties within the Project Site

In adaptive reuse projects, complexity of the building and site is among of major difficulties that might affect the flow of the construction processes and the on-site works (Bullen and Love, 2011c; Hein and Houck, 2008). Based on the reviewed

literature, researchers used different terms and phrases to indicate this factor (**Table 2.5**), namely: “complexity and technical difficulties” (Conejos et al., 2016), “temporary tie used to brace interior, limiting work space” (Hein and Houck, 2008), “difficult construction task” (Hein and Houck, 2008), “particular types of construction difficulty that the project may present” (Kincaid, 2002), “project complexity” (Kurul, 2007), “difficulty in getting the equipment in” (Mehr and Wilkinson, 2018), and “size and complexity of the works being carried out” (Bullen and Love, 2011c).

As shown above, there was no unified term used to express this factor in a clear and generic way. To overcome this gap ‘complexity and difficulties within the project site’ was formulated and adopted to be used in this research. This term reflects the literature terminologies in a broader context.

Conejos et al. (2016) described this factor from the perspective of heritage projects as *refurbishment techniques, technical installations and innovative solutions for the adaptive reuse of heritage buildings*”.

However, Conejos’s description is mostly correlated with the adaptive reuse of heritage buildings. Therefore, it could not be adopted in this research. The formulated term ‘complexity and difficulties within the project site’ was defined as the technical complications and challenges facing the construction process of the adaptive reuse project due to the physical attributes of the building site.

2.7.3.8 Availability and Accessibility of Loading Space

Accessibility of the building site for the transportation of the construction materials and equipment is among the challenging factors in adaptive reuse projects (Hein and Houck, 2008). Based on the reviewed literature, several terms and phrases were used to indicate this factor (**Table 2.5**), namely: “loading space” (Behdad, 2006; Bullen and Love, 2009; Riggs and Chamberlain, 2018), “limited access” (Hein and Houck, 2008), “site access for construction workers and equipment” (Hein and Houck, 2008), “movement of construction equipment and material” (Hein and Houck, 2008), “accessibility by car” (Wilkinson et al., 2014), and “access for materials delivery and removal of waste without disturbing or engaging in negotiations with neighbours” (Wilkinson et al., 2014).

As shown above, there was a no unified term used to express the impact of the availability and accessibility of an allocated space for delivering and transporting the construction materials and equipment. To overcome this gap, ‘availability and accessibility of loading space’ was formulated and adopted to be used in this research. This term expresses the literature terminologies in a broader context.

Based on the review of literature, there was no adopted definition yet that explains this factor and its impact. However, loading space is defined as “*the space for the loading or unloading of a vehicle either outside or inside a building or structure*” (City of Vancouver, 2019). The ADA Standard (2010) (Standards for Accessible Design) mentioned the requirements of the site arrival points as follows “*at least one accessible route shall be provided within the site from accessible parking*

spaces and accessible passenger loading zones; public streets and sidewalks; and public transportation stops to the accessible building or facility entrance they serve”. In addition, Hein and Houck (2008) stated that “the construction site should be fully accessible for workers and for movement of construction equipment and material”.

Relying on the mentioned definition and descriptions, the formulated term ‘availability and accessibility of loading space’ was defined as the possibility to offer an accessible space for transporting and delivering the construction materials and equipment, from and to the project site.

2.7.3.9 Availability of Spaces for Storing the Construction Materials and Equipment

Storage and preservation of the construction materials and equipment are among the important factors that need to be considered during the construction of adaptive reuse projects (Hein and Houck, 2008). Based on the reviewed literature, several terminologies were used to indicate this factor, using different terms and phrases (**Table 2.5**), namely: “temporary structural support of preserved components” (Hein and Houck, 2008), “storage of materials” (Douglas, 2006; LBDS, 2014), “storage space on existing building for the contractor” (Douglas, 2006), “storage space” (Zivkovic et al., 2016), and “material usage” (Zivkovic et al., 2016).

As shown above, there was no unified term used to express the influence of the availability of an assigned space used as a storage for the materials and equipment in adaptive reuse projects. The term ‘availability of spaces for storing the

construction materials and equipment’ was formulated and adopted to be used in this research, to broadly express the literature terminologies.

Based on the reviewed literature, it was noted that there was no stated definition and description explaining this factor. Arata (2006) stated that *“tools and equipment security is often overlooked on most job sites until thefts occur. The largest dollar loss to construction job sites is the result of thefts of tools, equipment and materials”*. Temporary structures are known as *“those structures that are erected and used to aid in the construction of permanent projects”* (Deerkoski, 2012). Nunnally (2014) stated *“ensure that temporary structures are properly designed, constructed, and braced”*. On the other hand, Douglas (2006) stated that there is a need to provide “storage space on existing building for the contractor”.

Relying on the mentioned information above, the formulated term ‘availability of spaces for storing the construction materials and equipment’ was defined as the possibility to offer an adequate space in/out the building to be used as a storage for the construction materials and equipment during the adaptive reuse execution.

2.7.3.10 Enforcement and Management of Safety Procedures at the Project Site

Enforcement and management of safety in construction areas are a crucial tasks, which have a direct bearing on the project success (Manu et al., 2010, 2012; Sherratt et al., 2013). It is an influential factor on the process of implementing refurbishment or alteration on projects (Anumba et al., 2004; Egbu et al., 2002; Lee and Egbu, 2005). Based on the reviewed literature, several terms were used to express the importance of enforcing safety in building projects (**Table 2.5**), namely:

“maintaining site safety and welfare standards” (Egbu, 1994), “management of health, safety and well-being on adaptive-retrofit projects” (Danso et al., 2015), “construction site safety” (Sherratt et al., 2013), “safety performance of repair, maintenance, minor alteration and addition (RMAA) works” (Hon et al., 2011), safety management in building refurbishment (Z. Chen et al., 2017), “implementation of all the health and safety procedures” (Anumba et al., 2004), and “managing health & safety in refurbishment projects” (Egbu et al., 2002).

As shown above, there was no unified expression used to describe the importance of implementing and controlling the safety in the site of building renovation/adaptation projects. In order to express the mentioned terms in a broad and brief context, the term ‘enforcement and management of safety procedures at the project site’ was formulated and adopted to be used in this research.

The reviewed literature revealed that there was no unified definition as well as description of this factor. Papadakis and Amendol (1997) defined the safety management as *“the aspect of the overall management function that determines and implements the safety policy”*. The authors also stated, *“this will involve a whole range of activities, initiatives, programs, etc., focused on technical, human and organizational aspects and referring to all the individual activities within the organization, which tend to be formalized as Safety Management Systems (SMS)”*.

The mentioned above definition and explanation is understandable and generic, where they are not directly relevant to building projects. Thus, the formulated term, ‘enforcement and management of safety procedures at the project site’, was defined

as the process of conducting, controlling and monitoring all field activities and measures required for providing safe environment to individuals, work performance and assets at the workplace of building projects.

2.7.4 Factors Related to the Operation and Maintenance Phase

This group includes the factors affecting adaptive reuse projects during the operation and maintenance (O&M) phase. Under this group, eight factors were identified based on the review of literature, namely: availability and adequacy of the commissioning process for the MEP systems, availability of accurate records of the building assets, efficiency of the utilization of the building spaces, compliance with health and safety measures, development and implementation of work schedules for different maintenance types (e.g. planned, unplanned), potentiality of obsolescence and/or deterioration of building components and/or systems, control over the operational characteristics of the building components and systems, and user satisfaction with the layout of the building as well as the workflow of activities.

2.7.4.1 Availability and Adequacy of the Commissioning Process for the MEP Systems

Commissioning process is highly recommended to be conducted in the buildings that have been adaptively reused (Douglas, 2006; Wilkinson et al., 2014). This is due to that fact that this process has the potential to increase the efficiency of the energy consumption of the MEP systems in the building (Haasl and Sharp, 1999). Based on the reviewed literature, several terms were used to express the importance of the commissioning tasks, using different terms (**Table 2.5**), namely:

“commissioning” (Fournier and Zimnicki, 2004), “commissioning process” (Douglas, 2006; Fournier and Zimnicki, 2004), “continuous commissioning” (Fournier and Zimnicki, 2004), “certificate of occupancy” (LBDS, 2014), “test procedures” (LBDS, 2014), “documented programming specification and revised the building technical manual” (Wilkinson et al., 2014), and “accurate as-built manuals” (Wilkinson et al., 2014).

As shown above, there was no unified term used to express the importance as well as the impact of implementing commissioning process on the performance of the adaptively reused building. However, “commissioning” was the mostly frequent term used in the literature to indicate this factor. Therefore, ‘availability and adequacy of the commissioning procedures for the MEP systems’ was formulated and adopted to be used in this research. This term expresses the literature terminologies, as well as clearly indicate the importance and the impact the factor within the context of building adaptive reuse.

However, commissioning can be defined as *“a systematic process of verifying and documenting building systems or subsystems performance against the building design criteria and the owner’s operational needs”* (Fournier and Zimnicki, 2004).

The above definition is generic, since the concept of building adaptive reuse is not included within its context. To respond to this gap, the formulated term, ‘availability and adequacy of the commissioning procedures for the MEP systems’ was defined as the possibility of offering an adequate and organized verification process on the performance of all MEP systems in the adaptively reused buildings.

2.7.4.2 Availability of Accurate Records of the Building Assets

There is a necessity to provide completed records on the building information after the implementation of adaptive reuse projects. These records need to comprise the as-built drawings and other documents, which would assist the O&M personnel to effectively accomplish their day-to-day activities (Fournier and Zimnicki, 2004). Based on the reviewed literature, several terminologies were used to express the importance of such factor in adaptive reuse projects, using different terms and phrases (**Table 2.5**), namely: “accurate “as built” drawings and other records” (Fournier and Zimnicki, 2004), “the corporate asset strategy and management plan” (Ladinski, 2017), “efficient use of property assets” (Ladinski, 2017), “standard asset management profile” (Wilkinson et al., 2014), “contemporary asset management” (Wilkinson et al., 2014), and “portfolio of assets” (Wilkinson et al., 2014).

As shown above, there was no unified term used to express this factor in the literature. However, “asset” was the most frequent term in the reviewed literature. In order to provide a term expressing the literature terminologies in a broader and clear context, ‘availability of accurate records of the building assets’ was formulated and adopted to be used in this research.

Moreover, there was no adopted definition describing this factor in a direct statement in the literature, as well. However, assets are defined as “*inventory, plant, equipment and other facility contents, and are distinct from real property like land and buildings*” (Devine, 2011). Fournier and Zimnicki, (2004) indicated the

importance of such kind of information in adaptive reuse projects, as follows
“accurate as built drawings and other records must be maintained to assist in the commissioning and ongoing operation and maintenance of the completed project”.

Accordingly, the formulated term ‘availability of accurate records of the building assets’ was described as the potential to offer an exact record keeping of all the contents within the building, including its components and systems.

2.7.4.3 Efficiency of the Utilization of the Building Spaces

Efficiency of using the spaces of buildings that were refurbished or adaptively reused is one of the factors that need to be fulfilled during the occupancy phase. Thus, facilities managers, or building administrators, of adaptively reused building should consider the spatial efficiency after the implementation of the change of use (Douglas, 2006). Based on the reviewed literature, this factor was mentioned and indicated in previous studies, using different terms (**Table 2.5**), namely: “accommodate space organization for new function” (Al-obaidi et al., 2017), “allocation of space and rooms for major event and post-event use” (Brown and Cresciani, 2017), “workplace strategy” (Ladinski, 2017), “efficient use of office spaces” (Ladinski, 2017), “space efficiency” (Douglas, 2006), “space planning exercise” (Douglas, 2006), and “efficiency ratio” (net-to-gross ratio) (Douglas, 2006).

As shown above, there was no unified and common term used to express the impact of the efficiency in adaptively reused buildings, in the literature. Accordingly, ‘efficiency of the utilization of the building spaces’ was formulated and adopted to be use in this research, for expressing the literature terminologies in a broad context.

However, space efficiency can be defined as the ratio of the net lettable or usable space (NLA) to the total (gross) floor area (TFA) (Douglas, 2006; Muir, 2011). This definition is generic, adequate and comprehensible. Consequently, it was adopted to clearly describe the formulated term 'efficiency of the utilization of the building spaces'.

2.7.4.4 Compliance with Health and Safety Measures

Health and safety aspects are among the major factors that need to be jointly considered for the occupants of adaptively reused buildings (Douglas, 2006). Based on the reviewed literature, different terminologies were used to express this factor in previous research (**Table 2.5**), namely: “align security and safety features” (Brown and Cresciani, 2017), “health and safety file” (Fieldson, 2017), “health and safety” (Jin, 1996), “health and safety of the occupant” (Mehr and Wilkinson, 2018), and “health and safety of occupiers and the public” (Douglas, 2006).

As mentioned above, there was a diversity in the terms used to express the factor of the health and safety, in context of adaptively reused buildings. However, the term ‘health and safety’ was frequent among the mentioned terminologies. In this regard, ‘compliance with health and safety measures’ was formulated and adopted to be used in this research. This term is generic and clear to express the factor

Based on the reviewed literature, there was no developed definition and description yet that directly explains the formulated term. However, Jin (1996) indicated the importance of the factor of the health and safety for the new occupancy as follows *“progress also demand reevaluation of standards of which the standard of public health and safety must be the most pertinent”*.

Relying on the mentioned information by Jin (1996), the formulated term ‘compliance with health and safety measures’ was defined as the obligation to the applicable health and safety requirements of the new function.

2.7.4.5 Development and Implementation of Work Schedules for Different Maintenance Types (e.g. Planned, Unplanned)

Implementation of maintenance activities in adaptively reused buildings is a critical factor that has a direct bearing on the efficiency of the facilities’ performance (Fieldson, 2017). Based on the reviewed literature, several terminologies were used to indicate the impact of maintenance on the O&M phase in adaptive reuse projects, using different terms and phrases (**Table 2.5**), namely: “a pack of information known as an operation and maintenance (O&M)” (Fieldson, 2017), “develop and use maintenance practices” (Fournier and Zimnicki, 2004), “proper operation and maintenance” (Fournier and Zimnicki, 2004), “repair and maintenance programs” (Douglas, 2006), “maintenance procedures” (Douglas, 2006), “types of maintenance: proactive (i.e. planned) and reactive (i.e. unplanned)” (Douglas, 2006), “maintenance schedules” (Douglas, 2006), “maintenance audit” (Douglas, 2006), and “day-to-day repair and maintenance works” (Wilkinson et al., 2014).

As mentioned above, there was a diversity in the terms used in the literature to indicate the impact of the maintenance factor on the life-cycle of the adaptive reuse projects. It was noted that all the literature terminologies include the term “maintenance” within their context. Thus, the term ‘development and implementation of work schedules for different maintenance types (e.g. planned, unplanned)’ was formulated and adopted to reflect this finding on the context of the research variables.

However, according to the BS 3811:1964, maintenance is defined as “*a combination of ant actions carried out to retain an item in, or restore it to, an acceptable condition*” (Wordsworth, 2001). In addition, there are seven types of maintenance works that are performed on existing buildings, namely: “*planned, unplanned, preventive, corrective, emergency, condition-based, and scheduled maintenance*” (Chanter and Swallow, 2007).

According to the mentioned definition and description, the formulated term ‘development and implementation of work schedules for different maintenance types (e.g. planned, unplanned)’ was defined as the comprehensive process of establishing and following time schedules for all maintenance activities required for the operation of building(s), including planned and unplanned activities.

2.7.4.6 Potentiality of Obsolescence and/or Deterioration of Building Components and/or Systems

Maintaining the availability of state-of-the-art systems, in an appropriate physical condition, is an important factor that needs to be satisfied in the adaptively reused buildings. Consideration of such factor in adaptively reused old buildings is more crucial, since it keeps the value and attractiveness of these premises (Z. Ali et al., 2018). This implies that the condition of the building systems needs to be maintained against the causes of obsolescence and/or deterioration. Based on the reviewed literature, several terminologies were used to express this factor, using different terms and phrases (**Table 2.5**), namely: “physical deterioration” (Al-obaidi et al., 2017), “moisture-related deterioration” (Fournier and Zimmnicki, 2004), “deterioration of materials and components” (Chanter and Swallow, 2007), “obsolescence and redundancy” (Douglas, 2006), “obsolescence or inefficiency” (Douglas, 2006), “obsolete construction” (Douglas, 2006), and “equip the site with an adequate level of services relating to its new usage” (Z. Ali et al., 2018).

As mentioned above, there was a diversity in the terms used in the literature to express the importance of considering the obsolescence and deterioration of adaptively reused buildings. The term ‘potentiality of obsolescence and/or deterioration of building components and/or systems potentiality of obsolescence and/or deterioration of building components and/or systems’ was formulated and adopted to be used in this research. This term expresses the factor in a broader context, as well as covers the literature terminologies in a comprehensive phrase.

Generally, obsolescence can be defined as *“the condition of being antiquated, old fashioned or out of date, resulting when there is a usually rapid change in the requirements or expectations regarding the shelter, comfort, profitability or other dimension of performance that a building or building subsystem is expected to provide”* (Douglas, 2006). According to the Oxford Wordpower dictionary, ‘deteriorate’ means *“to become worse”*.

Douglas’s definition explains a one-part of the factor, which is the obsolescence, where the deterioration was not covered within its context. Accordingly, the formulated term ‘obsolescence and/or deterioration of building components and/or systems’ was defined as the decline in the durability and desirability of the building components and/or systems, due to the changes in its physical conditions and/or market demand, so that they become outdated.

2.7.4.7 Control over the Operational Characteristics of the Building Components and Systems

Control over the operation of the building systems, is one of the major factors that affect the environmental condition and performance of the adaptively reused facilities (Al-obaidi et al., 2017). Based on the reviewed literature, many terminologies were used to express this factor, using different terms and phrases (**Table 2.5**), namely: “provide auto controlled indoor temperature system” (Al-obaidi et al., 2017), “provide flexible lighting controls” (Al-obaidi et al., 2017), “facilities are properly maintained and functional” (Z. Ali et al., 2018), “control of the internal conditions” (Brown and Cresciani, 2017), “effective and operational

controls” (Fournier and Zimnicki, 2004), “monitoring building operations” (Douglas, 2006), and “enhancing the performance characteristics of a building’s major elements, components and/or services” (Douglas, 2006).

As shown above, there was no unified term used to directly and clearly express this factor. Accordingly, the term ‘control over the operational characteristics of the building components and systems’ was formulated and adopted to be used in this research. This term provides broader context that reflects and expresses the literature terminologies.

Based on the reviewed literature, it was noted that there was no stated definition or description that adequately explains this factor. However, Fournier and Zimnicki (2004) described the importance of this factor as follows: *“education of the building operations and maintenance staff ensures that systems are operated as designed and are maintained at optimal performance throughout their life”*. In addition, Douglas (2006) defined the term “monitoring building operation” as the *“competent supervision of the works in progress is required to ensure adequate quality control”*.

According to the mentioned definition and description above, the formulated term ‘control over the operational characteristics of the building components and systems’ was defined as the process of monitoring and supervising the required operational works for all systems and components within the building.

2.7.4.8 User Satisfaction with the Layout of the Building as well as the Workflow of Activities

User satisfaction with the spaces of the adaptively reuse buildings is an important factor that needs to be analyzed and assessed. This due to the fact that users' satisfaction analysis provides a feedback on the design judgment and overall performance of the building, from the occupants' point view (Al-obaidi et al., 2017). Based on the review of literature, several terminologies were used to express this factor, using different terms and phrases (**Table 2.5**), namely: “occupants’ satisfaction of the interior spaces” (Al-obaidi et al., 2017), “expectations and perceptions of the service performance” (Z. Ali et al., 2018), “users' preferences and needs” (Chua and Deguchi, 2010), “occupant satisfaction and performance” (Fournier and Zimnicki, 2004), and “satisfaction of human needs” (Fournier and Zimnicki, 2004).

As shown above, there was a diversity in the terms used in the literature to indicate the importance of considering the users' satisfaction in adaptively reused buildings. However, the terms ‘occupants’ and “satisfaction” were frequently used in the literature. On the other hand, the term ‘user’ is more specific to express the specific kind of people who needs to be considered in the satisfaction assessment. In order to express the factor of user satisfaction with keeping in mind the other interfering issues, the term ‘user satisfaction with the layout of the building as well as the workflow of activities’ was formulated and adopted to be used in this research.

Based on the reviewed literature, there was no stated definition yet explains the formulated and adopted term in an adequate manner. However, satisfaction can be defined as *“acceptable accommodation of occupant/user needs”*(Preiser et al., 1988). On the other hand, Frontczak et al. (2012) stated that *“the definition of occupants’ satisfaction was not consistent among the studies, but all of them defined occupants satisfaction in a broad perspective and related it either to satisfaction/comfort with indoor environmental quality or satisfaction/ comfort with the workspace”*.

Relying on the mentioned definition and description above, the formulated term ‘user satisfaction with the layout of the building as well as the workflow of activities’ was defined as the occupant acceptance with the distribution of the spaces, and the flow of services and activities within the building context.

Table 2.5: List of the identified factors and their terminology(s), definition(s)/ description and measurements/assessment method(s)

#	Factor	Terminologies	Definition/ description	Formulated/adopted definition/ description
A) Factors related to the phase of conceptual planning and feasibility studies				
1.	Structural integrity of the building	- Structural integrity (Douglas, 2006) - Building's structural integrity after redevelopment (Aigwi et al., 2018) - Structural integrity of the building (Bullen, 2007; Hein and Houck, 2008; Shah, 2014; Wilkinson et al., 2014) - Deterioration of the structure and fabric of the buildings (Bullen and Love, 2011c) - Structural strength, stability and inset condition of the structure (Naidu, 2008) - Structural condition (Wilkinson et al., 2014)	- Structural integrity of the building can be described as the ability of the structure of an existing building for catering future uses and loads (Wilkinson et al., 2014).	- Structural integrity of the building can be described as the ability of the structure of an existing building for catering future uses and loads (Wilkinson et al., 2014).
2.	Municipal approval for the land use change	- Legal constraints (Conejos et al., 2016) - Planning and regulatory approval (Kincaid, 2002) - Regulations defined by planning and local authorities (Misiurilsoy and Günçe, 2016) - Legal consideration in term of the building classification (Wilkinson et al., 2014) - Existing land use (Wilkinson et al., 2014) - Municipal zoning plans (Remøy and Voordt, 2007)	- Compliance with the existing conservation guidelines, licensing and planning requirements (Conejos et al., 2016).	- Compliance with requirements of the local authorities, in terms of their planning guidelines and licensing procedures (Conejos et al., 2016).

Table 2.5: List of the identified factors and their terminology(s), definition(s)/ description and measurements/assessment method(s) (Cont.)

#	Factor	Terminologies	Definition/ description	Formulated/adopted definition/ description
3.	The condition of building components and/or systems	- Building condition (Al-obaidi et al., 2017) - Condition of external fabric and finishes (Bullen and Love, 2011c) - Depreciation of the buildings fabric and systems their (Bullen and Love, 2011c) - Architectural integrity of the building (Mehr and Wilkinson, 2018) - Poor performing envelopes and inadequate energy systems (Mehr and Wilkinson, 2018) - Physical condition of building; physical deterioration and building obsolescence (Wilkinson et al., 2014) - Physical deterioration and building obsolescence (Wilkinson et al., 2014) - Physical obsolescence (Langston et al., 2008) - Technological obsolescence (Langston et al., 2008) - Technical state (Wilkinson et al., 2014) - Existing physical condition of the building (Mİslirlişoy and Günçe, 2016)	- Physical obsolescence is the “<i>accelerated deterioration leads to reduced physical performance and obsolescence of the building</i>” (Langston et al., 2008). - Technological obsolescence is “<i>the change in owner objectives and needs leads to possible functional change from the purpose for which a building was originally designed</i>” (Langston et al., 2008).	- ‘The condition of building components and/or systems’ was defined therefore as the current state of the physical and performance capacities of the building components and systems.
4	Architectural program of the new function	- Programming requirements (Beck, 2014) - Programmatic needs (Beck, 2014) - New program requirements (Eyüce and Eyüce, 2010) - New program and new functional requirements (Eyüce and Eyüce, 2010) - Reprogramming process (Yaldiz and Asatekin, 2013) - Reprogramming process (Yaldiz and Asatekin, 2013) - Programming of the new function (Yaldiz and Asatekin, 2013) - Change of architectural program (Yaldiz and Asatekin, 2013) - Functional program me (Wilkinson et al., 2014) - Programme of requirements (Wilkinson et al., 2014)	- Architectural program can be defined as “<i>the document in which the identified values, goals, facts, and needs are presented</i>” (Hershberger, 2015) - Programming can be defined as “<i>the analytic stage of analysis design and information collection which includes observation and measurement as well</i>” (Yaldiz and Asatekin, 2013). - Architectural programming can be defined as “<i>the first stage of the architectural design process in which the relevant values of the client, users, architects, and society are identified, important project goals articulated, facts about the project are uncovered, and facility needs made explicit</i>” (Hershberger, 2015).	- ‘Architectural program of the new function’ was defined as the group of information and data gathered during the planning of adaptive reuse projects, including the goals and needs of the new function.

Table 2.5: List of the identified factors and their terminology(s), definition(s)/ description and measurements/assessment method(s) (Cont.)

#	Factor	Terminologies	Definition/ description	Formulated/adopted definition/ description
5.	Potential of the building spaces to be adaptively reused	- Adaptable buildings (Arge, 2005) - Adaptability of the space (Bullen and Love, 2011c) - Adaptive reuse potential (Langston et al., 2008) - Potential of the building for ‘alterations’ adaptation (Wilkinson et al., 2014) - Adaptability (Arge, 2005; Heidrich et al., 2017; Kincaid, 2000; Wilkinson et al., 2014) - Adaptability potential (Kincaid, 2000) - Re-use potential (Ball, 2002) - Convertibility (Conejos et al., 2011; Wilkinson et al., 2014)	- Adaptive reuse potential can be defined as “<i>the propensity of an asset to be ‘recycled’ to perform a significantly different function while keeping the basic attributes of the asset in place</i>” (Wilkinson et al., 2014) - Adaptability can be defined as “<i>the inherent properties in a building that gives it the ability to change, or the relative ease with which it can be changed through some external intervention</i>” (Heidrich et al., 2017). - Convertibility can be defined as “<i>ease of conversion to other use and costs associated with the conversion</i>” (Wilkinson et al., 2014).	- ‘Potential of the building spaces to be adaptively reused’ was defined as the ability of the building spaces to be functionally converted in an easy manner.
6.	Allocated budget for the adaptation process	- Costs of adapting a building (Bullen and Love, 2011b) - Project budget (Kincaid, 2002) - Budget estimate (Wilkinson et al., 2014) - Budget estimate (Wilkinson et al., 2014) - Capital budgeting criteria (Wilkinson et al., 2014) - Construction cost (Bullen and Love, 2011a; Langston et al., 2008) - Cost of financing (Langston et al., 2008) - Adaptation cost (Wilkinson et al., 2014)	- Budgeting can be defined as “<i>the disciplined pre-determination of cost, and such is a significant element of planning and control for any business or project</i>” (Langston, 2011). - Budget allocation can be described as “<i>complex process with too many contradictions in form of criteria or attributes</i>”, concerning about “<i>how to allocate and utilize the limited resources to all administrative issues in a reasonable way</i>” (Yadollahi and Zin, 2011).	- ‘Allocated budget for the adaptation process’ was defined as the determined client budget that will be spent in the whole process of the adaptive reuse project
7.	Expected yield from the adaptation	- Capital investment (Bullen and Love, 2011a) - Cost-benefit analysis (Bullen and Love, 2011b) - Introduce financial incentives to provide income (Bullen and Love, 2011c) - Financial incentives (Bullen and Love, 2011c) - Financial and technical perceptions (Conejos et al., 2016) - Yields (Wilkinson et al., 2014) - Total estimated yield (Wilkinson et al., 2014) - Anticipated yield performance (Kincaid, 2002) - Investment in adaptive reuse yields (Kincaid, 2002) - Profits from market demand (Mİslırlısoy and Günce, 2016)	- Yield can be defined as “ <i>the amount that is produced</i> ” (OXFORD, 2011).	- ‘Expected yield from the adaptation’ was defined as the probable amount that might be returned from the new function of the adaptive reuse project.

Table 2.5: List of the identified factors and their terminology(s), definition(s)/ description and measurements/assessment method(s) (Cont.)

#	Factor	Terminologies	Definition/ description	Formulated/adopted definition/ description
8.	The schedule of the adaptation activities	- Renovation activities (Hein and Houck, 2008) - Construction activities (Hein and Houck, 2008) - Planning and constructing an adaptive reuse project (Hein and Houck, 2008) - Construction schedule (Hein and Houck, 2008) - Refurbishment activities (Kincaid, 2002) - Planning activities (Kincaid, 2002) - Traces of activities and processes (Lardner et al., 2013) - Management plan (Lardner et al., 2013) - Main adaptation work being carried out on a building (Watson, 2009) - Adaptation work (Douglas, 2006) - Necessary interventions that will be applied (MIsIrIIsay and Günçe, 2016)	- Activities can be defined as “<i>anything that must be accomplished (whether by the owner, contractor, subcontractor, inspector, or other party) in order for the project to be completed may warrant inclusion in the network</i>” (Hinze, 2012). - Schedule is “<i>nothing more than time-phased plan which used as a guide during the performance of an operation in order to control the pace of activities and to permit completion of the operation at the desired or required time</i>” (Nunnally, 2014). - Adaptation is “<i>considered as work accommodating change in use or size or performance of a building which may include alterations, extensions, improvements, and other works modifying it in some way</i>” (Douglas, 2006).	- ‘Schedule of the adaptation activities’ was defined as the time schedule of the works required to execute the adaptive reuse project.
9.	Compatibility of the building appearance with the client desired design	- Building appearance (Kincaid, 2002; Wilkinson and Reed, 2011) - External appearance (Kincaid, 2002) - Ability to aesthetically fit streetscape (Bullen and Love, 2011b) - Aesthetics (Watson, 2009; Wilkinson et al., 2014) - High architectural merit including pleasing aesthetics and compatibility with its surrounding streetscape (Wilkinson et al., 2014) - Construction form, envelop, shape and height (Wilkinson, 2012b)	- Aesthetics indicates “<i>architectural beauty, good appearance, proportion, etc.</i>” (Wilkinson et al., 2014). - Premium buildings are that “<i>reflecting contemporary and modern appearance of the stock and current perceptions of what is aesthetically pleasing</i>” (Wilkinson, 2012b). - Compatible means that “<i>suitable to live together or to be used together</i>” (OXFORD, 2011).	- ‘Compatibility of the building appearance with the client desired design’ was defined as the suitability of the appearance of the building that will be adaptably reused with desired design outputs from the client.

Table 2.5: List of the identified factors and their terminology(s), definition(s)/ description and measurements/assessment method(s) (Cont.)

#	Factor	Terminologies	Definition/ description	Formulated/adopted definition/ description
B) Factors related to the design and engineering phase				
10.	Previous experience of the design team with adaptive reuse projects	- Lack of previous experience in the new form of building and construction (Al-ghamdi, 2011) - Knowledge and experienced (Al-ghamdi, 2011) - Limited skilled labor and experienced specialists in the field (Al-ghamdi, 2011) - Past experience (Alauddin, 2014) - Skills and experience of project team's member (Alauddin, 2014) - Experience and judgment of specialist consultants (Wilkinson et al., 2014) - Assembling the skills and experience (Kincaid, 2002)	- Kincaid (2002) stated that <i>"engineering consultants should have experience with the unique type of work required for each project"</i>. - Past experience can be defined as <i>"the practically-oriented knowledge that accumulates from past projects and the intervening period in a time series scenario"</i> (Alauddin, 2014).	- 'Previous experience of the design team with adaptive reuse projects' was defined as the knowledge and skills of the design professionals, that were gained from former adaptive reuse projects.
11.	Code requirements for the new occupancy	- Compliance with building codes (Bullen and Love, 2011b) - Building codes and regulations/legal constraints (Conejos et al., 2016) - Regulations (Lardner et al., 2013) - Occupational health and safety regulations (Lardner et al., 2013) - Legal attributes (Wilkinson et al., 2014) - Building codes (Wilkinson et al., 2014) - Fire codes (Wilkinson et al., 2014) - Health and safety issues (Wilkinson et al., 2014) - Legal inputs (Yaldiz and Asatekin, 2013) - Certain requirements of the new function (Yaldiz and Asatekin, 2013)	- Code requirements can be described as <i>"the minimum requirements to safeguard the public health, safety and general welfare through structural strength, means of egress facilities, stability, sanitation, adequate light and ventilation, energy conservation, and safety to life and property from fire and other hazards attributed to the built environment and to provide safety to fire fighters and emergency responders during emergency operations"</i> (IBC, 2018). - The aspect of the building codes and regulations/legal constraints can be described as <i>"Compliance with current building codes, regulations, conservation guidelines, licensing and planning requirements"</i> (Conejos et al., 2016).	- 'Code requirements for the new occupancy' was defined as the legal and design requirements of the new function, that are stated in the applicable building codes and standards .
12.	Availability and accuracy of the drawings and specifications of the existing project	- Inaccuracy of information and drawings (Conejos et al., 2016) - Background information on the building lacked accuracy (Oppong and Masahudu, 2014) - Risk of inaccurate drawings and differing construction (Wilkinson et al., 2014)	- This factor can be described as <i>"the lack of accurate information and drawings for heritage buildings (includes defects or dimensional and material inconsistencies)"</i> (Conejos et al., 2016). - Wilkinson et al. (2014) stated that <i>"measurements and materials used do not always correspond to the construction drawings"</i>.	- 'Availability and accuracy of the drawings and specifications of the existing project' was defined as potential to obtain an accurate drawings and specifications of the building that are recently updated to be identical to the current situation of the building

Table 2.5: List of the identified factors and their terminology(s), definition(s)/ description and measurements/assessment method(s) (Cont.)

#	Factor	Terminologies	Definition/ description	Formulated/adopted definition/ description
13.	Net area of the adaptable space	- Size and shape of the building (Al-obaidi et al., 2017) - A plot size of area (Oppong and Masahudu, 2014) - Floor area (Kincaid, 2002; Wilkinson et al., 2014) - Gross floor area (Wilkinson et al., 2014) - Floor size (Wilkinson et al., 2014) - Lower-grade space available (Wilkinson et al., 2014) - Total floor area (Kincaid, 2002) - Areas that are required for people's activities (Yaldiz and Asatekin, 2013) - Areas that are required for people's activities (Yaldiz and Asatekin, 2013) - Areas for the various human activities in the adaptation to the new function (Yaldiz and Asatekin, 2013)	- Gross floor area is defined as <i>"The floor area within the inside perimeter of the exterior walls of the building under consideration, exclusive of vent shafts and courts, without deduction for corridors' stairways, closets, the thickness of interior walls, columns or other features"</i> (IBC, 2018). - Net floor area is defined as <i>"actual occupied area not including unoccupied accessory areas such as corridors, stairways, toilet rooms, mechanical rooms and closets"</i> (IBC, 2018).	- 'Net area of the adaptable space' was defined as total area of the occupied spaces in the building, which can be adaptively reused.
14.	Layout of spaces within the building	- Building form or organization of space (Arge, 2005) - Functional organization (Arge, 2005) - Layouts and space plans (Arge, 2005) - Building layout (e.g. space efficiencies (Bullen and Love, 2011a, 2011c) - Internal layout (space plan) (Bullen and Love, 2011a) - Physical restriction (Conejos et al., 2016) - Shape of floor plate (Wilkinson et al., 2014) - Service core location (Wilkinson et al., 2014)	- This factors can be described as <i>"the restrictions due to existing floor layouts, number of columns/walls and structural system layouts"</i> (Wilkinson et al., 2014).	- 'Layout of spaces within the building' can be described as <i>"the restrictions due to existing floor layouts, number of columns/walls and structural system layouts"</i> (Wilkinson et al., 2014).

Table 2.5: List of the identified factors and their terminology(s), definition(s)/ description and measurements/assessment method(s) (Cont.)

#	Factor	Terminologies	Definition/ description	Formulated/adopted definition/ description
15.	Number and layout of the structural columns	- Number of columns/walls and structural system layouts (Conejos et al., 2016) - Difference in column sizing (Hein and Houck, 2008) - Column spacing and floor heights (Hein and Houck, 2008) - Distance between columns (Wilkinson et al., 2014) - Internal layout (columns) (Wilkinson et al., 2014) - Structural grid and section dimensions (Kincaid, 2002) - Technical grid/module (Arge, 2005)	- This factor can be described as <i>“the technical grid, or the distance between the structural columns on the floor plate”</i> (Wilkinson et al., 2014)	- The factor of the ‘number and layout of the structural columns’ can be described as <i>“the technical grid, or the distance between the structural columns on the floor plate”</i> (Wilkinson et al., 2014).
16.	Layout of the existing MEP systems	- Technical grid/module (Arge, 2005) - Complexity and technical difficulties (Conejos et al., 2016) - Vertical service location (Wilkinson et al., 2014) - Building services (Wilkinson et al., 2014) - Service ducts and corridors (Wilkinson et al., 2014) - Vertical circulation (Wilkinson et al., 2014) - Service elements (Wilkinson et al., 2014) - Utilities and existing building infrastructure (LBDS, 2014) - Location of vertical services (Wilkinson and Reed, 2011) - Building services and equipment (Wilkinson and Reed, 2011) - Building service designs (Halvitigala and Reed, 2015) - HVAC systems, electrical systems, lighting and water supply systems (Halvitigala and Reed, 2015)	- Wilkinson et al. (2014) described this factor as the criterion that concerned with <i>“service ducts and corridors: vertical circulation, service elements, raised floors, etc.”</i> .	- ‘Layout of the existing MEP systems’ was defined as the design and distribution of the currently available MEP systems in the building.

Table 2.5: List of the identified factors and their terminology(s), definition(s)/ description and measurements/assessment method(s) (Cont.)

#	Factor	Terminologies	Definition/ description	Formulated/adopted definition/ description
17.	Capacity of the existing MEP systems to serve the new function	- Reduced levels of amenity and service (Bullen and Love, 2011c) - Condition of mechanical, plumbing and electrical systems and their capacity for modification (Bullen and Love, 2011a) - Capacity of the electrical, water, gas, and sewer services (LBDS, 2014) - Services to meet new use requirements (Wilkinson and Reed, 2011) - Outdated building services (Wilkinson and Reed, 2011) - Additional operational requirements (Halvitigala and Reed, 2015) - Buildings extra capacity (Conejos et al., 2016) - Characteristics of a potential use and the related performance requirements can be matched (Kincaid, 2002)	- This factor can be described as <i>“the additional operational requirements caused by space-use intensification”</i> (Halvitigala and Reed, 2015) - It was mentioned in the LBDS manual that <i>“existing buildings may also be limited as far as the capacity of the electrical, water, gas, and sewer services”</i> (LBDS, 2014). - Conejos et al. (2016) stated that <i>“buildings extra capacity must be considered for future servicing and insulation”</i>.	- ‘Capacity of the existing MEP systems’ can be described as the operational size of the currently available MEP systems in the building
18.	Potential to install additional and/or new systems	- Install new services that would be required to reduce resource consumption (Bullen and Love, 2011a) - Installing mechanical air conditioning to improve indoor air quality and meet user expectations (Mehr and Wilkinson, 2018) - Installation of electrical equipment and lighting (Mehr and Wilkinson, 2018) - Installation of electrical equipment and lighting (Mehr and Wilkinson, 2018) - Installation of telecommunications equipment (Mehr and Wilkinson, 2018) - Flexibility (Arge, 2005; Halvitigala and Reed, 2015) - Installations (Wilkinson et al., 2014) - Potential technical difficulties (Kincaid, 2002)	- Flexibility means that <i>“a building has built-in possibilities to rearrange, take away or add elements and systems, when the needs of the users change”</i> (Arge, 2005). - Wilkinson et al. (2014) stated that <i>“parts of the installation works had technical issues relating to latent conditions”</i> - Wilkinson et al. (2014) described the issue of installation flexibility as <i>“the impossible to fit vertical ventilation shafts”</i>	- ‘Potential to install additional and/or new systems’ was defined as the possibility to install new and/or extra services systems to the building in an easy way.

Table 2.5: List of the identified factors and their terminology(s), definition(s)/ description and measurements/assessment method(s) (Cont.)

#	Factor	Terminologies	Definition/ description	Formulated/adopted definition/ description
19.	Site configuration and requirements	- Onsite contamination (Conejos et al., 2016) - Site access (Conejos et al., 2015; Kincaid, 2002) - Parking provision (Kincaid, 2002) - Site amenity (Kincaid, 2002) - Locational and site characteristics (Kincaid, 2002) - Site orientation (Wilkinson et al., 2014) - Spatial configuration (Wilkinson et al., 2014) - Car parking (Wilkinson et al., 2014) - Locational and land use attribute (Wilkinson et al., 2014) - Location and site (Wilkinson et al., 2014) - Plot size and site plan (Wilkinson et al., 2014) - Spatial formation (Yaldiz and Asatekin, 2013) - Spatial organization (Yaldiz and Asatekin, 2013) - Spatial requirements (Yaldiz and Asatekin, 2013)	- Site access can be defined as “<i>the proximity or link to access roads, parking and communal facilities, etc.</i>” (Conejos et al., 2015; Wilkinson et al., 2014). - Locational and site characteristics are the physical attributes that include the following five variables: “<i>site access, boundary condition, parking provision, site density, site amenity</i>” (Kincaid, 2002).	- ‘Site configuration and requirements’ was defined as the characteristics and legal provisions concerned with the size, accessibility, parking, amenities, neighboring areas considerations, and arrangement of the site of adaptive reuse projects.
20.	Sustainability and energy saving measures	- Principle of sustainability (Al-obaidi et al., 2017) - Sustainable design approach (Al-obaidi et al., 2017) - Promote energy efficiency (Al-obaidi et al., 2017) - Environmental sustainability and reduce energy consumption (Mehr and Wilkinson, 2018) - Sustainable strategies (Mehr and Wilkinson, 2018) - Requirements of sustainable development (Wilkinson et al., 2014) - Sustainability measures (Wilkinson et al., 2014) - Ensure the sustainability (Yaldiz and Asatekin, 2013) - Energy- saving measures (Wilkinson et al., 2014)	- Wilkinson et al (2014) stated “<i>sustainability is explored within the context of social, economic and environmental paradigms</i>”. - Sustainability can be defined as “<i>the ability to meet the needs of the current generation without compromising the ability of future generations to meet their needs</i>” (Foster, 2017) - Sustainable design is referred to “<i>the principle that recognizes resources are finite, and the intelligent design and construction can mitigate the impact of building on the environment</i>” (Kalin et al., 2010). - Energy-saving of a product or systems implies that “use as little electricity, gas, etc. as possible” (Cambridge Dictionary, 2019).	- ‘Sustainability and energy saving measures’ was defined as the actions concerned with the principles of environmental sustainability and energy conservation in the building.

Table 2.5: List of the identified factors and their terminology(s), definition(s)/ description and measurements/assessment method(s) (Cont.)

#	Factor	Terminologies	Definition/ description	Formulated/adopted definition/ description
C) Factors related to the construction phase				
21.	Previous experience of the contractor with adaptive reuse projects	- Inventive architects and engineers experienced with older buildings (Hein and Houck, 2008) - Availability of materials and lack of skilled tradesmen (Conejos et al., 2016) - Experience remaining private to the individual firms involved (Kincaid, 2002) - Experienced project manager (Kincaid, 2002) - Expert practitioners (Kincaid, 2002) - Contractors experienced in the type of use proposed and in the level of specification intended (Kincaid, 2002)	- Hein and Houck (2008) quoted the following statement <i>“Inventive architects and engineers experienced with older buildings can recognize and take advantage of design opportunities presented by the existing building as well as devise cost-effective solutions to structural constraints that are certain to materialize”</i> - Conejos et al. (2016) described this factor as the <i>“compatibility of new materials with existing materials, as well as the availability of local expertise and tradesmen capable of implementing conservation works”</i>.	- ‘Previous experience of the contractor with adaptive reuse projects’ was defined as the former knowledge and skills of the construction organization in implementing adaptive reuse projects.
22.	Accuracy and completeness of the contract documents	- Inaccuracy of information and drawings (Conejos et al., 2016) - Construction documents and specifications (Fournier and Zimnicki, 2004) - Construction documents (Hein and Houck, 2008) - Construction drawings (Wilkinson et al., 2014) - Costs, quantities and specification details (Wilkinson et al., 2014) - Durable specification and design details (Wilkinson et al., 2014) - Specification (Kincaid, 2002) - Project specification (Kincaid, 2002) - Building specification (Kincaid, 2002) - Material specification (Kincaid, 2002) - Level of specification (Kincaid, 2002) - Level of specification appropriate to the project proposed (Kincaid, 2002) - Level of specification intended (Kincaid, 2002)	- Conejos et al. (2016) described this factor described as <i>“the lack of accurate information and drawings for heritage buildings (includes defects or dimensional and material inconsistencies)”</i>(Conejos et al., 2016). - Fournier and Zimnicki (2004) stated that <i>“Construction documents, representing the methods used to achieve the design intent, are included in the standard design drawings and specifications, but integrated systems drawings and supporting documents should also be developed as part of any adaptive reuse project”</i>. - Fournier and Zimnicki (2004) stated that <i>“Specifications work hand in hand with the construction drawings to provide information that cannot be effectively illustrated, or that requires special procedural or component emphasis”</i>. - Fournier and Zimnicki (2004) stated that <i>“Typical design documentation includes the construction drawings, specifications, and any change orders that materialize during construction and commissioning”</i>. - Kalin et al. (2010) mentioned that the contract documents (also known as construction documents) consist of five components, namely: agreement, condition of contracts, drawings, specifications and modifications.	‘Accuracy and completeness of the contract documents’ can be described as the defined as the availability of exact and adequate construction documents which include: agreement, contractual conditions, modifications, and drawings and specifications of the building and its systems.

Table 2.5: List of the identified factors and their terminology(s), definition(s)/ description and measurements/assessment method(s) (Cont.)

#	Factor	Terminologies	Definition/ description	Formulated/adopted definition/ description
23.	Availability of skilled workforce	- Worker and space efficiencies (Bullen and Love, 2011c) - Workmanship (Doran et al., 2009; Wilkinson et al., 2014) - Material durability and workmanship (Wilkinson et al., 2014) - Human resourcing (Kincaid, 2002) - Poor quality of construction materials and workmanship (Hui et al., 2008) - Workforce development (Rayman et al., 2017) - Selection and recruitment of workforce (Egbu, 1994) - Shortage of skilled workforce (Egbu, 1994) - Training and experience of the work force (Doran et al., 2009)	- Wilkinson et al. (2014) described the criterion of the workmanship as <i>“the quality of craftsmanship of structure and finishes”</i>. - Workman is defined as <i>“a man who works with his hands especially at building or making things”</i> (OXFORD, 2011). - Workmanship is defined as <i>“a skill that a workman needs or uses to do or make sth well”</i> (OXFORD, 2011). - Workforce is defined as <i>“total number of people who work in a company, factory, etc.”</i> (OXFORD, 2011).	- ‘Availability of skilled workforce’ was defined as the potentiality to have skillful workers who are capable to execute the adaptation process successfully.
24.	Construction equipment and methods	- Construction methods (Hein and Houck, 2008) - Construction equipment and methods (Hein and Houck, 2008) - Complexity and technical difficulties (Conejos et al., 2016) - Construction techniques (Mehr and Wilkinson, 2018; Olivadesse et al., 2017) - Construction practices (Oppong and Masahudu, 2014)	- Conejos et al. (2016) stated <i>“refurbishment techniques, technical installations and innovative solutions for the adaptive reuse of heritage buildings”</i> are among the challenges of the adaptive reuse. - Construction equipment is referred to as the "group of machines" used in the construction process, such as "excavator, trucks, dozer, roller, etc." (Peurifoy et al., 2011) - Tatum (1988) defined the construction methods as <i>“means of achieving construction”</i>. - Tatum (1988) describe the construction methods as <i>“the means used to transform resources into constructed products. They define how construction applies resources”</i>. (Tatum, 1988)	- ‘Construction equipment and methods’ was defined as the construction means and machines used in the execution process of building projects (e.g. adaptive reuse project).

Table 2.5: List of the identified factors and their terminology(s), definition(s)/ description and measurements/assessment method(s) (Cont.)

#	Factor	Terminologies	Definition/ description	Formulated/adopted definition/ description
25.	Planning and control of the financial resources	- Financial investigations (Hein and Houck, 2008) - Financing (Kincaid, 2002) - Reducing financing costs and risk (Kincaid, 2002) - Financial and professional services (Kincaid, 2002) - Costing and project financial analysis (Kincaid, 2002) - Financial factor (Shehada et al., 2015) - Total financial implications (Shehada et al., 2015) - Overrun budgets (Wilkinson et al., 2014) - Cost plan (Wilkinson et al., 2014) - Cost control process (Wilkinson et al., 2014)	- Nunnally (2014) stated that “<i>financial management of a construction company is equally as important to company success as is its technical management</i>”. - Nunnally (2014) described the financial planning for a construction project as the process that “<i>includes cost estimating prior to bidding or negotiating a contract, forecasting project income and expenditure (or cash flow), and determining the amount of work that a construction firm can safely undertake at one time</i>”. - Nunnally (2014) described the project cost control as the process that “<i>involves the measurement and recording of project costs and progress and a comparison between actual and planned performance</i>”.	- ‘Planning and control of the financial resources’ was defined as the managerial processes that are concerned in estimating, forecasting, defining and managing the expenditures (cash flow) of the project, against to the execution activities.
26.	Quality assurance / control requirements	- Quality control methods (Hein and Houck, 2008) - Quality of local amenities (Kincaid, 2002) - Preference to quality of project (Kincaid, 2002) - Quality of renovation (Al-ghamdi, 2011) - Quality of adaptive reuse and (Al-ghamdi, 2011) - Quality (Wilkinson et al., 2014) - Quality of construction (Wilkinson et al., 2014) - Building quality (Wilkinson et al., 2014) - Inadequate quality assurance (Glew et al., 2017) - Adequate quality control (Douglas, 2006).	- Nunnally (2014) stated that “<i>the terms quality management (QM) and quality assurance (QA) have been adopted to include all aspects of producing and accepting a construction project which meets all required quality standards</i>”. - Nunnally (2014) stated that “<i>quality control is primarily concerned with the process control function. Since the contractor has the greatest control over the construction process, it has been found that quality control is most effective when performed by the contractor</i>”. - Nunnally (2014) stated that “<i>the construction contractor is primarily responsible for construction quality. Quality assurance inspections and tests performed by an owner’s representative or government agency provide little more than spot checks to verify that some particular aspect of the project meets minimum standards</i>”.	- “<i>Quality control is primarily concerned with the process control function. Since the contractor has the greatest control over the construction process, it has been found that quality control is most effective when performed when performed</i> (Nunnally, 2014). - Nunnally (2014) “<i>Quality assurance inspections and tests performed by an owner’s representative or government agency provide little more than spot checks to verify that some particular aspect of the project meets minimum standards</i>” (Nunnally, 2014).

Table 2.5: List of the identified factors and their terminology(s), definition(s)/ description and measurements/assessment method(s) (Cont.)

#	Factor	Terminologies	Definition/ description	Formulated/adopted definition/ description
27.	Complexity and difficulties within the project site	- Complexity and technical difficulties (Conejos et al., 2016) - Temporary tie used to brace interior, limiting work space (Hein and Houck, 2008) - Difficult construction task (Hein and Houck, 2008) - Particular types of construction difficulty that the project may present (Kincaid, 2002) - Project complexity (Kurul, 2007) - Difficulty in getting the equipment in (Mehr and Wilkinson, 2018) - Size and complexity of the works being carried out (Bullen and Love, 2011c)	- Conejos et al. (2016) described this factor from the perspective of heritage projects as <i>refurbishment techniques, technical installations and innovative solutions for the adaptive reuse of heritage buildings</i> ”.	- ‘Complexity and difficulties within the project site’ was defined as the technical complications and challenges facing the construction process of the adaptive reuse project due to the physical attributes of the building site.
28.	Availability and accessibility of loading space	- Loading space (Behdad, 2006; Bullen and Love, 2009; Riggs and Chamberlain, 2018) - Limited access (Hein and Houck, 2008) - Site access for construction workers and equipment (Hein and Houck, 2008) - Movement of construction equipment and material (Hein and Houck, 2008) - Accessibility by car (Wilkinson et al., 2014) - Access for materials delivery and removal of waste without disturbing or engaging in negotiations with neighbours (Wilkinson et al., 2014) (ADA, 2010)	- Loading space is defined as “<i>the space for the loading or unloading of a vehicle either outside or inside a building or structure</i>” (City of Vancouver, 2019). - The ADA Standard (2010) (Standards for Accessible Design) mentioned the requirements of the site arrival points as follows “<i>at least one accessible route shall be provided within the site from accessible parking spaces and accessible passenger loading zones; public streets and sidewalks; and public transportation stops to the accessible building or facility entrance they serve</i>”. - Hein and Houck (2008) stated “<i>the construction site should be fully accessible for workers and for movement of construction equipment and material</i>”.	- ‘Availability and accessibility of loading space’ was defined as the possibility to offer an accessible space for transporting and delivering the construction materials and equipment, from and to the project site.

Table 2.5: List of the identified factors and their terminology(s), definition(s)/ description and measurements/assessment method(s) (Cont.)

#	Factor	Terminologies	Definition/ description	Formulated/adopted definition/ description
29.	Availability of spaces for storing the construction materials and equipment	- Temporary structural support of preserved components (Hein and Houck, 2008) - Storage of materials (Douglas, 2006; LBDS, 2014) - Storage space on existing building for the contractor (Douglas, 2006) - Storage space (Zivkovic et al., 2016) - Material usage (Zivkovic et al., 2016) (Arata, 2006)	- Arata (2006) stated that <i>“tools and equipment security is often overlooked on most job sites until thefts occur. The largest dollar loss to construction job sites is the result of thefts of tools, equipment and materials”</i> - Temporary structures can be defined as <i>“those structures that are erected and used to aid in the construction of permanent projects”</i> (Deerkoski, 2012). - Nunnally (2014) stated <i>“ensure that temporary structures are properly designed, constructed, and braced”</i>. - Douglas (2006) stated that there is a need to provide <i>“storage space on existing building for the contractor”</i>.	- ‘Availability of spaces for storing the construction materials and equipment’ was defined as the possibility to offer an adequate space in/out the building to be used as a storage for the construction materials and equipment during the adaptive reuse execution.
30.	Enforcement and management of safety procedures at the project site’	- Maintaining site safety and welfare standards (Egbu, 1994) - Management of health, safety and well-being on adaptive-retrofit projects (Danso et al., 2015) - Construction site safety (Sherratt et al., 2013) - Safety performance of repair, maintenance, minor alteration and addition (RMAA) works (Hon et al., 2011) - Safety management in building refurbishment (Z. Chen et al., 2017) - Implementation of all the health and safety procedures (Anumba et al., 2004) - Managing health & safety in refurbishment projects (Egbu et al., 2002).	- Safety management is defined t as <i>“the aspect of the overall management function that determines and implements the safety policy”</i> (Papadakis and Amendola, 1997)	- ‘Enforcement and management of safety procedures at the project site’, was defined as the process of conducting, controlling and monitoring all field activities and measures required for providing safe environment to individuals, work performance and assets at the workplace of building projects.

Table 2.5: List of the identified factors and their terminology(s), definition(s)/ description and measurements/assessment method(s) (Cont.)

#	Factor	Terminologies	Definition/ description	Formulated/adopted definition/ description
D) Factors related to the operation and maintenance phase				
31.	Availability and adequacy of the commissioning process for the MEP systems	- Commissioning (Fournier and Zimnicki, 2004) - Commissioning process (Douglas, 2006; Fournier and Zimnicki, 2004) - Continuous commissioning (Fournier and Zimnicki, 2004) - Certificate of occupancy (LBDS, 2014) - Test procedures (LBDS, 2014) - Documented programming specification and revised the building technical manual (Wilkinson et al., 2014) - Accurate as-built manuals (Wilkinson et al., 2014)	- Commissioning can be defined as <i>“a systematic process of verifying and documenting building systems or subsystems performance against the building design criteria and the owner’s operational needs”</i> (Fournier and Zimnicki, 2004).	- ‘Availability and adequacy of the commissioning procedures for the MEP systems’ was defined as the possibility of offering an adequate and organized verification process on the performance of all MEP systems in the adaptively reused buildings.
32.	Availability of accurate records of the building assets	- Accurate “as built” drawings and other records (Fournier and Zimnicki, 2004) - The corporate asset strategy and management plan (Ladinski, 2017) - Efficient use of property assets (Ladinski, 2017) - Standard asset management profile (Wilkinson et al., 2014) - Contemporary asset management (Wilkinson et al., 2014) - Portfolio of assets (Wilkinson et al., 2014)	- Assets are defined as <i>“inventory, plant, equipment and other facility contents, and are distinct from real property like land and buildings”</i> (Devine, 2011) - Fournier and Zimnicki, (2004) described the importance of such kind of information as follows <i>“accurate as built drawings and other records must be maintained to assist in the commissioning and ongoing operation and maintenance of the completed project”</i>	- ‘Availability of accurate records of the building assets’ can be described as the potential to offer an exact record keeping of all the contents within the building, including components and systems.
33.	Efficiency of the utilization of the building spaces	- Accommodate space organization for new function (Al-obaidi et al., 2017) - Allocation of space and rooms for major event and post-event use (Brown and Cresciani, 2017) - Workplace strategy (Ladinski, 2017) - Efficient use of office spaces (Ladinski, 2017) - Space efficiency (Douglas, 2006) - Space planning exercise (Douglas, 2006) - Efficiency ratio (net-to-gross ratio) (Douglas, 2006)	- Space efficiency can be defined as the ratio of the net lettable or usable space (NLA) to the total (gross) floor area (TFA) (Douglas, 2006; Muir, 2011).	- Space efficiency was defined as the ratio of the net lettable or usable space (NLA) to the total (gross) floor area (TFA) (Douglas, 2006; Muir, 2011).

Table 2.5: List of the identified factors and their terminology(s), definition(s)/ description and measurements/assessment method(s) (Cont.)

#	Factor	Terminologies	Definition/ description	Formulated/adopted definition/ description
34.	Compliance with health and safety measures	- Align security and safety features (Brown and Cresciani, 2017) - Health and safety file (Fieldson, 2017) - Health and safety (Jin, 1996) - Health and safety of the occupant (Mehr and Wilkinson, 2018) - Health and safety of occupiers and the public (Douglas, 2006)	- Jin (1996) stated that “ <i>progress also demand reevaluation of standards of which the standard of public health and safety must be the most pertinent</i> ”.	- ‘Compliance with health and safety measures’ was defined as the obligation to the applicable health and safety requirements of the new function.
35.	Development and implementation of work schedules for different maintenance types (e.g. planned, unplanned)	- A pack of information known as an operation and maintenance (O&M) (Fieldson, 2017) - Develop and use maintenance practices (Fournier and Zimnicki, 2004) - Proper operation and maintenance (Fournier and Zimnicki, 2004) - Repair and maintenance programs (Douglas, 2006), - Maintenance procedures (Douglas, 2006) - Types of maintenance: proactive (i.e. planned) and reactive (i.e. unplanned) (Douglas, 2006), - Maintenance schedules (Douglas, 2006), - Maintenance audit (Douglas, 2006) - Day-to-day repair and maintenance works(Wilkinson et al., 2014).	- According to the BS 3811:1964, maintenance is defined as “<i>a combination of ant actions carried out to retain an item in, or restore it to, an acceptable condition</i>” (Wordsworth, 2001). - There are seven types of maintenance works that are performed on the existing buildings, namely: “<i>planned, unplanned, preventive, corrective, emergency, condition-based, and scheduled maintenance</i>” (Chanter and Swallow, 2007).	- ‘Development and implementation of work schedules for different maintenance types (e.g. planned, unplanned)’ was defined as the comprehensive process of establishing and following time schedules for all maintenance activities required for the operation of building(s), including planned and unplanned activities.
36.	Potentiality of obsolescence and/or deterioration of building components and/or systems	- Physical deterioration (Al-obaidi et al., 2017) - Moisture-related deterioration (Fournier and Zimnicki, 2004) - Deterioration of materials and components (Chanter and Swallow, 2007) - Obsolescence and redundancy (Douglas, 2006) - Obsolescence or inefficiency (Douglas, 2006) - Obsolete construction (Douglas, 2006) - Equip the site with an adequate level of services relating to its new usage(Z. Ali et al., 2018)	- Obsolescence can be defined as “<i>the condition of being antiquated, old fashioned or out of date, resulting when there is a usually rapid change in the requirements or expectations regarding the shelter, comfort, profitability or other dimension of performance that a building or building subsystem is expected to provide</i>” (Douglas, 2006). - According to the Oxford Wordpower dictionary, ‘deteriorate’ means “<i>to become worse</i>”	- ‘Potentiality of obsolescence and/or deterioration of building components and/or systems’ was defined as the decline in the durability and desirability of the building components and/or systems, due to the changes in its physical conditions and/or market demand, so that they become outdated.

Table 2.5: List of the identified factors and their terminology(s), definition(s)/ description and measurements/assessment method(s) (Cont.)

#	Factor	Terminologies	Definition/ description	Formulated/adopted definition/ description
37.	Control over the operational characteristics of the building components and systems	- Provide auto controlled indoor temperature system (Al-obaidi et al., 2017) - Provide flexible lighting controls (Al-obaidi et al., 2017) - Facilities are properly maintained and functional (Z. Ali et al., 2018) - Control of the internal conditions (Brown and Cresciani, 2017) - Effective and operational controls (Fournier and Zimnicki, 2004) - Monitoring building operations (Douglas, 2006) - Enhancing the performance characteristics of a building's major elements, components and/or services (Douglas, 2006)	- Fournier and Zimnicki (2004) described the importance of this factor as follows: <i>"Education of the building operations and maintenance staff ensures that systems are operated as designed and are maintained at optimal performance throughout their life"</i>. - Douglas (2006) defined the term "monitoring building operation" as the <i>"competent supervision of the works in progress is required to ensure adequate quality control"</i>. (Frontczak et al., 2012)	- 'Control over the operational characteristics of the building components and systems' was defined as the process of monitoring and supervising the required operational works for all systems and components within the building.
38.	User satisfaction with the layout of the building as well as the workflow of activities	- Occupants' satisfaction of the interior spaces (Al-obaidi et al., 2017) - Expectations and perceptions of the service performance (Z. Ali et al., 2018) - Users' preferences and needs (Chua and Deguchi, 2010) - Occupant satisfaction and performance (Fournier and Zimnicki, 2004) - Satisfaction of human needs (Fournier and Zimnicki, 2004)	- Satisfaction can be defined as <i>"acceptable accommodation of occupant/user needs"</i> (Preiser et al., 1988) - Frontczak et al. (2012) stated that <i>"the definition of occupants satisfaction was not consistent among the studies, but all of them defined occupants satisfaction in a broad perspective and related it either to satisfaction/comfort with indoor environmental quality or satisfaction/ comfort with the workspace"</i>	- 'User satisfaction with the layout of the building as well as the workflow of activities' was defined the occupant acceptance with the distribution of the spaces, and the flow of services and activities within the building context.

2.8 Summary and Discussion

This chapter covered four main topics, namely: the traditional building life-cycle, concepts of modifications conducted on existing buildings, the practice of adaptive reuse of building, and concept of building performance and building performance assessment. The chapter presented the review of a set of previous studies that are relevant to this research. The chapter was concluded with a preliminary identification of the factors affecting building adaptive reuse throughout the project life-cycle.

Building project are complex, since they undergo many processes throughout their life-cycle. Several classifications were made for the phases of the life-cycle of building projects. However, the traditional building life-cycle of building projects consists of four main sequential phases, namely: conceptual planning and feasibility studies, design and engineering, construction, and operation and maintenance phases.

During the operation and maintenance phase, several types of modifications may be conducted on existing buildings. These modifications are carried out in order to enhance the condition of these buildings, in terms the physical, economic, functional, social, legal and environmental dimensions. There are four main types of modifications that are conducted on existing buildings, namely: modernization, rehabilitation, renovation and adaptive reuse.

Adaptive reuse is the process of converting the use of an existing facility, or part of it, to provide a new function which differs from that in which it the facility was built for. The practice of building adaptive reuse is in line with the context of sustainable development, since it has the potential to provide economic, social and environmental befits to the

communities. On the other hand, this practice is among the complex projects in the built-environment, since it may encounter with a set of legal, financial, technical, functional and cultural challenges. Several stakeholders are involved in this practice, including investor, producer, marketer, regulator, policy-maker, developer and user/occupant. Many practical programs and guidelines were developed for the practice of building adaptive reuse. However, most of these programs/guidelines focused only on offering procedures of the adaptive reuse of the heritage buildings.

Several studies were carried out on the adaptive reuse of buildings domain, in terms of assessing the building adaptability, supporting the decision-making on the implementation the change of use, and transferring and capturing the knowledge from previously successful adaptation projects., Based on the reviewed theoretical background and previous studies, it was concluded that there was a gap in the knowledge about the life-cycle of adaptive reuse projects. Although some decision-making models were developed for building adaptive reuse, the development of a life-cycle-oriented framework for these projects has not been accomplished yet

Based on the reviewed literature, a preliminary identification of the factors affecting adaptive reuse projects, throughout their life-cycle, was performed and presented in this chapter. Thirty-eight factors were identified and grouped in the basis of the phases of the traditional life-cycle of building projects. Thus, they were classified under the following groups: conceptual planning and feasibility studies, design and engineering, construction, and operation and maintenance. A semantic analysis was performed in the formulation of the terms and definitions of the identified factors.

CHAPTER 3:

LOCAL PRACTICE OF BUILDING ADAPTIVE REUSE

3.1 Overview

This chapter covers a discussion of the findings of the performed investigation on the local practice of building adaptive reuse in Saudi Arabia. It presents discussion of the responses received in the second section (Section B) of each of the three questionnaire surveys. The three questionnaire surveys were conducted on 90 AEC/FM practitioners (30 A/Es, 30 contractors and 30 facilities managers) of building adaptive reuse in the Eastern Province of Saudi Arabia. In this chapter, the analysis of the responses is presented per each group of respondents. Firstly, the chapter covers a section for the demographic information pertaining to the background of the respondents of the three questionnaire surveys. Thereafter, the chapter presents discussion of the findings of the investigated local practice in three separate sections. Each of the three section comprises outcomes of one of the three questionnaire surveys. Finally, the chapter concludes with a summary and discussion of the overall outcomes.

3.2 Respondents' Demographic Information

This section covers the demographic information pertaining to the respondents involved in the three questionnaire surveys. In the three questionnaire surveys, respondents were asked to indicate their profile in terms of name, address, organization address, scope of work, years of experience, number of adaptive reuse projects in which they were involved in, and types of projects where they were familiar with. Refer to **Appendix E** for more information about name, address and organization address of the respondents.

3.2.1 Spatial Distribution of the Overall Respondents

Respondents of the three questionnaire surveys ($n = 90$) were spatially distributed across the scoped region of the study, Eastern Province of Saudi Arabia. Most of respondents were from the three-adjacent cities of Dammam Metropolitan Area (DMA), namely: Dammam, Dhahran and Khobar (**Figure 3.1**). Some respondents were from other cities, namely: Jubail, Qatif, Safwa and Ras Tannurah. This distribution contributed to capture the knowledge and point of views of different experts within the study region.

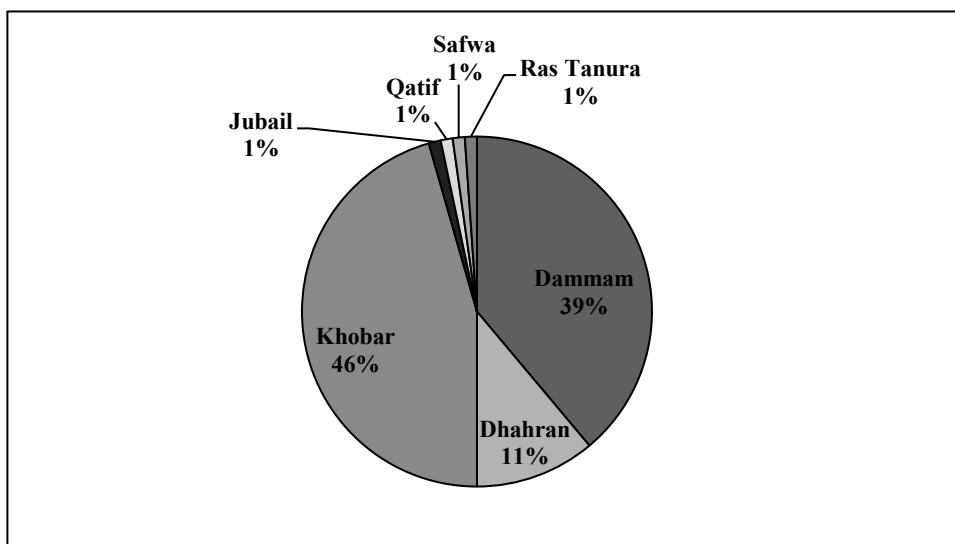


Figure 3.1: Spatial distribution of the respondents

As shown in **Figure 3.1**, the distribution of respondents among the mentioned cities was as follows: Khobar, 46% (*frequency* = 41); Dammam, 39% (*frequency* = 35); Dhahran, 11% (*frequency* = 10); Jubail, 1% (*frequency* = 1); Qatif, 1% (*frequency* = 1); Safwa, 1% (*frequency* = 1); and Ras Tanura, 1% (*frequency* = 1). Most of the questionnaire surveys were conducted through holding face-to-face-based interview sessions with the respondents. Questionnaire surveys with respondents from Jubail, Qatif, Safwa and Ras Tannurah were conducted by phone. Some questionnaire surveys were also conducted by phone with respondents from the three-adjacent cities of DMA. Refer to **Appendix E** for more information about the method of interview that was carried out with each respondent.

3.2.2 Respondents' Scope of Work (Field of Work)

Respondents of the three questionnaire surveys were varying in term of their scope of work. Thus, this subsection covers data regarding the scope of work of the respondents who have participated in the questionnaire surveys from of the three professional domains, namely: A/E, construction, and FM.

3.2.2.1 Scope of Work of the Respondents of the A/Es' Questionnaire Survey

The conducted questionnaire survey on the A/E practitioners revealed that respondents were varying in term of their scope of work within the context of A/E profession. Scope of work of the involved practitioners ($n = 30$) in the A/Es' questionnaire survey is illustrated in **Figure 3.2**.

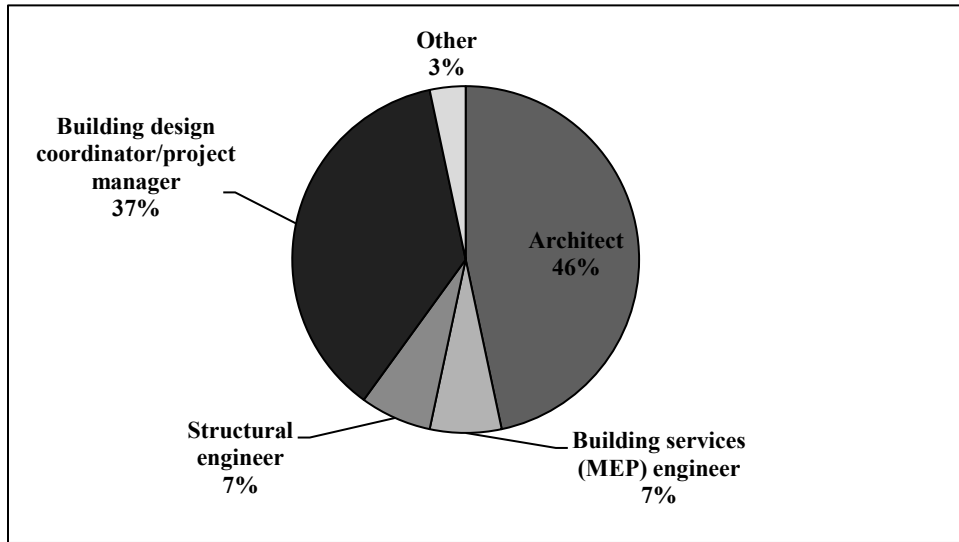


Figure 3.2: Scope of work of the involved practitioners in the A/Es' questionnaire survey

As shown in **Figure 3.2**, most of respondents were architects, accounting for 46% (*frequency* = 14) of the total number of respondents. The scope of work of other respondents was as follows: building design coordinator/project manager, 37% (*frequency* = 11); building services (MEP) engineers, 7% (*frequency* = 2); structural engineers, 7% (*frequency* = 2); and other fields of work, 3% (*frequency* = 1). Respondent who selected “other” was working as a planning engineer in a semi-public organization.

3.2.2.2 Scope of Work of the Respondents of the Contractors' Questionnaire Survey

The conducted questionnaire survey on the contractors revealed that respondents were varying in term of their scope of work, within the context of construction profession. **Figure 3.3** illustrates the scope of work of the practitioners (*n* = 30) involved in the contractors' questionnaire survey.

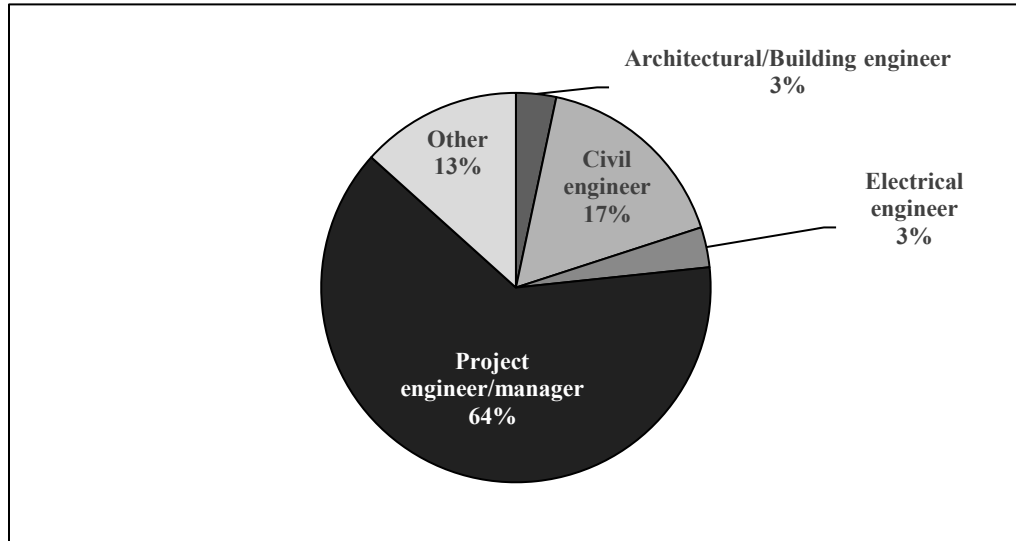


Figure 3.3: Scope of work of the involved practitioners in the contractors' questionnaire survey

As shown in **Figure 3.3**, most of respondents were working as project managers/engineers, accounting for 64% (*frequency* = 19) of the total number of respondents. The scope of work of the other respondents was as follows: civil engineers, 17% (*frequency* = 5); architectural/building engineers, 3% (*frequency* = 1); electrical engineers, 3% (*frequency* = 1); and other fields of work, 13% (*frequency* = 4). Respondents who selected “other” were working in different fields of work that were within the construction profession, namely: cost-control engineer, surveying engineer, finishes engineer and executive manager of a construction firm.

3.2.2.3 Scope of Work of the Respondents of the FMs' Questionnaire Survey

The conducted questionnaire survey on the FM practitioners revealed that respondents were varying in term of their scope of work, within the context of FM/O&M profession. **Figure 3.4** illustrates the scope of work of the involved practitioners ($n = 30$) in the FMs' questionnaire survey.

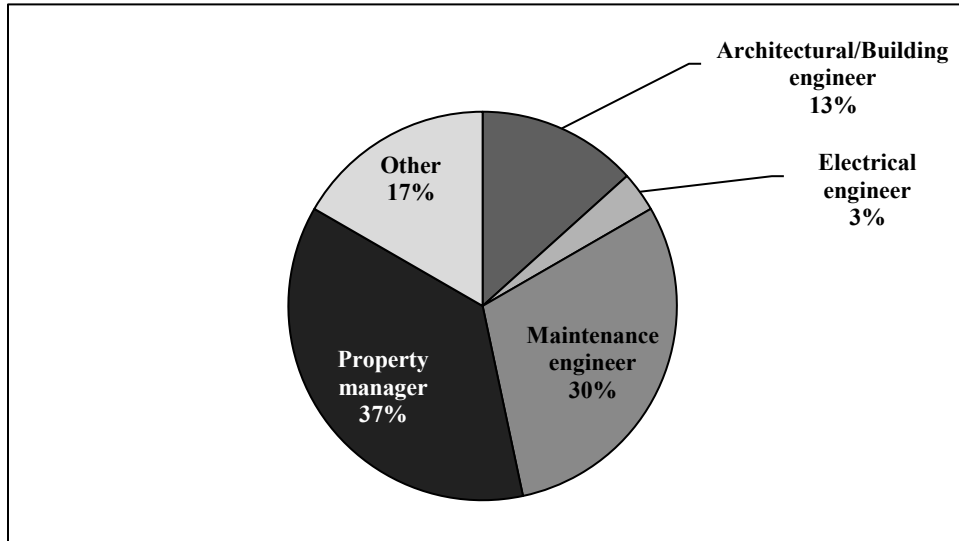


Figure 3.4: Scope of work of the involved practitioners in the FM's questionnaire survey

As shown in **Figure 3.4**, most of the respondents were working as property managers, accounting for 37% (*frequency* = 11) of the total number of respondents. The scope of work of the other respondents was as follows: maintenance engineers, 30% (*frequency* = 9); architectural/building engineer, 13% (*frequency* = 4); electrical engineer, 3% (*frequency* = 1); and other fields of work, 17% (*frequency* = 5). Respondents who selected “other” were working in different fields of work within the FM context, namely: facilities engineer, park manager, project assessor, operation manager, and HR manager of FM company. The HR manager had a previous experience in the practice of operating adaptively reused buildings in DMA.

3.2.3 Respondents' Years of Experience

Respondents of the three questionnaire surveys were varying in term of their years of experience. Thus, this subsection covers data regarding the number of years of experience of the practitioners participated in the three questionnaire surveys from AEC/FM professions.

3.2.3.1 Ranges of Years of Experience of the Respondents Involved in the A/Es' Questionnaire Survey

The conducted questionnaire survey on the A/E practitioners revealed that respondents were varying in term of their years of experience. **Figure 3.5** illustrates the ranges of years of experience of the practitioners ($n = 30$) involved in the A/Es' questionnaire survey.

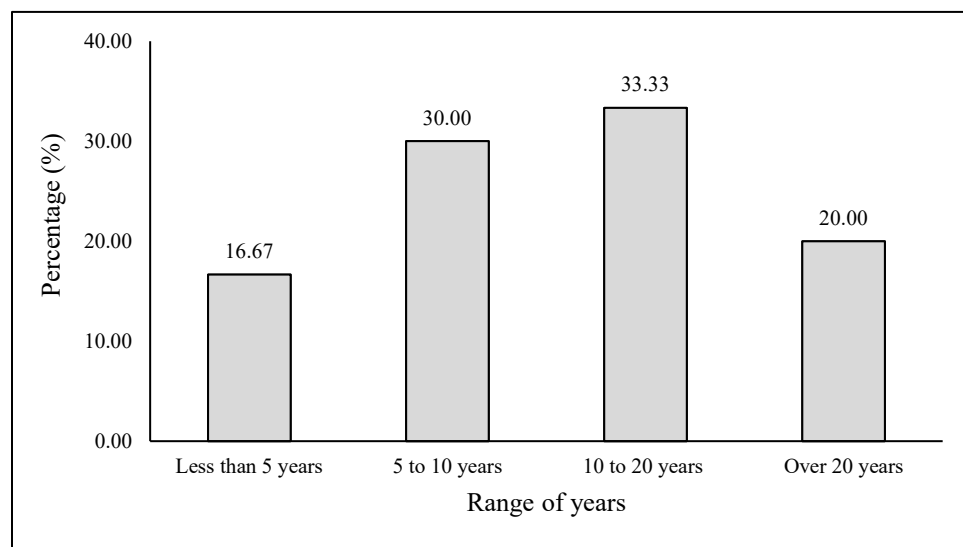


Figure 3.5: Ranges of years of experience of the practitioners involved in the A/Es' questionnaire survey

As shown in **Figure 3.5**, ranges of years of experience of the practitioners involved in the A/Es' questionnaire survey were as follows: less than 5 years, 16.67% (*frequency* = 5); 5 to 10 years, 30% (*frequency* = 9); 10 to 20 years, 33.33% (*frequency* = 10); and over 20 years, 20% (*frequency* = 6).

3.2.3.2 Ranges of Years of Experience of the Respondents Involved in the Contractors' Questionnaire Survey

The conducted questionnaire survey on the construction practitioners revealed that respondents were varying in term of their years of experience. **Figure 3.6** illustrates the ranges of years of experience of the practitioners ($n = 30$) involved in the contractors' questionnaire survey.

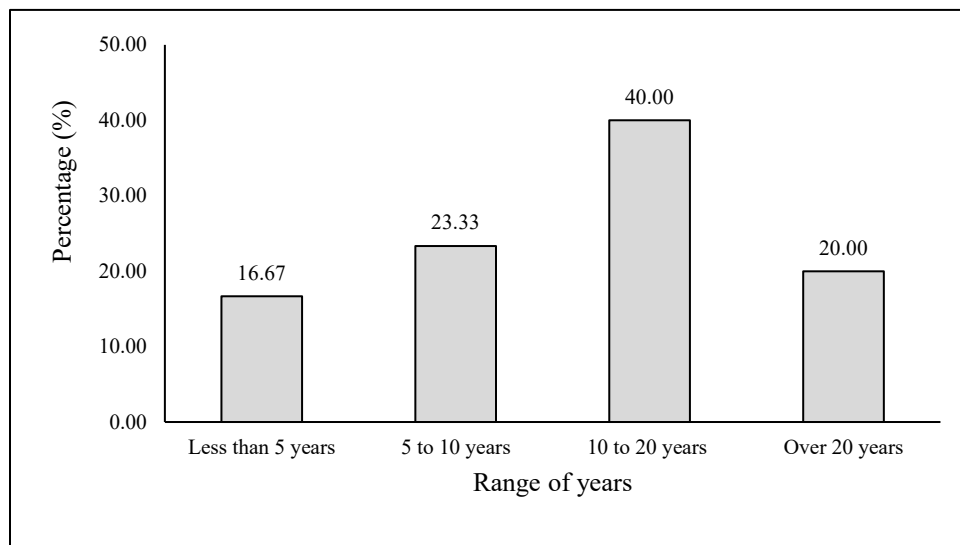


Figure 3.6: Ranges of years of experience of the practitioners involved in the contractors' questionnaire survey

As shown in **Figure 3.6**, ranges of years of experience of the practitioners involved in the contractors' questionnaire surveys were as follows: less than 5 years, 16.67% (*frequency* = 5); 5 to 10 years, 23.33% (*frequency* = 7); 10 to 20 years, 40% (*frequency* = 12); and over 20 years, 20% (*frequency* = 6).

3.2.3.3 Ranges of Years of Experience of the Respondents Involved in the FMs' Questionnaire Survey

The conducted questionnaire survey on the FM practitioners revealed that respondents were varying in term of their years of experience. **Figure 3.7** illustrates the ranges of years of experience of the practitioners ($n = 30$) involved in the FMs' questionnaire survey.

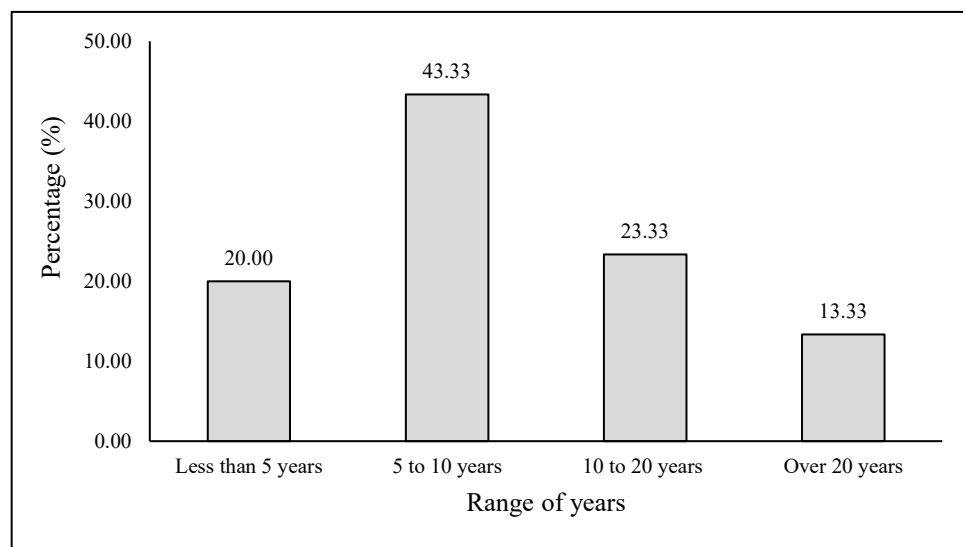


Figure 3.7: Ranges of years of experience of the practitioners involved in the FMs' questionnaire survey

As shown in **Figure 3.7**, ranges of years of experience of the practitioners involved in the FMs' questionnaire surveys were as follows: less than 5 years, 20% (*frequency* = 6); 5 to 10 years, 43.33% (*frequency* = 13); 10 to 20 years, 23.33% (*frequency* = 7); and over 20 years, 13.33% (*frequency* = 4).

3.2.4 Number of Adaptive Reuse Projects in which Respondents were Involved in

Respondents of the three questionnaire surveys were varying in term of their experience in adaptive reuse projects. Thus, this subsection covers data regarding the number of adaptive reuse projects in which respondents of the three questionnaire surveys were involved in.

3.2.4.1 Ranges of Number of Adaptive Reuse Projects in which Respondents of the A/Es' Questionnaire Survey were Involved in

The conducted questionnaire survey on the A/E practitioners revealed that respondents were varying in term of the number of adaptive reuse projects in which they were involved in. **Figure 3.8** illustrates the ranges of adaptive reuse projects' number of in which respondents ($n = 30$) of the A/Es' questionnaire survey were involved in.

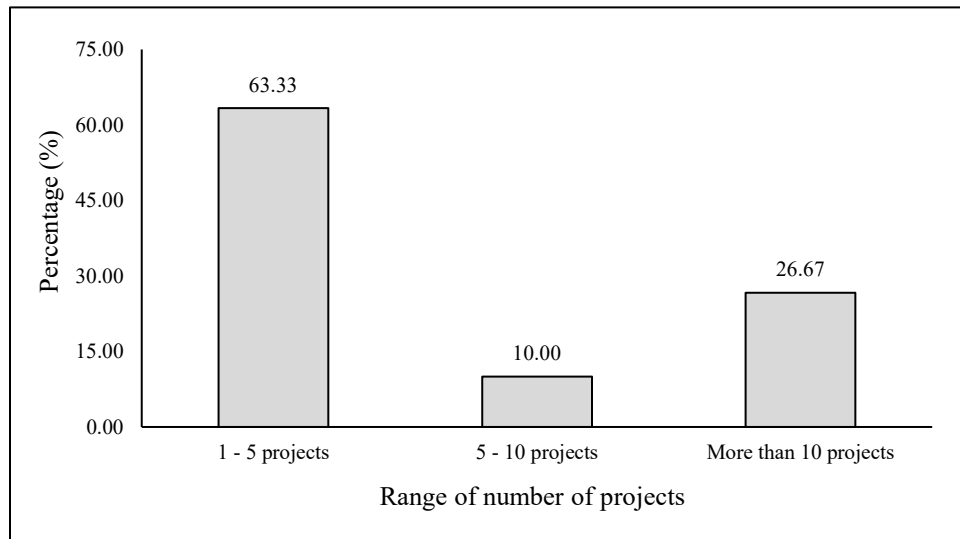


Figure 3.8: Ranges of number of adaptive reuse projects in which respondents of the A/Es' questionnaire survey were involved in

As shown in **Figure 3.8**, the follows are the ranges of number of adaptive reuse projects where respondents of the A/Es' questionnaire surveys were involved in: 1 to 5 projects, 63.33% (*frequency* = 19); 5 to 10 projects, 10% (*frequency* = 3); and more than 10 projects, 26.67% (*frequency* = 8).

3.2.4.2 Ranges of Number of Adaptive Reuse Projects in which Respondents of the Contractors' Questionnaire Survey were Involved in

The conducted questionnaire survey on the construction practitioners revealed that respondents were varying in term of the number of adaptive reuse projects in which they were involved in. **Figure 3.9** illustrates the ranges of number of adaptive reuse projects in which respondents (*n* = 30) of the contractors' questionnaire survey were involved in.

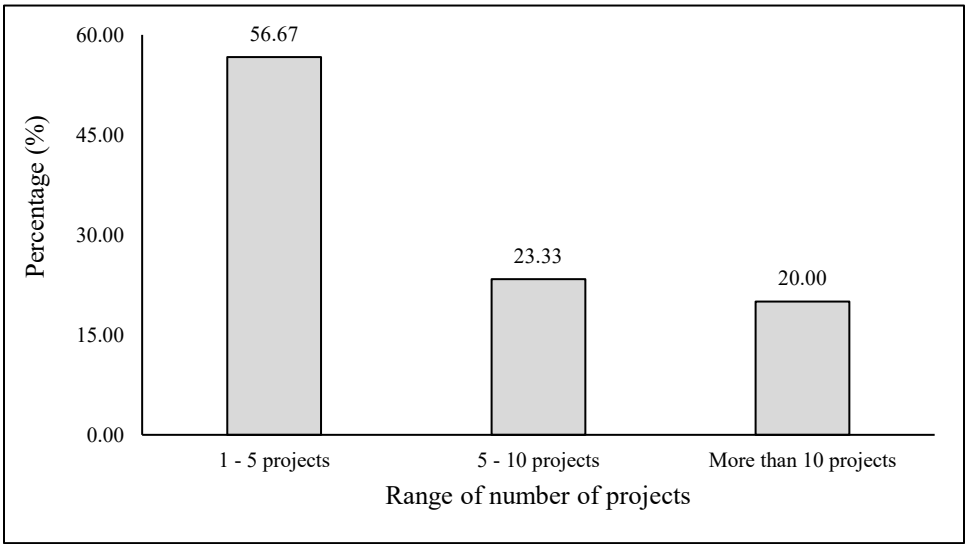


Figure 3.9: Ranges of number of adaptive reuse projects in which respondents of the contractors' questionnaire survey were involved in

As shown in **Figure 3.9**, the follows are the ranges of number of adaptive reuse projects where respondents of the contractors' questionnaire surveys were involved in: 1 to 5 projects, 56.67% (*frequency* = 17); 5 to 10 projects, 23.33% (*frequency* = 7); and more than 10 projects, 20% (*frequency* = 6).

3.2.4.3 Ranges of Number of Adaptive Reuse Projects in which Respondents of the FMs' Questionnaire Survey were Involved in

The conducted questionnaire survey on the FM practitioners revealed that respondents were varying in term of the number of adaptive reuse projects in which they were involved in. **Figure 3.10** illustrates the ranges of number of adaptive reuse projects in which respondents ($n = 30$) of the FMs' questionnaire survey were involved in.

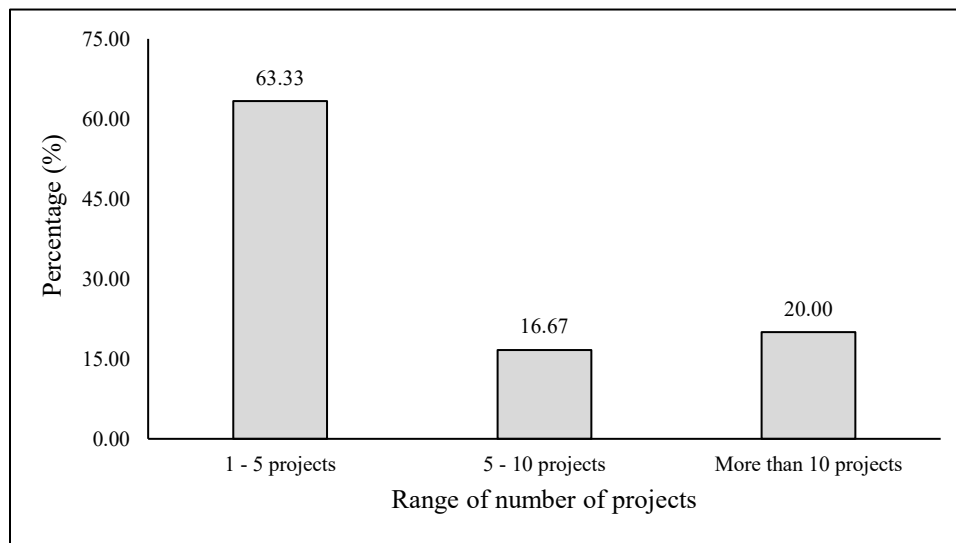


Figure 3.10: Ranges of number of adaptive reuse projects in which respondents of the FMs' questionnaire survey were involved in

As shown in **Figure 3.10**, the follows are the ranges of number of adaptive reuse projects where respondents of the FMs’ questionnaire surveys were involved in: 1 to 5 projects, 63.33% (*frequency* = 19); 5 to 10 projects, 16.67% (*frequency* = 5); and more than 10 projects, 20% (*frequency* = 6).

3.2.5 Types of Projects in which Respondents were Involved in

Respondents of the three questionnaire surveys were varying in term of the types of projects in which they were involved in. Thus, this subsection covers data regarding the types of projects where respondents of the three questionnaire surveys were involved in.

3.2.5.1 Types of Projects in which Respondents of the A/Es’ Questionnaire Survey were Involved in A/Es’

The conducted questionnaire survey on the A/E practitioners revealed that respondents were varying in term of the types of projects in which they were involved in. **Figure 3.11** illustrates the types projects in which respondents (*n* = 30) of the A/Es’ questionnaire survey were involved in.

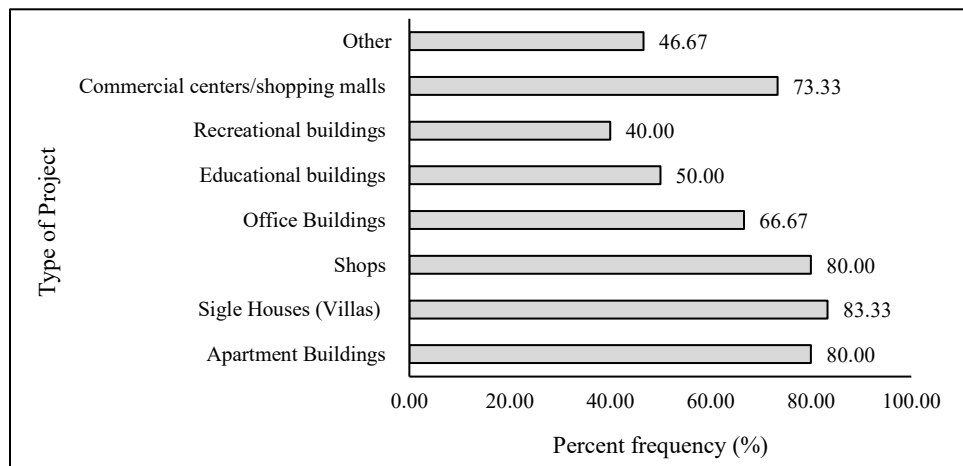


Figure 3.11: Types of projects in which respondents of the A/Es’ questionnaire survey were involved in

As shown in **Figure 3.11**, the follows are percent frequencies of the types of projects in which respondents of the A/Es' questionnaire surveys were involved in: apartment buildings, 80% (*frequency* = 24); single houses, 83.33% (*frequency* = 25); shops, 80% (*frequency* = 24); office buildings, 66.67% (*frequency* = 20); educational buildings, 50% (*frequency* = 15); recreational buildings, 40% (*frequency* = 12); commercial centers/shopping malls, 73.33% (*frequency* = 22); and others, 46.67% (*frequency* = 14). Most of the mentioned other projects were medical projects, accounting for 26.67 (*frequency* = 8)

3.2.5.2 Types of Projects in which Respondents of the Contractors' Questionnaire Survey were Involved in

The conducted questionnaire survey on the A/E practitioners revealed that respondents were varying in term of types of projects in which they were involved in. **Figure 3.12** illustrates the types projects in which respondents ($n = 30$) of the contractors' questionnaire survey were involved in.

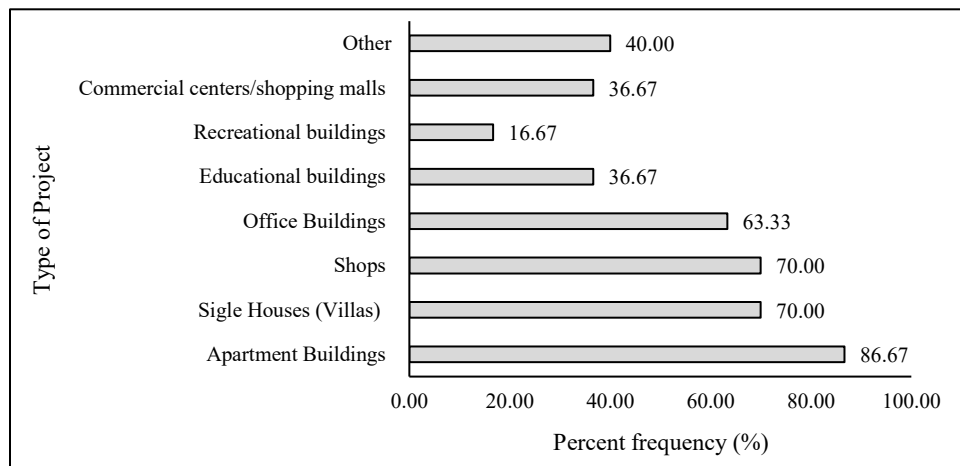


Figure 3.12: Types of projects in which respondents of the contractors' questionnaire survey were involved in

As shown in **Figure 3.12**, the follows are percent frequencies of the types of projects in which respondents of the contractors' questionnaire surveys were involved in: apartment buildings, 86.67% (*frequency* = 26); single houses, 70% (*frequency* = 21); shops, 70% (*frequency* = 21); office buildings, 63.33% (*frequency* = 19); educational buildings, 36.67% (*frequency* = 11); recreational buildings, 16.67% (*frequency* = 5); commercial centers/shopping malls, 36.67 (*frequency* = 11); and others, 40% (*frequency* = 12). Most of the mentioned other projects were medical projects, accounting for 23.33% (*frequency* = 7)

3.2.5.3 Types of Projects in which Respondents of the FMs' Questionnaire Survey were Involved in

The conducted questionnaire survey on the FM practitioners revealed that respondents were varying in term of types of projects in which they were involved in. **Figure 3.13** illustrates the types projects in which respondents (*n* = 30) of the FMs' questionnaire survey were involved in.

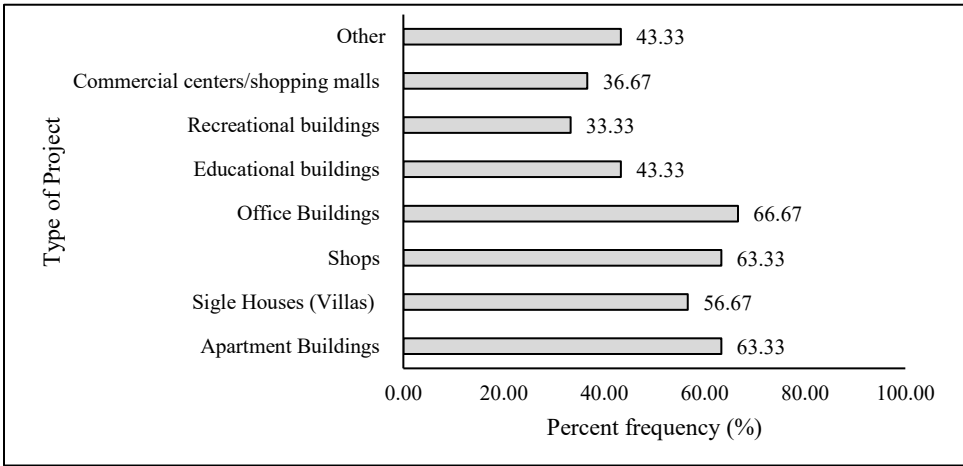


Figure 3.13: Types of projects in which respondents of the FMs' questionnaire survey were involved in

As shown in **Figure 3.13**, the follows are percent frequencies of the types of projects in which respondents of the FMs' questionnaire surveys were involved in: apartment buildings, 63.33% (*frequency* = 19); single houses, 56.67% (*frequency* = 17); shops, 63.33% (*frequency* = 19); office buildings, 66.67% (*frequency* = 20); educational buildings, 43.33% (*frequency* = 13); recreational buildings, 33.33% (*frequency* = 10); commercial centers/shopping malls, 36.67% (*frequency* = 11); and others, 43.33% (*frequency* = 13) . Most of the mentioned other projects were industrial facilities, accounting for 30% (*frequency* = 9).

3.3 The Local Practice of Planning and Design of Adaptive Reuse Projects

Planning and design of building adaptive reuse in Saudi Arabia is taking place since more than three decades. Thus, this section covers a discussion of the findings of the second section which was provided in A/Es' questionnaire survey. It covers an analysis of the point of views, perceptions and knowledge captured through the conducted questionnaire survey on the adaptive reuse practitioners from the A/E profession.

Ten aspects were considered in this section, namely: (1) common scenarios of adaptive reuse projects in Saudi Arabia, (2) A/Es' perception about the process of implementing adaptive reuse projects, (3) drivers/causes of implementing adaptive reuse projects in Saudi Arabia, (4) methods used in the communication among the parties during the design and/or documents preparation of adaptive reuse projects, (5) information and data needed during the design process and documents preparation of adaptive reuse projects, (6) followed methods for obtaining data and information needed during the design process and documents preparation of adaptive reuse projects, (7) utilized tools in the design process and documents preparation of adaptive reuse projects, (8) applicable challenges that

possibly face A/E professionals during the design process and documents preparation of adaptive reuse projects, (9) affected systems by the requirements of the new function in adaptive reuse projects, and (10) methods suggested for improving the design process and documents preparation in adaptive reuse projects.

3.3.1 Common Scenarios of Adaptive Reuse Projects in Saudi Arabia

There is a diversity in the possible scenarios of adaptive reuse projects in Saudi Arabia. Thus, respondents ($n = 30$) were asked to choose the common scenarios of adaptive reuse projects in Saudi Arabia, according to their experience. Six scenarios were listed in this question, namely: from commercial into residential use, from commercial into another commercial use, from commercial into medical use, from residential into commercial use, from residential into medical use, and from industrial into commercial use. Respondents were also given the opportunity to add further scenarios. **Figure 3.14** illustrates the A/Es' responses to the common scenarios of adaptive reuse projects in Saudi Arabia.

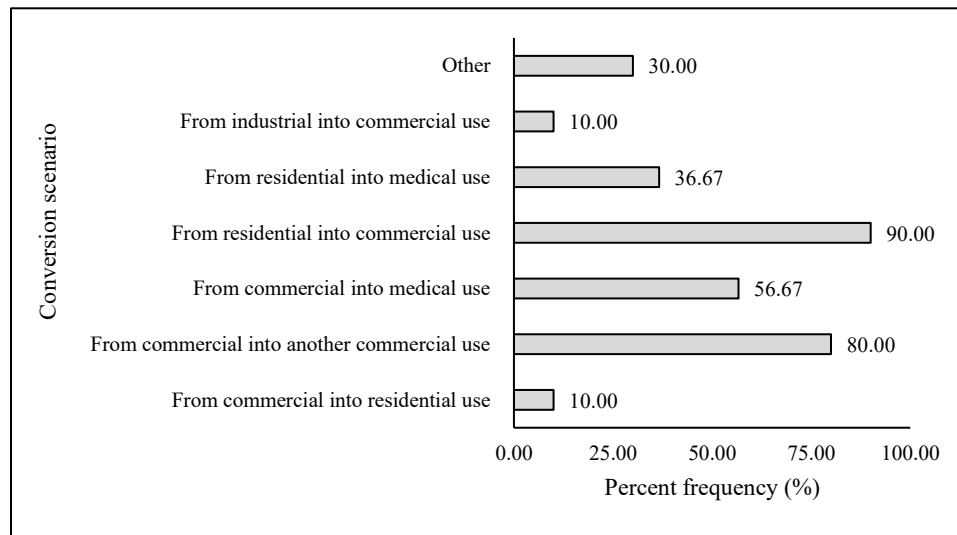


Figure 3.14: A/Es' responses to the common scenarios of adaptive reuse projects in Saudi Arabia

As shown in **Figure 3.14**, results indicate that the follows are the most common scenarios of adaptive reuse projects in Saudi Arabia: from residential into commercial use, 90% (*frequency* = 27); from commercial into another commercial use, 80% (*frequency* = 24); from commercial into medical use, 56.67% (*frequency* = 17). The scenario of converting a building from residential into medical use received a percent frequency of 36.67% (*frequency* = 11). The reset scenarios, converting a building from commercial into residential use and from industrial into commercial use, received a percent frequency of 10% (*frequency* = 3), respectively. This indicate both scenarios are not common across the building sector of Saudi Arabia. However, 30% (*frequency* = 9) of the respondents chose “other”, and thus, they mentioned further scenarios. The most mentioned scenario was converting a building from a residential use into another type of residential uses (e.g. from single house into apartment units, which accounted for 16.66% (*frequency* = 5).

3.3.2 A/Es’ Perception of the Process of Implementing Adaptive Reuse Projects

An open-ended question was asked to the A/E practitioners about their perception of the generic process of implementing adaptive reuse projects. Respondents were asked to provide a brief description about their experience on the processes that are implemented within the life-cycle of these projects in Saudi Arabia. This question contributed to capture the knowledge of the interviewees in term of their different point of views. Based on the provided answers, the general process of implementing adaptive reuse projects in Saudi Arabia consists of the following phases:

A. Planning phase

Many interviewees mentioned that the economic considerations are the most common types of drivers for implementing adaptive reuse projects in Saudi Arabia. Consequently, professionals involved in this phase would usually develop conceptual design and conduct economic study, to assess the feasibility of the proposed new use. Many practitioners emphasized that the owner, or his/her representative, should verify in this phase the potential of implementing the intended use, from the legal dimension. This can be fulfilled by the reviewing the requirements of the local municipality. Usually, each building use comprises a set of standard and legislative requirements that should be fulfilled, to satisfy the needs of the end users. Accordingly, A/Es' should work at developing the initial design of the new use in line with the functional (e.g. architectural program) and municipal requirements. Subsequently, the developed design should be submitted to the municipality for obtaining the initial approval on the proposed initial design for the new occupancy. The initial approval is important for continuing the design of the other detailed elements and technical systems in the building. In fact, obtaining the initial approval is highly recommended and important for obtaining the other applicable legal approvals (e.g. final design approval and building license). During this phase, different aspects should be considered within the context of the building conversion, including: structural condition of the skeleton, layout of the spaces, code requirements, financial considerations of the new use, and supply and demand trends.

B. Design phase

After obtaining the initial design approval from the municipality, the A/E and owner can work toward the development of the detailed and engineering design of the projects. In this phase, designers should work at meeting the technical and regulatory requirements of the new function, without compromising the functional needs of the end users. This requires a critical consideration about the requirements of the fire safety of the General Directorate of Civil Defense, and the energy efficiency (e.g. thermal insulation) of the Saudi Electricity Company. This phase usually ends up with completion of project documents, including: floor plans, structural drawings, MEP drawings, building specifications, and Bill of Quantities (BOQ) tables. The effective completion of these documents will facilitate the obtainment of the final approval of the design, and then, other permissions required for the construction.

C. Construction phase

The contractor and owner should carry out a set of managerial and on-site activities before the starting the implementation of the changes of use. These activities are necessary for obtaining the approval of starting the construction process (which is known as construction/building license). Obtaining the construction license requires a preparation of the project site. A set of requirements need to be fulfilled for that, including the provision of the construction waste bins and temporary fencing. The managerial aspects include the submission of copies of ownership certificate (ownership deed), letter about the works that are going to be carried out,

technical drawings, and endorsement letter stating the responsibility for complying with all technical and regulatory requirements for construction activities.

Once the pre-construction activities are successfully accomplished, the contractor can then start the execution activities. The contractors usually work in two main phases in adaptive reuse projects. In the first phase, contractors usually work at removing the old elements, such as unneeded/old walls, MEP systems and finishes. In the second phase, contractors usually work at establishing and installing the new systems and components. Both phases require effective planning and supervision. In the end of the construction process, the contractor should follow up with the Saudi Electricity Company for inspecting the compliance with the energy saving requirements. This activity will facilitate the process of launching the electricity and water services. Thereafter, it is highly recommended that a field inspection needs to be conducted by the owner, or his/her representative, throughout the entire building before moving to the application of obtaining the project completion certificate.

D. Operation phase

The occupancy phase starts once the project is delivered to the owner, his/her representative of the end user. All information and data regarding the implemented works and building documentations should be provided to one of these parties. This is due to the fact that these information and data would be needed for the daily operational and managerial uses. These information and data include, and not limited to, the follows: drawings, specifications, manuals, certificates, approvals and operation instructions.

3.3.3 Drivers/Causes of Implementing Adaptive Reuse Projects in Saudi Arabia

There are many drivers and causes of implementing adaptive reuse of the existing built facilities in Saudi Arabia. Respondents ($n = 30$) were asked to choose the possible causes/drivers of implementing adaptive reuse projects in Saudi Arabia. **Figure 3.15** illustrates the A/Es' responses to the drivers/causes of implementing adaptive reuse projects in Saudi Arabia.

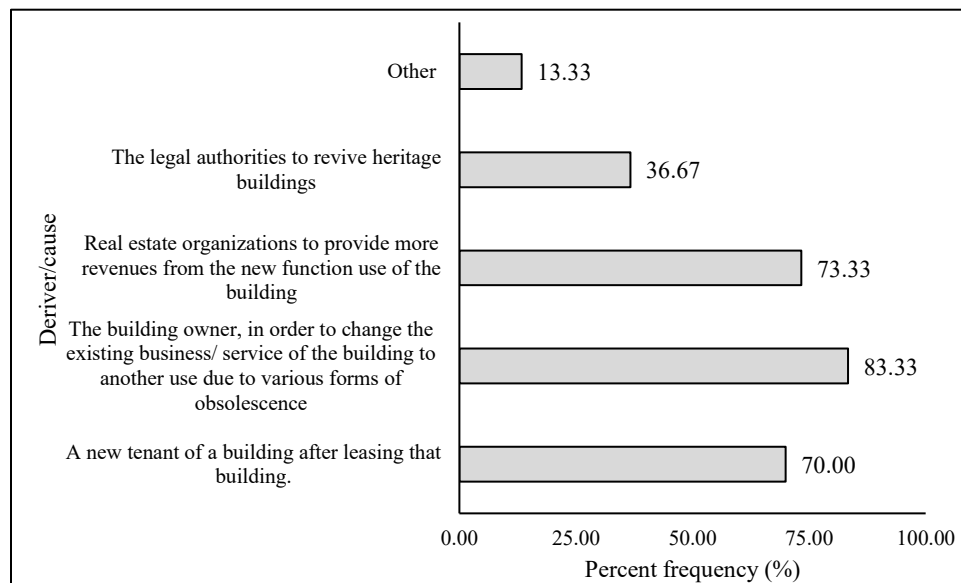


Figure 3.15: A/Es' responses to the drivers/causes of implementing adaptive reuse projects in Saudi Arabia

As shown in **Figure 3.15**, results indicate that the follows are the most possible causes/drivers of implementing adaptive reuse projects in Saudi Arabia: the building owner in order to change the existing business/service to another use due to various forms of obsolescence, 83.33% (*frequency* = 25); real estate organization to provide more revenues from the new function of the building, 73.33% (*frequency* = 22); and a new tenant of a building after leasing that building, 70% (*frequency* = 21). The social driver, legal authorities to revive heritage buildings, received a percent frequency of 36.67% (*frequency*

= 11). This indicates that the reuse of heritage buildings in Saudi is not a common as such as the first three causes/drivers. However, 13.33% (*frequency* = 4) of the respondents chose “other”, and thus, they mentioned further drivers/causes of the implementation of adaptive reuse projects in Saudi Arabia. The four respondents indicated that the market condition, which is known as “supply and demand”, is among these

3.3.4 Methods Used in the Communication among the Parties during the Design and Documents Preparation of Adaptive Reuse Projects

The used methods in the communication among the project parties are varying from a project into another. Thus, this question aimed to explore the adopted methods used in the A/E sector for the communication among the parties of adaptive reuse projects. Three communication methods were given to the respondents ($n = 30$), namely: workshops during the design development and review phases, informal meeting with all parties of the projects, and formal meeting with all parties of the projects. **Figure 3.16** illustrates the A/Es’ responses to the methods used in the communication among the parties during the design and/or documents preparation of adaptive reuse projects.

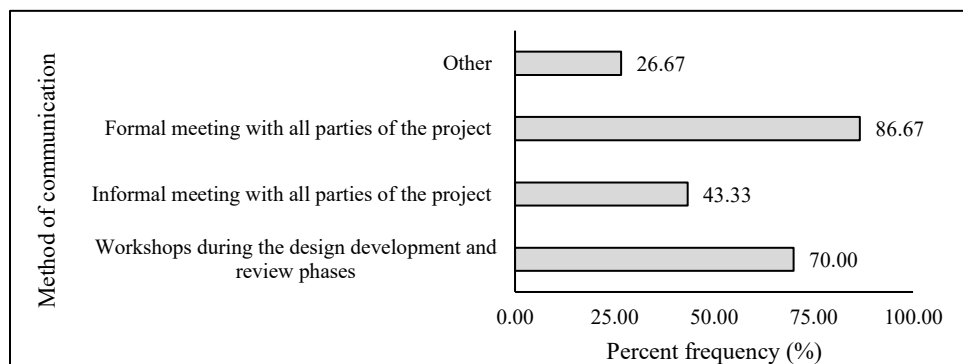


Figure 3.16: A/Es’ responses to the methods used in the communication among the parties during the design and/or documents preparation of adaptive reuse projects

As shown in **Figure 3.16**, results indicate that ‘formal meeting with all parties of the project’ and ‘workshop during the design development and review phase’ are the most methods used in communication among the parties of adaptive reuse projects. Both methods received percent frequencies of 86.67% (*frequency* = 26) and 70% (*frequency* = 21), respectively. Results indicate that the third communication method ‘informal meeting with all parties of the project’ is not preferably and always used in adaptive reuse projects. This method received a percent frequency of 43.33% (*frequency* = 13). However, 26.67% of the respondents (*frequency* = 8) chose “other”, and thus, they mentioned further methods of communication used among the project parties of adaptive reuse projects, namely: official letters, 6.66% (*frequency* = 2); phone 6.66% (*frequency* = 2); and emails 13.33% (*frequency* = 4).

3.3.5 Information and Data Needed During the Design Process and Documents

Preparation of Adaptive Reuse Projects

There is a set of information and data that should be provided for the A/E during the processes of design development and documents preparation of adaptive reuse projects. Thus, eight major types of information/data were listed in this question, namely: as-built architectural blueprints, built structural blueprints, built services (MEP) blueprints, as-built construction details’ drawings, construction specifications, systems and equipment manuals, design calculations/design calculation sheets for all systems, and legal approvals. Respondents ($n = 30$) were asked to choose all data/information that need to be provided during the design process and documents preparation of adaptive reuse projects. **Figure 3.17** illustrates the A/Es’ responses to the information and data needed during the design process and documents preparation of adaptive reuse projects.

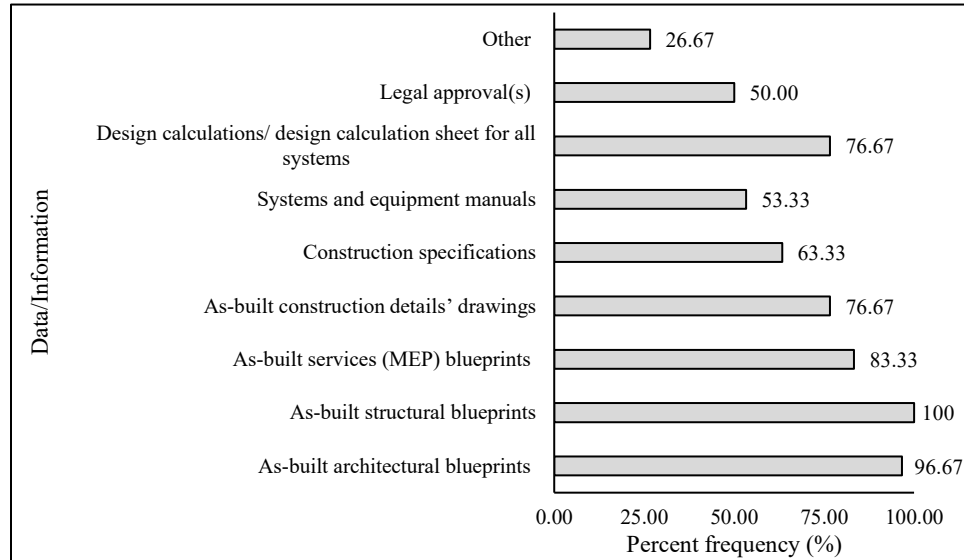


Figure 3.17: A/Es' responses to the information and data needed during the design process and documents preparation of adaptive reuse projects

As shown in **Figure 3.17**, most of the listed information/data received high percent frequencies. Results indicate that percent frequencies of the listed types of data/information were as follows: as-built structural blueprints, 100% (*frequency* = 30); as-built architectural blueprints, 96.67% (*frequency* = 29); as-built services (MEP) blueprints, 83.33% (*frequency* = 25); as-built construction details' drawings, 76.67% (*frequency* = 23); design calculations/design calculation sheets for all systems, 76.67% (*frequency* = 23); construction specifications, 63.33% (*frequency* = 19); systems and equipment manuals, 53.33% (*frequency* = 16); and legal approvals, 50% (*frequency* = 15). However, 26.67% (*frequency* = 8) of the respondents chose "other", and thus, they mentioned further types of information/data that need to be provided in this regard, namely: updated documentation of the condition and layout of the buildings, 16.67% (*frequency* = 5); photographs, 6.67% (*frequency* = 2); and case studies, 3.33% (*frequency* = 1).

3.3.6 Followed Methods for Obtaining Data and Information Needed during the Design Process and Documents Preparation of Adaptive Reuse Projects

There are different methods followed for obtaining the information/data needed during the design process and documents preparation of adaptive reuse projects. This question aimed to capture A/Es' knowledge in this regard. Four possible methods were listed in this question, namely: direct contact with the owner/owner representative, direct contact with the project manager, direct contact with the real estate organization that leases the building, and direct request during the meetings and/or workshops with the project parties. Respondents ($n = 30$) were asked to choose all applicable and followed methods. **Figure 3.18** illustrates the A/Es' responses to the followed methods for obtaining data/information needed during the design process and documents preparation of adaptive reuse projects.

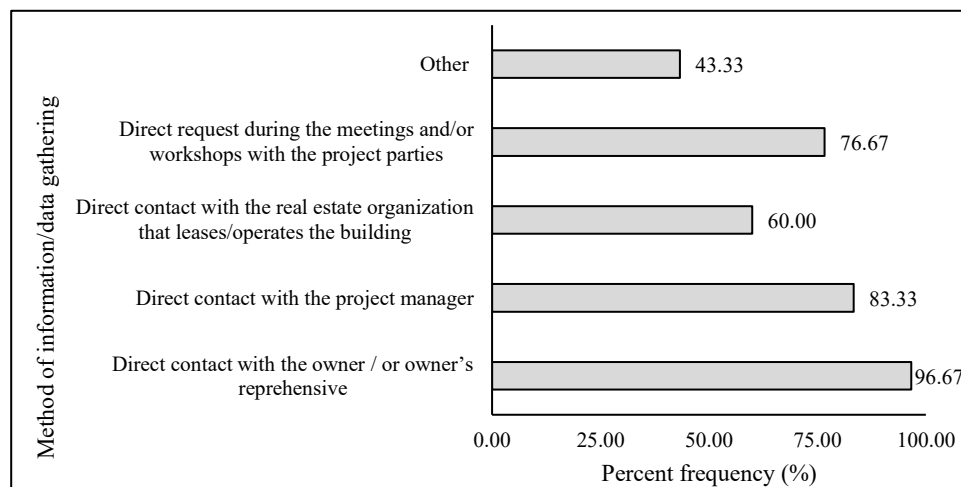


Figure 3.18: A/Es' responses to the followed methods for obtaining data/information needed during the design process and documents preparation of adaptive reuse projects

Based on the presented results in **Figure 3.18**, it is remarkable that most of the listed methods are followed in the data/information gathering. Their percent frequencies were as follows: direct contact with the owner/or owner representative, 96.67% (*frequency* = 29); direct contact with the project manager, 83.33% (*frequency* = 25); direct request during the meetings and/or workshops with the project parties, 76.67% (*frequency* = 23); direct contact with the real estate organization that leases/operates the building, 60% (*frequency* = 18). However, 43.33% (*frequency* = 13) of the respondents chose “other”, and thus, they stated other methods of data gathering, namely: regulatory authorities and service providers (e.g. municipality and/or electricity company), 26.67% (*frequency* = 8); previous A/E of the project, 13.33% (*frequency* = 4); and previous contractor, 3.33% (*frequency* = 1).

3.3.7 Utilized Tools in the Design Process and Documents Preparation of Adaptive Reuse Projects

Different tools are used in the design process and documents preparation of adaptive reuse projects. Thus, this question aimed to investigate the utilized tools in the design process and documents preparation of adaptive reuse projects. Respondents ($n = 30$) were asked to choose all tools utilized in these projects, where four tools were listed, namely: computer-aided design (CAD), building information modeling (BIM), manual drafting, and word processing applications. **Figure 3.19** illustrates the A/Es’ responses to the utilized tools in the design process and documents preparation of adaptive reuse projects.

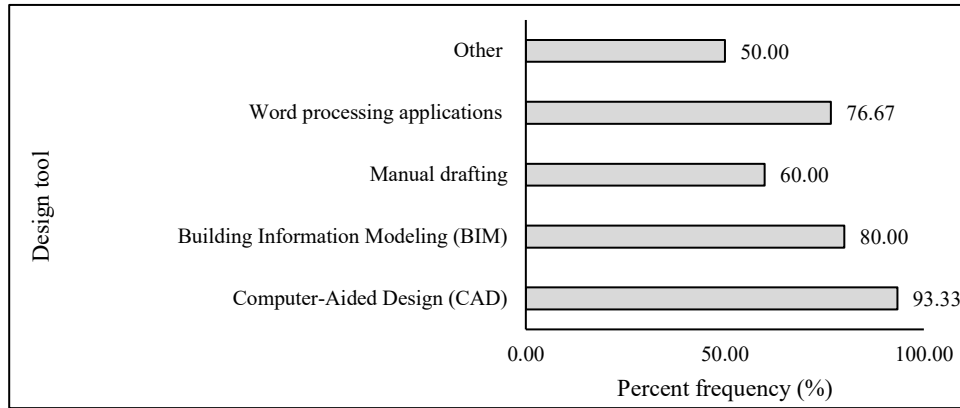


Figure 3.19: A/Es' responses to the utilized tools in the design process and documents preparation of adaptive reuse projects

As shown in **Figure 3.19**, most of the listed tools are almost used in the design process and documents preparation of these projects. Their percent frequencies were as follows: CAD, 93.33% (*frequency* = 28); BIM, 80% (*frequency* = 24); word processing applications, 76.67% (*frequency* = 23); and manual drafting, 60% (*frequency* = 18). However, 50% (*frequency* = 15) of the respondents chose “other”, and thus, they mentioned further design tools, namely: 3D graphics software (e.g. 3D Max), 40% (*frequency* = 12); and structural analysis software (e.g. STAAD Pro.), 10% (*frequency* = 3).

3.3.8 Applicable Challenges that Possibly Face A/E Professionals During the Design Process and Documents Preparation of Adaptive Reuse Projects

There are different challenges facing the practitioners who are involved in the design process and documents preparation of adaptive reuse projects. Thus, this question aimed to investigate all applicable challenges that face the A/Es' professionals who are working in developing design and/or preparing the documents of adaptive reuse projects.

Respondents ($n = 30$) were asked to choose all applicable challenges facing the processes of design development and documents preparation of adaptive reuse projects. In this question, 13 challenges were listed, namely: time allocated to complete the preparation of the documents, budget allocated to complete the documents, lack of client's experience on the adaptive reuse projects, lack of data and information, limitations on area to achieve the space requirements of the new function, inaccurate as-built drawings, lack of flexibility due to the layout of the structural systems, lack of flexibility due to the layout of the original architectural configuration, lack of flexibility due to the layout of MEP systems, inadequate structural integrity to accommodate the newly imposed loads, inadequate capacity of the existing MEP systems to suit the requirements of the new function, ability to accommodate the requirements and needs of the new users, and ability to satisfy the requirements of design codes and standards. **Figure 3.20** illustrates the A/Es' responses to the applicable challenges that possibly face the design process and documents preparation of adaptive reuse projects.

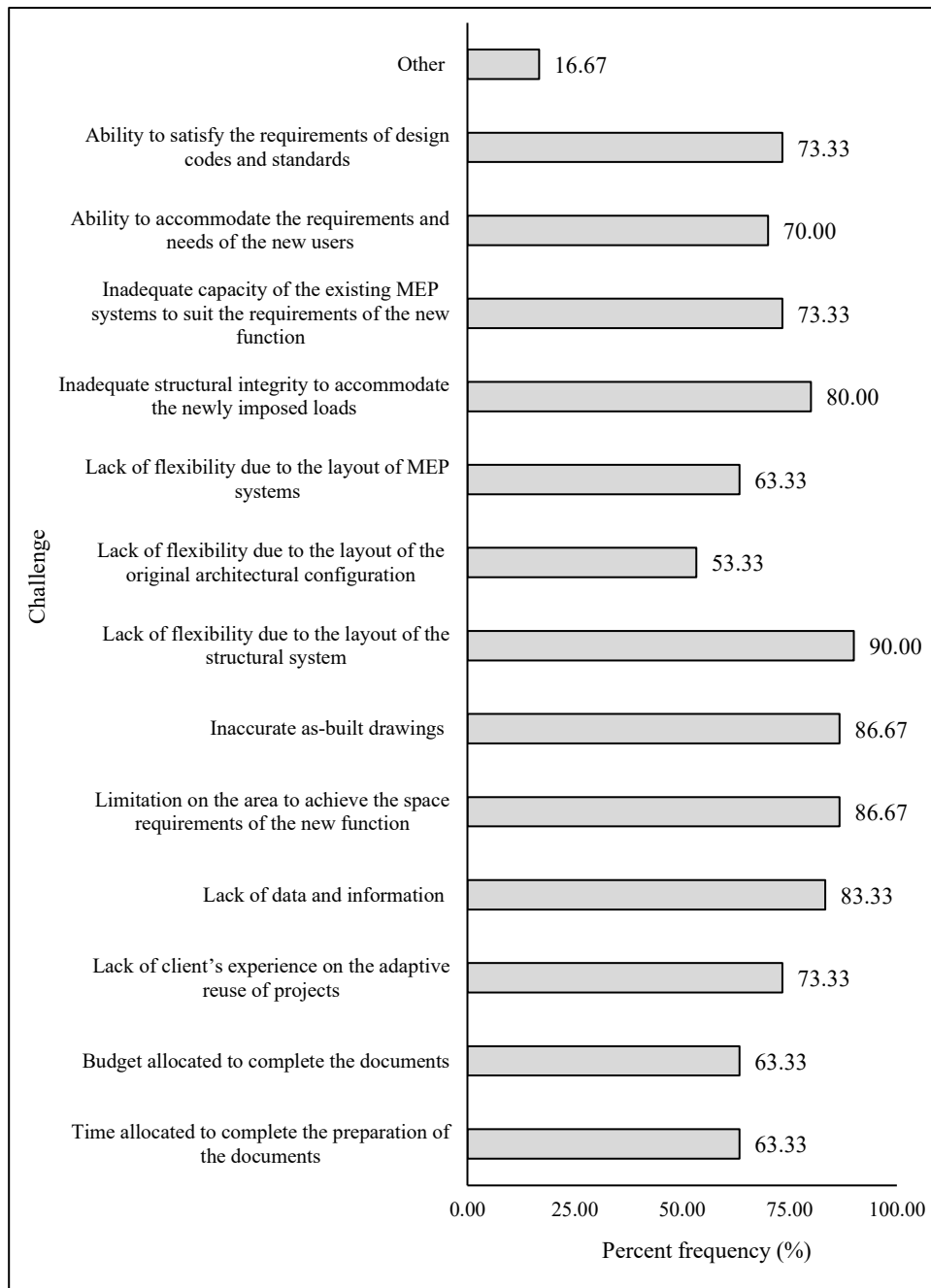


Figure 3.20: A/Es' responses to the applicable challenges that possibly face the design process and documents preparation of adaptive reuse projects

As shown in **Figure 3.20**, most of the listed challenges received percent frequencies above 50%, which indicate that they are applicable. The calculated percent frequencies of the listed challenges were as follows: lack of flexibility due to the layout of the structural systems, 90% (*frequency* = 27); inaccurate as-built drawings, 86.67% (*frequency* = 26); limitations on area to achieve the space requirements of the new function, 86.67% (*frequency* = 26); lack of data and information, 83.33 (*frequency* = 25); inadequate structural integrity to accommodate the newly imposed loads, 80% (*frequency* = 24); lack of client's experience on the adaptive reuse projects, 73.33% (*frequency* = 22); inadequate capacity of the existing MEP systems to suit the requirements of the new function, 73.33% (*frequency* = 22); ability to satisfy the requirements of design codes and standards, 73.33% (*frequency* = 22); ability to accommodate the requirements and needs of the new users, 70% (*frequency* = 21); time allocated to complete the preparation of the documents, 63.33% (*frequency* = 19); budget allocated to complete the documents, 63.33% (*frequency* = 19); lack of flexibility due to the layout of MEP systems, 63.33% (*frequency* = 19); and lack of flexibility due to the layout of the original architectural configuration, 53.33 (*frequency* = 16). The last challenge 'lack of flexibility due to the layout of the original architectural configuration' received the lowest percent frequency. Some interviewee mentioned that this challenge is not a serious, since the architectural elements are the most easiest and flexible elements in terms of their potential for modification and/or replacement. However, 16.67 (*frequency* = 5) of the respondents chose "other", and thus, they mentioned further design challenges, namely: time to get the legal approval about the proposed initial design, 13.33% (*frequency* = 4); and unclear requirements, 3.33% (*frequency* = 1).

3.3.9 Systems Affected by the Requirements of the New Function in Adaptive Reuse Projects

Recall in the review of literature that adaptive reuse projects require the implementation of renovation and/or refurbishment works across the building systems. Accordingly, this question aimed to provide a general insight on the changes that are mostly carried out across the building systems in adaptive reuse projects. Respondents ($n = 30$) were asked to choose the building systems that are usually influenced by the requirements of the new function in adaptive reuse projects. Three major systems were listed in this question, namely: structural, MEP and construction systems. **Figure 3.21** illustrates the A/Es' responses to the systems affected by the requirements of the new function in adaptive reuse projects.

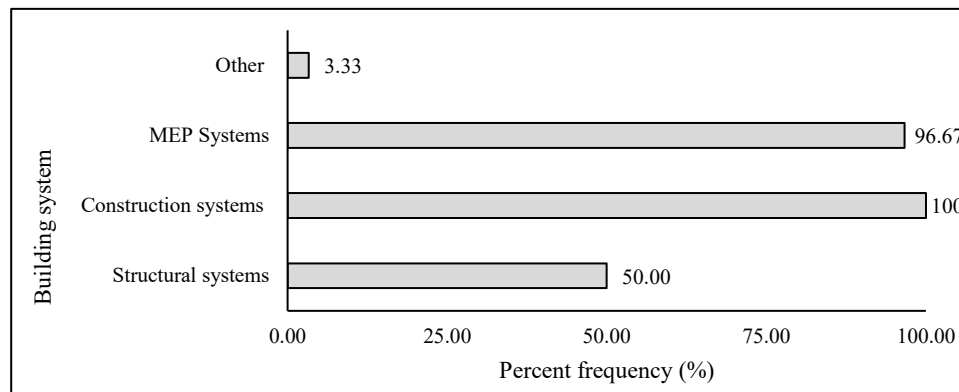


Figure 3.21: A/Es' responses to the systems affected by the requirements of the new function in adaptive reuse projects

As shown in **Figure 3.21**, results indicate that the construction and MEP systems are the most elements that are affected by the requirements of the new function in adaptive reuse projects. They received percent frequencies of 100% (*frequency* = 30) and 96.67% (*frequency* = 29), respectively. On the other hand, structural systems received a percent frequency of 50% (*frequency* = 15). This indicates that performing changes on the built

structural elements is not common in adaptive reuse projects. Most of respondents who chose this choice mentioned that the changes in the structural elements are performed when there is a need for an extension to the current structure. Hence, establishment of additional structural elements are the most common change in this case. Further, those respondents also mentioned that removing a structural element from an existing building is not a sound action for the integrity of the building structure, and thus, it is not carried out at all. One respondent, accounting for 3.33%, chose “other”, and mentioned that the ITs (information technology systems) are among the systems that are affected by the refurbishment and/or renovation works of adaptive reuse projects.

3.3.10 Methods Suggested for Improving the Design Process and Documents

Preparation in Adaptive Reuse Projects

There are different methods that can be considered and carried out to improve the design process and document preparation of adaptive reuse projects. Thus, this question aimed to investigate the possible methods that can be proposed for enhancing the design process as well as documents preparation of adaptive reuse projects. Four suggested methods were listed in this question, namely: development of adequate architectural program of the new function in the early design process, identify the client budget in the early design process, and review the design with the client periodically. Respondents ($n = 30$) were asked to choose the methods that are effective and can be proposed in this context. **Figure 3.22** illustrates the A/Es' responses to the methods suggested for improving the design process and documents preparation in adaptive reuse project.

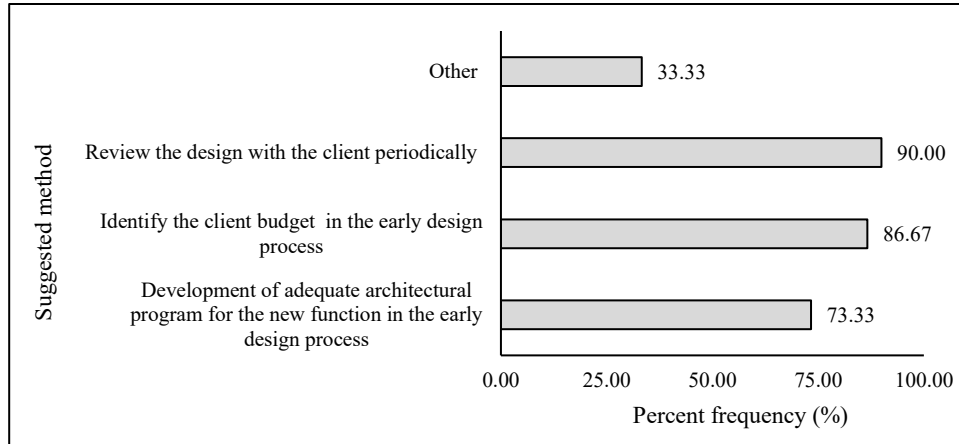


Figure 3.22: A/Es' responses to the methods suggested for improving the design process and documents preparation in adaptive reuse project

As shown in **Figure 3.22**, all suggested methods received high percent frequencies, in which this implies that they can be considered and proposed for future adaptive reuse projects. The percent frequencies of these methods were as follows: review the design with the client periodically, 90% (*frequency* = 27); identify the client budget in the early design process, 86.67 (*frequency* = 26); and development of adequate architectural program of the new function in the early design process, 73.33 (*frequency* = 22). However, 33.33% (*frequency* = 10) of the respondents chose “other”, and thus, they mentioned further methods that can be proposed for improving the design process and documents preparation of adaptive reuse projects. These methods included: utilization of state-of-the-art-technologies in the design development processes, 16.67% (*frequency* = 5); studying the market trend and business feasibility; 10% (*frequency* = 3); and conducting case studies, 6.67% (*frequency* = 2)

3.3.11 Concluding Remarks of A/Es' Responses

This subsection summarizes the main conclusions of the discussed findings of investigation of the local practice of building adaptive reuse in the A/E profession in Saudi Arabia. The followings are the concluding remarks of this section:

- The most common two scenarios of adaptive reuse projects in Saudi Arabia are the conversion of a building from residential into commercial use, and from commercial into another commercial use.
- Planning, design, construction and operation phases are the major milestones of the life-cycle of adaptive reuse projects, in which many managerial and technical efforts need to be carried out across these stages.
- The most common drivers/causes of implementing adaptive reuse projects in Saudi Arabia are three, namely: building owner in order to change the existing business/service to another use due to various forms of obsolescence, real estate organization to provide more revenues from the new function of the building, and a new tenant of a building after leasing that building.
- 'Formal meeting with all parties of the project' and 'workshop during the design development and review phase' are the most useable methods for the communication among the parties of adaptive reuse projects.
- There is a set of information/data that needs to be provided to the A/E during the design process and documents preparation of adaptive reuse projects, namely: as-built structural blueprints, as-built architectural blueprints, as-built services (MEP) blueprints, as-built construction details' drawings, design

calculations/design calculation sheets for all systems, construction specifications, and systems and equipment manuals.

- The most followed methods for gathering these information are: direct contact with the owner/or owner representative, direct contact with the project manager, direct request during the meetings and/or workshops with the project parties, and direct contact with the real estate organization that leases/operates the building.
- CAD, BIM, word processing applications, manual drafting and graphics applications are the most utilized tools in the design process and documents preparation of adaptive reuse projects.
- The follows are the applicable challenges facing the A/E team during the design of adaptive reuse projects: lack of flexibility due to the layout of the structural systems, inaccurate as-built drawings, limitations on area to achieve the space requirements of the new function, lack of data and information, inadequate structural integrity to accommodate the newly imposed loads, lack of client's experience on the adaptive reuse projects, inadequate capacity of the existing MEP systems to suit the requirements of the new function, ability to satisfy the requirements of design codes and standards, ability to accommodate the requirements and needs of the new users, time allocated to complete the preparation of the documents, budget allocated to complete the documents, lack of flexibility due to the layout of MEP systems, and lack of flexibility due to the layout of the original architectural configuration.

- MEP and construction systems are the mostly affected building elements by the requirements of adaptive reuse projects, whereas the structural system is affected in case if there is a need for building extension.
- There are four possible methods that can be proposed for improving the design process and documents preparation of adaptive reuse projects, namely: review of the design with the client periodically, identification of client budget in the early design process, development of adequate architectural program of the new function in the early design process, and use of state-of-the-art technologies.

3.4 The Local Practice of Constructing Adaptive Reuse Projects

Construction contractors started to execute adaptive reuse projects in Saudi Arabia since a long period of time, in response to the grow up of this practice. Thus, this section covers a discussion of the findings of the second section which was provided in the contractors' questionnaire surveys. It covers an analysis of the point of views, perceptions and knowledge captured through the conducted questionnaire survey on the adaptive reuse practitioners from the construction industry.

Eight aspects were considered in this section, namely: (1) common scenarios of adaptive reuse projects in Saudi Arabia, (2) contractors' perception about the process of implementing adaptive reuse projects, (3) methods used in the communication among the parties during the implementation of adaptive reuse projects, (4) information and data needed during the implementation of adaptive reuse projects, (5) followed methods for obtaining data and information needed during the implementation of adaptive reuse projects, (6) extent of work that usually takes place during the implementation of adaptive reuse projects, (7) applicable challenges that possibly face contractors during the

implementation of adaptive reuse projects, and (8) methods suggested for improving the implementation process of adaptive reuse projects.

3.4.1 Common Scenarios of Adaptive Reuse Projects in Saudi Arabia

There is a diversity in the possible scenarios of adaptive reuse projects in Saudi Arabia. Thus, respondents of the contractors' questionnaire survey ($n = 30$) were asked to choose the common scenarios of adaptive reuse projects in Saudi Arabia, according to their professional practice. Six scenarios were listed in this question, namely: from commercial into residential use, from commercial into another commercial use, from commercial into medical use, from residential into commercial use, from residential into medical use, and from industrial into commercial use. Respondents were also given the opportunity to add other scenarios. **Figure 3.23** illustrates the contractors' responses to the common scenarios of adaptive reuse projects in Saudi Arabia.

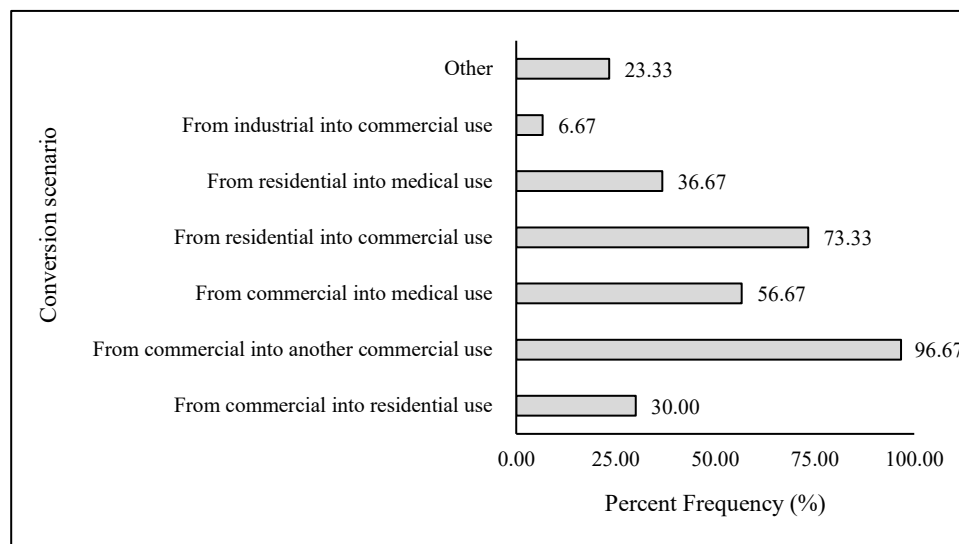


Figure 3.23: Contractors' responses to the common scenarios of adaptive reuse projects in Saudi Arabia

As shown in **Figure 3.23**, contractors' responses indicate that the follows are the most common scenarios of adaptive reuse projects in Saudi Arabia: from commercial into another commercial use, 96.67% (*frequency* = 29); from residential into commercial use, 73.33% (*frequency* = 22); and from commercial into medical use, 56.67% (*frequency* = 17). The follows are the received percent frequencies of the other scenarios: from residential into medical use, 36.67% (*frequency* = 11); from commercial into residential use, 23.33%, (*frequency* = 11); from industrial into commercial, 6.67% (*frequency* = 2). This indicate these three scenarios are not common across the building sector of Saudi Arabia. However, 23.33% (*frequency* = 7) of the respondents chose "other", and thus, they mentioned further scenarios, namely: from residential into another form of residential uses, 13.33% (*frequency* = 4); and from residential into educational use, 10% (*frequency* = 3).

3.4.2 Contractors' Perception about the Process of Implementing Adaptive Reuse Projects

An open-ended question was asked to the construction practitioners about their perception of the generic process of implementing adaptive reuse projects. They were asked to provide a brief description about their experience on the processes that are carried out through the life-cycle of adaptive reuse projects in Saudi Arabia. This question contributed to capture the knowledge of the interviewees in term of their different point of views. Based on the provided answers, the general process of implementing adaptive reuse projects in Saudi Arabia consists of the following phases:

A. Planning phase

The planning phase is the first stage of the life-cycle of adaptive reuse projects. Interviewed construction practitioners indicated that the planning phase comprises a set of the crucial activities that need to be effectively carried out for a successful adaptive reuse.

The property's owner, investor, or end user should study the feasibility of the project from different dimensions, not limited to the economic perspective. This implies that the owner, investor, end user and/or A/E should consider many aspects, in an integrated manner, within the context of the adaptive reuse feasibility. Six aspect should be considered in this regard, namely:

- Market condition (in terms of supply and demand trends).
- Zoning policies and spatial requirements of the local municipality and the Ministry of Municipal and Rural Affairs (MoMRA), including: car parking, setbacks, and the policies of the land use of the parcels.
- Requirements of the applicable building codes and standards, in terms of fire safety requirements of the General Directorate of Civil Defense and the other technical requirements of the Saudi Building Code (SBC).
- Functional considerations of the new function (architecture program).
- Structural condition of the building, in terms of the structural integrity and strength of the building skeleton to carry the new loads.
- Dimensional and physical characteristics of the building layout, including: areas, forms, length, width, heights, orientation and distribution of the spaces and the other systems throughout the building.

First, many of the interviewees indicated that a review of the guidelines, requirements and standards of the local municipality should be performed by the property investor/owner. They highly recommended that the implementation of these process needs to be performed before studying the feasibility of the adaptive reuse. This due to the fact that this process enables the owner/investor to initially explore the legality and requirements of the change of use. Further it serves for identifying all possible uses that are approved by the municipality. Many factors affect the outputs of this process, including spatial requirements, zoning policies, structural condition, building age, dimensional characteristics of the building, and the other requirements of the building codes and municipality. Once the parties have investigated the adaptive reuse potential from the legal dimension, they will become able to carry out the activities pertaining to the conceptual planning and feasibility studies.

Second, parties of this phase can perform the activities pertaining to the feasibility assessment and conceptual planning of the adaptive reuse project. These activities may include, but not limited to, the follows:

- Collection and analysis the client's functional requirements.
- Development of initial design.
- Preparation of initial cost estimates.
- Assessment of the expected net cash flow of the proposed possible alternative/
group of alternatives.

These activities should be carried out in line with the following considerations:

- Technical and legislative requirements.
- Client's needs from space.
- Available recourses (e.g. time and money).
- Physical attributes/restrictions of the building (e.g. structural characteristics and layout of the spaces).

An interviewee mentioned that the accuracy of this process is mainly based on the allocated efforts and time for its accomplishment. Additionally, it was mentioned that the more information and data being provided in this process, the more accurate outcomes will be produced in the feasibility assessment, accordingly. Once the project parties have developed the conceptual plan and determined its feasibility, they can then move into the process of developing the preliminary design.

Third, the process of developing a preliminary design of building adaptive reuse is within the context of the planning phase of these projects. In this process, project parties need to work together at developing a preliminary architectural design of the intended use. The development of the preliminary design should be accomplished also in line with following considerations:

- Cost and budgetary limitations
- Technical and legislative requirements
- Physical and structural characteristics of the building,
- Available resources of the project
- Functional requirements.

Output of this phase usually include technical drawings of the architectural layout of the new function of the project., namely:

- Floor plan blueprints,
- Sections and elevations views,
- Site plan,
- Table of space utilization (areas and number of rooms)
- Illustration of the satisfactory of the safety requirements of the General Directorate of Civil Defense.

These outputs need to be assembled in one document and submitted to the municipality for the review of their compliance with their applicable requirements. If the developed documents satisfy the municipality requirements, an initial approval on the preliminary design will be issued. This approval enables the project parties to move into the design and engineering phase. Otherwise, the municipality will reject the issuing of the preliminary approval, and enhancements on the documents will be asked for another submission for review.

B. Design phase

Interviewees indicated that the detailed design of all building systems and components of adaptive reuse projects is developed during this phase. The A/E should work in this phase in accordance with requirements of the applicable technical and legislative requirements. Many technical, spatial, legal and functional considerations should be kept in mind in this phase, including:

- Requirements of the end users
- Characteristics and layout of the structural members
- Number of occupants, and their activities and behavior.
- Workflow of activates.
- Layout and capacities of the MEP systems.
- Operational loads, of the MEP systems.
- Health and safety measures.
- Energy saving strategies through the design of the building and its systems.

First, A/E should survey the condition of all construction elements and systems in the building, namely: partitions, façade, openings, MEPs, and finishes. Some interviewees indicated this process usually facilitates the judgement on the systems which can be kept, and the others which need to be removed and/or replaced. The judgment will be generated based upon the developed preliminary design, findings of the performed survey, and the mentioned above considerations. It was highly recommended by many respondents that A/Es should inform the client (e.g. owner, investor, end user of the property) about these design decisions to take the approval. Thereafter, A/E should reflect all changes on the technical drawings of the new layout, and illustrate them in detailing sheets, to avoid any deficiencies in the construction documents later on.

In case of the need for an extension to structural (vertical/horizontal), the A/E is responsible to conduct a structural analysis and design of the new members according to the applicable codes and standards. It is also the A/E's responsibility to document all these alteration in the drawings and specifications of the project.

Many respondents emphasized that the structural layout need to be updated according to the reality, even if there will be no alterations over it.

Second, A/E should study the technical capacity and condition of all MEP systems in the building, including: HVAC, power distribution, lighting fixtures, and plumbing services. A/E should also analyze and determine the loads of all these systems according to the demands of the new function, including water, electricity, cooling demands. The determination of these demands should be performed in accordance with the applicable building codes and standards. In this regard, A/E should identify which of the existing systems are capable to serve these demands, and which are not so. If there will be a replacement of an existing system, the client should be informed about this action by the A/E. In addition, these actions need to be reflected on the engineering documents of the project, in a detailed manner. The new layout of the MEP systems needs to be updated and well in such manner. Building codes also should be followed in the selection and design of the new MEP systems.

Third, many respondents emphasized the importance of developing completed project document. This requires the preparation of comprehensive specifications of all systems and materials that are going to be used. Further, table of quantities and detailed cost estimates should be developed in this context. These information and data are important for obtaining the building license from the municipality, as well as the subsequent contractual and construction activities.

Finally, adaptive reuse client should carry out some preparatory activities on the site, before submitting the final design to the municipality for obtaining the building license. This is due to the fact that issuing building license requires the implementation of some preparatory activities on the site, namely: placing construction waste bins and temporary fencing. Thereafter, A/E and client can submit the final design to the municipality for obtaining the building license. Once the building license is issued, the client can move into the contractual activities of the construction phase.

C. Construction phase

Most of the interviewed construction practitioners emphasized the importance of carrying out the contractual activities in an accurate manner. The completed documents will be submitted to a contractor, group of contractors, for the procurement process. Based on the adopted procurement method, the selection of the suitable contractor will be performed, accordingly. Thereafter, the contract of agreement will be formulated and signed by the project stakeholders. The project contract should comprise the follows:

- Scope and coordination of the different items of work.
- Schedule and prices of the different work items.
- Terms and conditions.
- Completed technical drawings and specifications.
- Other specific requirements of the adaptive reuse.

Once the contract document is formulated and signed, contractor will become responsible to implement the adaptive reuse project. It is the contractor's responsibility to manage the adaptive reuse project in line with the stated price, time, requirements, specifications, terms, and conditions. In the construction site, most of the respondents stated that the contractor must start firstly at mobilizing the site of the building by all tools, equipment and materials needed for the executional activities. All these physical assets should be placed and secured safely in the project site. It was highly recommended that contractor of adaptive reuse projects should effectively manage the storage and delivery of the construction materials and equipment. This also requires the allocation of a space within the building to be used as a storage, since the provision temporary structures in the site of adaptive reuse projects might be difficult due to the physical and spatial limitations. Safety and security measures should be also considered and be adequately enforces in this context. Once the site of the adaptive reuse project has been prepared, the contractor will be able to implement the adaptation activities, accordingly.

Most of the interviewee indicated that the adaptation activities start by removing the elements and systems that are going to be taken out and/or replaced by new items. As first step of the adaptation execution, the contractors need to start the removal work by taking off all obsolete opening, partitions, finishes, and then the MEP systems. Thereafter, re-extension and re-establishment of the supplying lines of all MEP systems will be carried out, including the layout of the plumbing piping, electricity wiring and HVAC ducting. Once all MEPs lines are re-configured and installed, establishment of the new partitions will be implemented. Installation of

the other building components will be carried out after the establishment of all partitions. These components include ceiling, tiles, paints, doors and windows. Installation of the MEP fixtures are the final executional activities that are carried out during the construction phase in adaptive reuse projects. These fixtures include all fittings of the MEP systems, namely: lights, diffusers, water closet, lavatories and tabs.

Before the end of the construction accomplishment, a request needs to be raised to the Saudi Electricity Company for launching the electric current. This process is essential when there is a need for an upgrade on the size/number of meters. In this case, the Saudi electricity company will not launch the current till they ensure that their energy saving measures are fulfilled.

Many construction practitioners recommended that the client should conduct a full testing over the building systems and component, before signing the project delivery. This is due to the fact this process enables the adaptive reuse client to assure that all systems and components satisfies the recommended criteria in the contract document. Once the owner has ensured the performance of all components and systems, signing and issuing the project completion certificate would be accomplished, accordingly.

D. Operation phase

Operation phase starts after the building handing to the client, where the daily FM activities would start to take place in this period. Recruitment of O&M/FM personnel for managing the operational activities of the converted building is a necessary task that need to be carried out as a first step. In this regard, contractual

activities would be needed in this step. Many respondents indicated that clients of small adaptively reused buildings would assign a property (real estate) manager to perform these activities, in addition to the trading and marketing responsibilities. In both cases, it is highly recommended that a clear contact document should be prepared and signed by the client and the operator. The contract document needs to comprise many items, namely: required operational activities, responsibilities, building records and drawings.

Once the building is assigned to an operator, personnel should be assigned to operate the building, and informed about their roles and responsibilities. All information required for the operation should be provided to them, including manuals, drawings, work schedules and other data. For the ongoing occupancy phase, the operation personnel and their supervisor should carry out all daily operational activities in accordance with the agreed contract.

3.4.3 Methods Used in the Communication among the Parties during the Implementation of Adaptive Reuse Projects

Methods used in the communication among the parties during the implementation of adaptive reuse projects are varying from a project into another, and from an organization into another. Thus, this question aimed to explore all adopted and used methods in the communication among the project stakeholders involved in the construction of adaptive reuse projects. Three communication methods were given to the in this question ($n = 30$). Respondents ($n = 30$) were asked to choose all the communication methods that are always used in these projects. Three methods were listed in this question, namely: meeting with parties in case of inspection/follow up for the progress of the construction, informal

meeting with all parties of the projects, and formal meeting with all parties of the projects.

Figure 3.24 illustrates the contractors' responses to the methods used in the communication among the parties during the implementation of adaptive reuse projects.

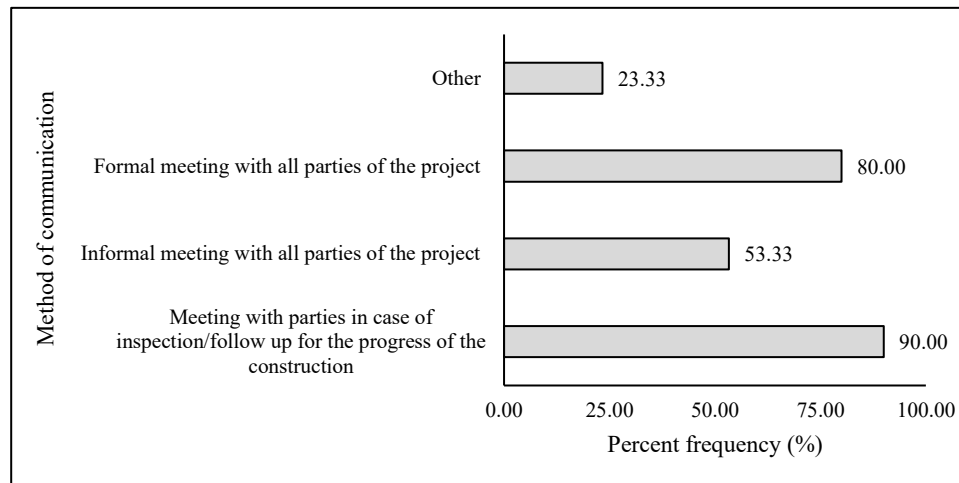


Figure 3.24: Contractors' responses to the methods used in the communication among the parties during the implementation of adaptive reuse projects

As shown in **Figure 3.24**, results indicate that 'meeting with parties in case of inspection/follow up for the progress of the construction', 90% (*frequency* = 27); and 'formal meeting with all project parties', 80% (*frequency* = 24) are the most methods used in the communication between the parties during the execution of adaptive reuse projects. According to the responses, informal meeting with all project parties is not common method used in the communication among the parties of adaptive reuse projects. It received a percent frequency of 53.33% (*frequency* = 16). However, 23.33% of the respondents (*frequency* = 7) chose "other", and thus, they mentioned further methods of communication used among the parties during the execution of adaptive reuse projects, namely: phone, 13.33% (*frequency* = 4); emails, 6.67% (*frequency* = 2); and letters, 3.33% (*frequency* = 1).

3.4.4 Information and Data Needed during the Implementation of Adaptive Reuse Projects

There are different types information and data that need be provided for the contractor during the process implementing adaptive reuse projects. Thus, respondents ($n = 30$) were asked to choose all information/data that are needed during the process of implementing adaptive reuse projects. Fourteen types of information/data were listed in this question, namely: as-built architectural blueprints for the previous function of the project, as-built structural blueprints for the previous function of the project, as-built blueprints for the MEP systems for the previous function of the project, as-built construction details for the previous function of the project, construction specifications of the previous function of the project, systems and equipment manuals of the previous function of the project, technical blueprints of the architectural layout of the new function of the project, construction details drawings of the new function of the project, updated structural drawings of the new function of the project, updated blueprints of the MEP systems of the new function of the project, construction specifications of the new function of the project, systems and equipment manuals of the new function of the project, project time schedule, and bill of quantities (BOQ) of the project.

Figure 3.25 illustrates the contractors' responses to the information and data needed during the implementation of adaptive reuse projects. Overall, it is noted that most of the listed information/data are important and need to be provided to the contractor during the execution of adaptive reuse projects.

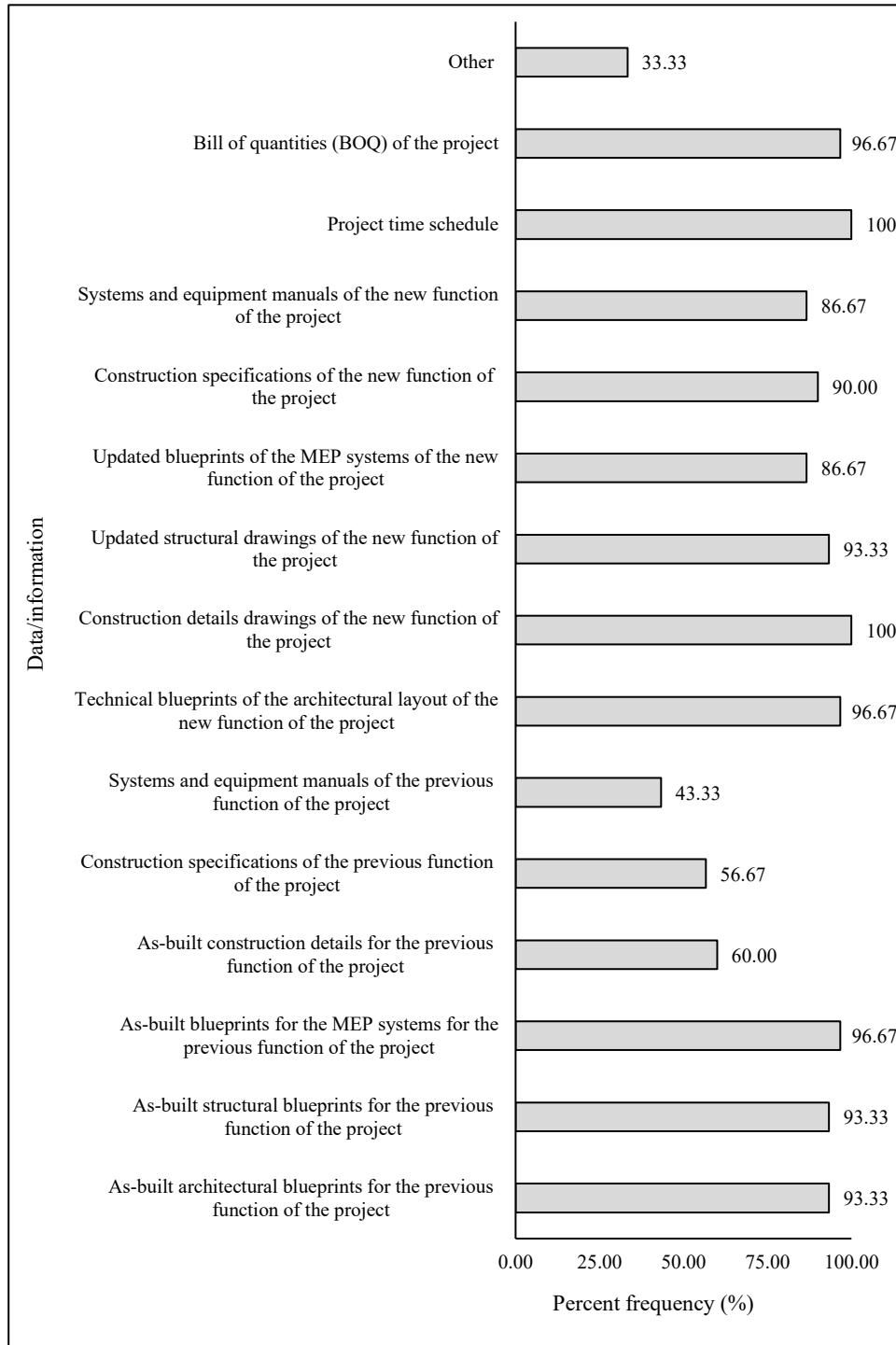


Figure 3.25: Contractors' responses to the information and data needed during the implementation of adaptive reuse projects

Results indicate that the followers are the most important information that needs to be available with the contractor during the execution of adaptive reuse projects: construction details drawings of the new function of the project, 100% (*frequency* = 30); project schedule, 100% (*frequency* = 30); built blueprints for the MEP systems for the previous function of the project, 96.67% (*frequency* = 29); technical blueprints of the architectural layout of the new function of the project, 96.67% (*frequency* = 29); project BOQ, 96.67% (*frequency* = 29); as-built architectural blueprints for the previous function of the project, 93.33% (*frequency* = 28); as-built structural blueprints for the previous function of the project, 93.33% (*frequency* = 28); updated structural drawings of the new function of the project, 93.33% (*frequency* = 28); construction specifications of the new function of the project, 90% (*frequency* = 27); updated blueprints of the MEP systems of the new function of the project, 86.67% (*frequency* = 26); systems and equipment manuals of the new function of the project, 86.67% (*frequency* = 26); and as-built construction details of the new for the previous function of the project, 60% (*frequency* = 18). According to the responses, construction specifications of the previous function of the project, and systems and equipment manuals of the previous function of the project are not always needed in adaptive reuse projects. Their percent frequencies were 56.67% (*frequency* = 17) and 43.33% (*frequency* = 13), respectively. However, 33.33% of the respondents (*frequency* = 10) chose “other”, and thus, they mentioned further types of information/data needed during the execution of adaptive reuse projects. These types of information included the follows: legal approvals/license, 20% (*frequency* = 6); contact information of suppliers/materials vendors, 10% (*frequency* = 3); and list of the site workers, 3.33% (*frequency* = 1).

3.4.5 Followed Methods for Obtaining Data and Information Needed during the Implementation of Adaptive Reuse Projects

There are different possible methods used in the construction industry for obtaining the data and information needed during the execution of adaptive reuse projects. Respondents ($n = 30$) were asked to choose all methods followed to obtain the data and information needed during the execution of adaptive reuse projects. A list of five methods was provided in this question. The five methods comprised: direct contact with the owner/owner's representative, direct contact with the A/E, direct contact with the real estate organization that leases/operates the build, direct request during meetings/inspections on the project's progress by the owner/owner's representative, and direct request during the meeting with the project parties. **Figure 3.26** illustrates the contractors' responses to the followed methods for obtaining data and information needed during the implementation of adaptive reuse projects.

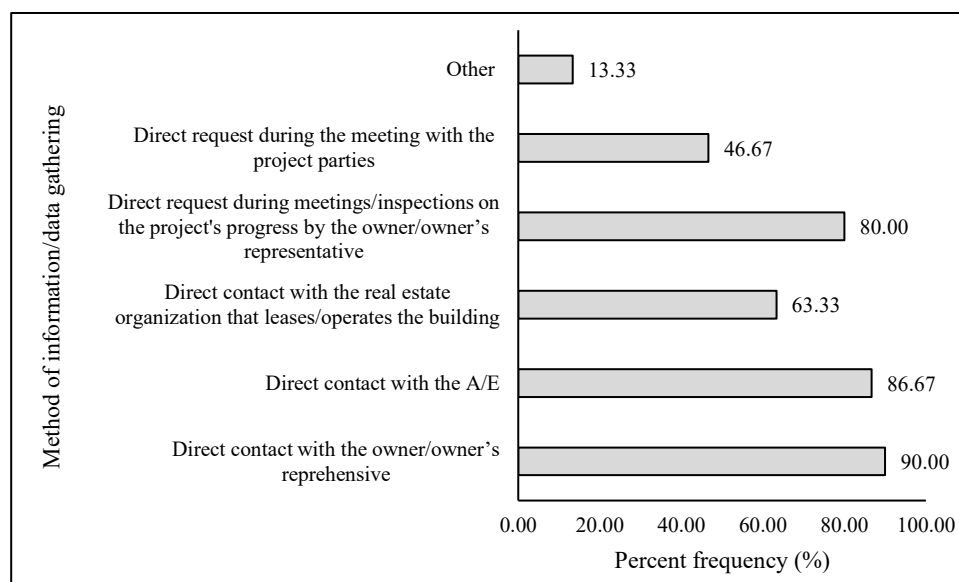


Figure 3.26: Contractors' responses to the followed methods for obtaining data and information needed during the implementation of adaptive reuse projects

As shown in **Figure 3.26**, results indicate that the follows are the mostly followed methods for obtaining data and information needed during the execution of adaptive reuse projects: direct contact with the owner/owner's representative, 90% (*frequency* = 27); direct contact with the A/E , 86.67% (*frequency* = 26); direct request during meetings/inspections on the project's progress by the owner/owner's representative, 80% (*frequency* = 24); and direct contact with the real estate organization that leases/operates the building, 63.33% (*frequency* = 19). On the other hand, results indicated that 'direct request during the meeting with the project parties' is not common method that is followed to obtain the data/information needed during the execution of adaptive reuse projects. It received a percent frequency of 46.67% (*frequency* = 14). However, 13.33% of the respondents (*frequency* = 4) chose "other", and thus, they mentioned further methods, namely: official request from the archive of the municipality, 6.67% (*frequency* = 2); official request from the Saudi Electricity Company 6.67% (*frequency* = 2).

3.4.6 Extent of Work that Usually Takes Place during the Implementation of Adaptive Reuse Projects

There are several types of works that take place in the field during the execution phase of adaptive reuse projects. Thus, a question was asked to the respondents about the extent of work that usually takes place during the implementation of adaptive reuse project. The purpose of this question was to explore the extent of all works that usually takes place in these projects. A list of eight field works was provided to the respondents ($n = 30$), namely: demolition of construction elements, demolition of structural elements, addition to the existing structure (vertically/horizontally), renewal of interior finishes, renewal of exterior finishes, replacement of MEP systems, repair of structural elements, and construction of

interior elements. **Figure 3.27** illustrates the contractors' responses to the extent of work that usually takes place during the implementation of adaptive reuse projects.

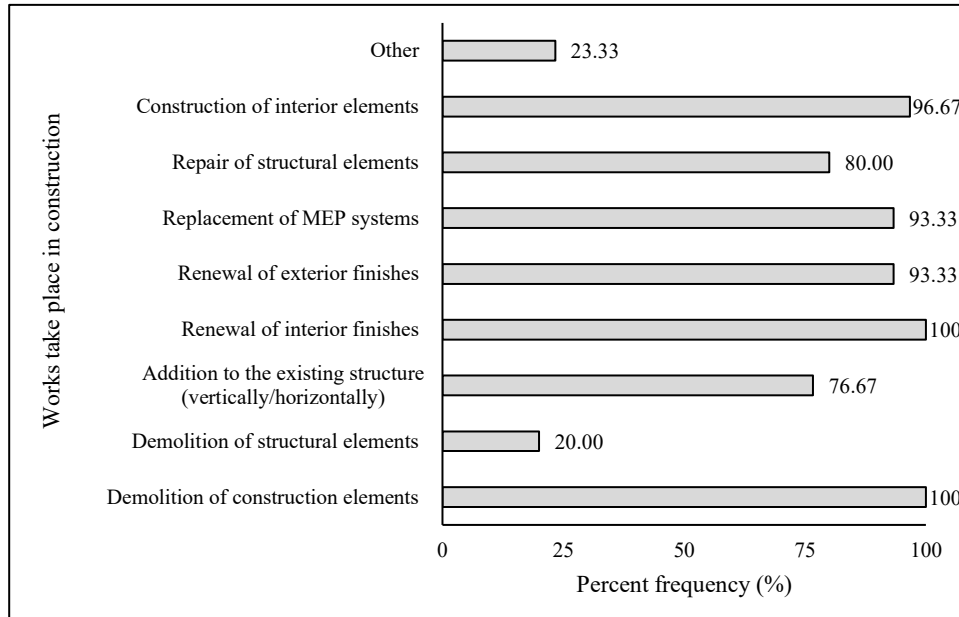


Figure 3.27: Contractors' responses to the extent of work that usually takes place during the implementation of adaptive reuse projects

As shown in **Figure 3.27**, most of the listed works usually take place in site of adaptive reuse projects. The percent frequencies of these works were as follows: demolition of construction elements, 100% (*frequency* = 30); renewal of interior finishes, 100% (*frequency* = 30); construction of interior elements, 96.67% (*frequency* = 29); renewal of exterior finishes, 93.33% (*frequency* = 28); replacement of MEP systems, 93.33% (*frequency* = 28); repair of structural elements, 80% (*frequency* = 24); and addition to the existing structure, 76.67 (*frequency* = 23). On the other hand, results indicate that the demolition of structural elements does not usually take place in the adaptive reuse projects, where it received a percent frequency of 20% (*frequency* = 6). However, 23.33% of the respondents (*frequency* = 7) chose "other", and thus, they mentioned further extent of works in this context, namely: upgrading of the number of electricity meters, 16.67%

(*frequency* = 5), adding water meter, 3.33% (*frequency* = 1); and adding vertical circulation elements (e.g. elevator), 3.33% (*frequency* = 1).

3.4.7 Applicable Challenges that Possibly Face Contractors during the Implementation of Adaptive Reuse Projects

There are different challenges facing the contractors of adaptive reuse projects. Thus, this question aimed to investigate all applicable challenges that face the contractors of these projects. Respondents ($n = 30$) were asked to choose all applicable challenges in this regard. Eight challenges were listed in this question, namely: limited access to the project site, inadequate loading space, limited space for workers to carry out their activities, lack of space for storing construction materials and equipment, lack of data and information, enforcement of safety measures during construction, errors in design documents, and lack of skilled workforce. **Figure 3.28** illustrates the contractors' responses to the applicable challenges that possibly face the process of implementing of adaptive reuse projects.

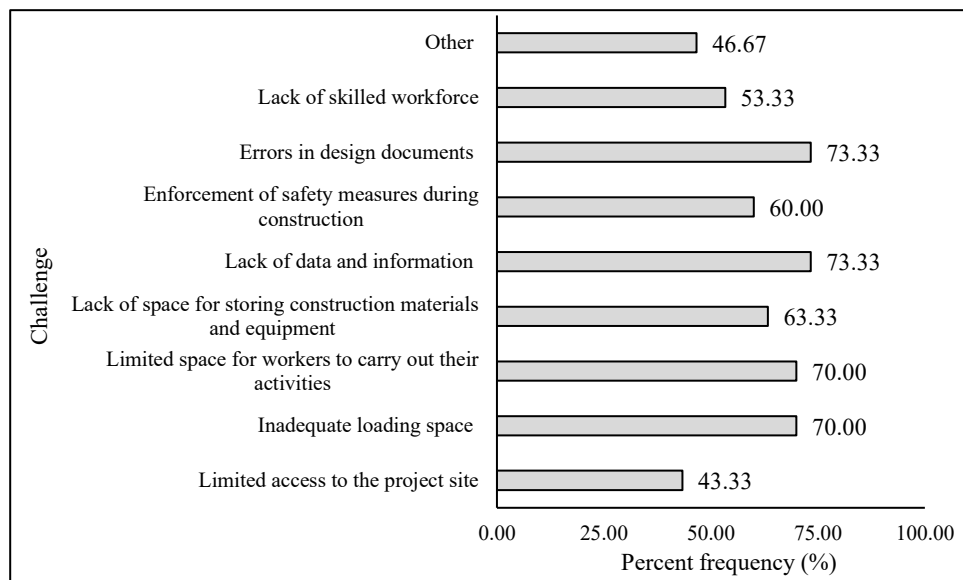


Figure 3.28: Contractors' responses to the applicable challenges that possibly face the process of implementing of adaptive reuse projects

It can be noted that not all the listed challenges are and applicable, but in overall, most of them received high percent frequencies. Results indicate that the follows are the applicable challenges facing contractors of adaptive reuse projects: lack of data and information, 73.33% (frequency = 22); errors in the design documents, 73.33% (frequency = 22); inadequate loading space, 70% (frequency = 21); limited space for workers to carry out their activities, 70% (frequency = 21); lack of space for storing construction materials and equipment, 63.33% (frequency = 19); and enforcement of safety measures during construction, 60% (frequency = 18). However, the rest two challenges, lack of skilled workforce and limited access to the project site, appear to be not possibly applicable as revealed in the results. Their percent frequencies were 53.33% (frequency = 16) and 43.33% (frequency = 13), respectively. However, 46.67 % of the respondents (*frequency* = 14) chose “other”, and thus, they mentioned further challenges, namely: difficulty at implementing the MEPs, 20% (*frequency* = 6); financial disputes among the project parties, 13.33% (*frequency* = 4); rework of construction activities, 6.67% (frequency = 2); climate condition, 3.33% (frequency = 1); and obtaining legal approvals 3.33% (frequency = 1).

3.4.8 Methods Suggested for Improving the Implementation Process of Adaptive Reuse Projects

There are many possible methods that can be considered and carried out to improve the process of implementing adaptive reuse projects. This question aimed to investigate all possible methods that can be proposed to enhance the implementation of these projects. Two suggested methods were listed in this question, namely: ensure competent supervision of activities during construction, and ensure the adherence to QA/QC procedures.

Respondents ($n = 30$) were asked to choose the methods that are effective and can be proposed for this purpose. **Figure 3.29** illustrates contractors' responses to the methods suggested for improving the implementation process of adaptive reuse projects.

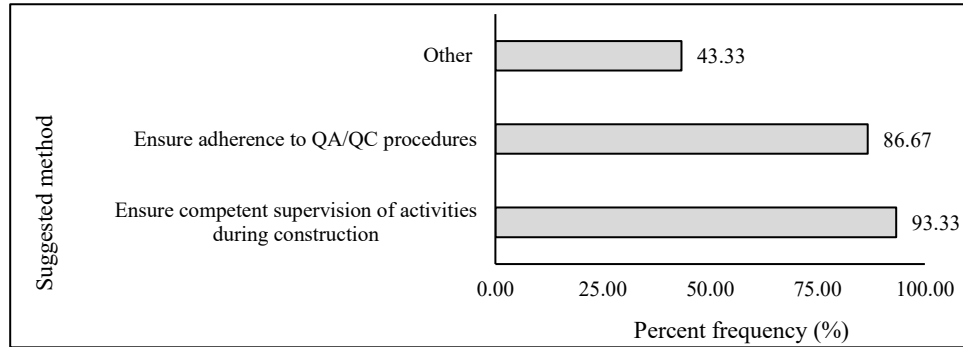


Figure 3.29: Contractors' responses to the methods suggested for improving the implementation process of adaptive reuse projects

As shown in **Figure 3.29**, both methods were highly considerable to be proposed according to the calculated percent frequencies. Their percent frequencies were as follows: ensure competent supervision of activities during construction, 93.33% (*frequency* = 28); and ensure the adherence to QA/QC procedures, 86.67% (*frequency* = 26). However, 43.33% of the respondents (*frequency* = 13) chose "other", and thus, they mentioned further methods that can be proposed to improve the implementation process of adaptive reuse projects. These methods included: document all financial payments in an official manner, 13.33% (*frequency* = 4); conduct effective coordination among the vendors and suppliers, 13.33% (*frequency* = 4); conduct frequent assessment of the cash flow throughout the implementation processes, 6.67% (*frequency* = 2); consider the legal guidelines of all change orders, 3.33% (*frequency* = 1); preserve the structural elements throughout the construction process, 3.33% (*frequency* = 1); and conduct feasibility study on all proposed changes during the construction 3.33% (*frequency* = 1).

3.4.9 Concluding Remarks of Contractors' Responses

This subsection summarizes the main conclusions of the discussed findings of investigation of the local practice of building adaptive reuse in the construction industry in Saudi Arabia.

The followings are the concluding remarks of this section:

- The most common three scenarios of adaptive reuse projects in Saudi Arabia are the conversion of a building from commercial into another commercial use, from residential into commercial use, and from commercial into medical use.
- In adaptive reuse projects, the planning, design, construction and O&M phases comprise a set of activities that need to be systematically carried out and fulfilled according to all regulatory, economic, functional, and technical requirements.
- 'Meeting with parties in case of inspection/follow up for the progress of the construction' and 'formal meeting with all project parties' are the most useable methods for communication among the parties of adaptive reuse projects.
- There is a set of information and data that needs to be provided to the contractor during the implementation adaptive reuse projects, namely: construction details drawings of the new function of the project, project schedule, built blueprints for the MEP systems for the previous function of the project, technical blueprints of the architectural layout of the new function of the project, project BOQ, as-built architectural blueprints for the previous function of the project, as-built structural blueprints for the previous function of the project, updated structural drawings of the new function of the project, construction specifications of the new function of the project, updated blueprints of the MEP systems of the new function of the

project, systems and equipment manuals of the new function of the project, and as-built construction details of the previous function of the project.

- The most followed methods for gathering these information are: direct contact with the owner/owner's representative, direct contact with the A/E , direct request during meetings/inspections on the project's progress by the owner/owner's representative, and direct contact with the real estate organization that leases/operates the building.
- The follows are the common extent of works that usually takes place during the implementation of adaptive reuse projects: demolition of construction elements, renewal of interior finishes, construction of interior elements, renewal of exterior finishes, replacement of MEP systems, repair of structural elements, addition to the existing structure, and adding/upgrading electricity and/or water meters.
- The follows are the applicable challenges facing the contractors of adaptive reuse projects: lack of data and information, errors in the design documents, inadequate loading space, limited space for workers to carry out their activities, lack of space for storing construction materials and equipment, and enforcement of safety measures during construction.
- There are four proposed methods for improving the process implementing adaptive reuse projects, namely: ensuring competent supervision of activities during construction, ensuring the adherence to QA/QC procedures, documenting all financial payments in an official manner, and conducting effective coordination among the vendors and suppliers.

3.5 The Local Practice of Managing and Operating Adaptive Reuse Projects

O&M/FM practitioners are usually involved in the operation phase of adaptively reused buildings. They are assigned to perform all day-to-day operational activities that are needed for ensuring the performance of these facilities, after the implementation of the change of use. Thus, this section covers a discussion of the findings of the second section which was provided in the facilities managers' questionnaire surveys. It covers an analysis of the point of views, perceptions and knowledge captured through the conducted questionnaire survey on the adaptive reuse practitioners from the O&M/FM industry.

Six aspects were considered in this section, namely: (1) perception of FM practitioners about the practice of operating adaptively reused buildings, (2) information and data needed during the operation and maintenance (O&M) of adaptively reused buildings, (3) followed methods for obtaining data and information needed during the O&M phase of the adaptively reused buildings, (4) applicable challenges that possibly face facilities management team during the O&M of adaptively reused buildings, (5) systems and components that frequently require maintenance and repair (M&R) works in adaptively reused buildings, and (6) suggested methods for improving the performance of adaptively reused buildings.

An open-ended question was asked to the FM practitioners about their perception of the generic process of implementing adaptive reuse projects. They were asked to provide a brief description about their experience on the processes that are carried out through the life-cycle of adaptive reuse projects in Saudi Arabia. This question contributed to capture

the knowledge of the interviewees in term of their different point of views. the general process of implementing adaptive reuse projects in Saudi Arabia consists of the following phases

3.5.1 Perception of FM Practitioners about the Practice of Operating Adaptively Reused Buildings

An open-ended question was asked to FM practitioners about their experience in operating and managing adaptively reused buildings in Saudi Arabia. They were asked to provide a brief description about their experience on the processes that are carried out during the O&M phase of the adaptively reused buildings. This question contributed to capture the knowledge of the interviewees in term of their different point of views. Based on the provided answers, the general process of operating and managing adaptively reused buildings in Saudi Arabia comprises the following processes:

A. Assigning/recruiting FM personnel

According to the point of views of different interviewees, assignment/recruitment of personnel for operating the adaptively reused building is the first step in the O&M phase. Many respondents indicated that assigning or recruiting of O&M personnel differs from a project into another. Some clients recruit FM personnel to work under their business, whereas some outscores this kind of service. In case of outsourcing, personnel from O&M, FM or property management organizations are assigned. In both cases, the roles, responsibilities, rights, operation techniques and number of workers should be identified and agreed from the client and operator. Building documents should be provided in this context, including drawings, manuals, and records on all physical elements and systems.

In case of outsourcing, a procurement of all FM services and activities will be carried out. The selection of the provider of the FM services usually differs from a project into another. In some projects, the client selects the provider of FM personnel relying on previous experience and special criteria.

On the other hand, the client may select the provider of the FM services according to a competitive bidding process. In both ways of selection, contractual activities will be needed to be carried out. Thus, client should provide all information and data regarding the building as well as the operational requirements to the service provider(s). Many interviewees recommended that these information and data need to include the follows:

- As-built drawings.
- Manuals and catalogs of all MEP systems in the building.
- Requirements of the FM services.
- List of building assets.
- Responsibilities and roles of the workers.
- Materials and supplies that need to be provided by the service provider.
- Number of workers needed for each FM service.
- Time of initiation.
- Contract period.

Based on the provided data and information, provider(s) of the FM services will develop a proposal to the client. The proposal includes the price of all operational services. If the proposal is agreed by the client, then a contract document should be developed including all the mentioned data and information. This contract will be

therefore signed by both parties. Thereafter, the FM personnel should start the operational activities, as stated in the contract document. Many respondents indicated that the FM personnel should perform entry activities on the building.

B. Carry out entry activity

The FM personnel should perform some entry activities on the beginning of operating adaptively reused buildings. This includes the implementation of an investigative tour throughout the building. Some respondents indicated that this process enables the personnel to gain an insight about the nature and condition of the adaptively reused building, after the implementation of the change of use. Some interviewees mentioned that the FM personnel should record all physical assets, if this was not provided adequately by the client. Further, they mentioned that a commissioning process on all MEP systems should be carried out as well, to test the condition of the systems after the implementation of the conversion. Thereafter, roles and responsibilities of each member should be assigned and clarified. In this context, information, data, tools, materials should be offered to each member, relying on his/her scope of work.

C. Schedule and Manage the day-to-day operational activities

Once the entry activities are successfully carried out, work schedules of all operational activities need to be developed. Many respondents indicated that it is highly recommended to develop schedule, including the time and resources, for different types of operational activities. These activities may include, but not limited to the follows: inspections, tests, evaluations, cleanings, replacements and

retrofits. Further, daily monitoring of the accomplishment of all operational activities is a critical task that needs to be effectively accomplished across the O&M phase of these projects. In this regard, ongoing updating of these schedules should be also considered and performed.

3.5.2 Information and Data Needed during the Operation and Maintenance (O&M) of Adaptively Reused Buildings

There are different types of the information and data needed for the FM personnel during the process operating and managing adaptively reused buildings. Thus, respondents ($n = 30$) were asked to choose all information/data that are needed during the O&M of adaptively reused buildings. Sixteen types of information/data were listed in this question, namely: as-built architectural blueprints for the previous function of the project, as-built structural blueprints for the previous function of the project, as-built blueprints for the MEP systems for the previous function of the project, as-built construction details for the previous function of the project, construction specifications of the previous function of the project, systems and equipment manuals of the previous function of the project, as-built technical blueprints of the architectural layout of the new function of the project, as-built construction details drawings of the new function of the project, as-built structural drawings of the new function of the project, as-built blueprints of the MEP systems of the new function of the project, construction specifications of the new function of the project, systems and equipment manuals of the new function of the project, contact information of suppliers of building services and systems, inventory of all assets in the building, records of space utilization, and reports of the commissioning tests of all systems and components.

Figure 3.30 illustrates FMs' responses to the information and data needed during the operation and maintenance (O&M) of adaptively reused buildings.

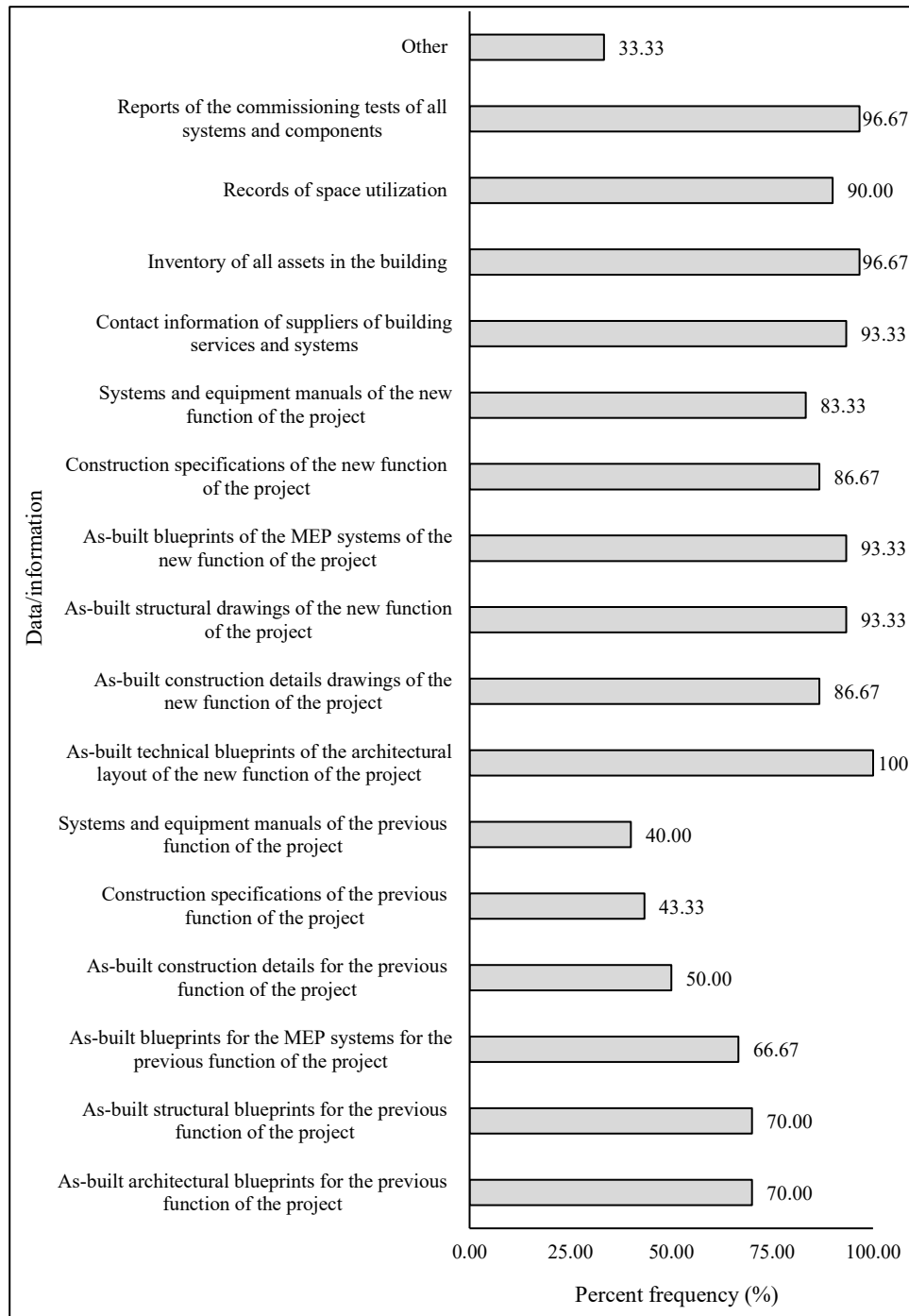


Figure 3.30: FMs' responses to the information and data needed during the operation and maintenance (O&M) of adaptively reused buildings

Results indicate that most of the listed information/data should be provided to the FM personnel during the O&M of adaptively reused building. According the calculated percent frequencies, the follows are the most important data/information during the O&M of adaptively reused buildings: as-built technical blueprints of the architectural layout of the new function of the project, 100% (*frequency* = 30); inventory of all assets in the building, 96.67% (*frequency* = 29); reports of the commissioning tests of all systems and components, 96.67% (*frequency* = 29); as-built structural drawings of the new function of the project, 93.33% (*frequency* = 28); as-built blueprints of the MEP systems of the new function of the project, 93.33% (*frequency* = 28); contact information of suppliers of building services and systems, 93.33% (*frequency* = 28); records of space utilization, 90% (*frequency* = 27); as-built construction details drawings of the new function of the project, 86.67% (*frequency* = 26); construction specifications of the new function of the project, 86.67% (*frequency* = 26); systems and equipment manuals of the new function of the project, 83.33% (*frequency* = 25); as-built architectural blueprints for the previous function of the project, 70% (*frequency* = 21); as-built structural blueprints for the previous function of the project, 70% (*frequency* = 21); and as-built blueprints for the MEP systems for the previous function of the project, 66.67% (*frequency* = 20). According to the responses, the rest three types of information, as-built construction details for the previous function of the project; construction specifications of the previous function of the project; and systems and equipment manuals of the previous function of the project, are not always needed. Their present frequencies were 50% (*frequency* = 15), 43.33% (*frequency* = 13), and 40% (*frequency* = 12), respectively.

However, 33.33% (*frequency* = 10) of the respondents chose “other”, and thus, they mentioned further types of information/data, namely: list of consumable material/products, 13.33% (*frequency* = 4); warranties documents, 10% (*frequency* = 3); fire safety documents (including invoice of the replacement of fire extinguishers and report of the inspection of the standby power systems), 6.67% (*frequency* = 2); and monthly bills of the energy and water consumptions, 3.33% (*frequency* = 1).

3.5.3 Followed Methods for Obtaining Data and Information Needed during the O&M Phase of the Adaptively Reused Buildings

There are many possible methods used in the O&M/FM industries for obtaining data and information needed during the occupancy phase of adaptively reused buildings. Respondents ($n = 30$) were asked to choose all methods that are followed to obtain the data and information needed during the O&M of adaptively reused buildings. Two methods were listed in this question, namely: direct contact with the owner/owner’s representative, and direct contact with the A/E. **Figure 3.31** illustrates the FMs’ responses to the followed methods for obtaining data and information needed during the O&M phase in adaptively reused buildings. It is noticed that both methods are followed for obtaining the needed data and information. They received percent frequencies of 80% (*frequency* = 24) and 63.33% (*frequency* = 19), respectively. However, 50% (*frequency* = 10) of the respondents chose “other”, and thus, they mentioned further methods, namely: direct contact with the contractor, 36.67% (*frequency* = 11); request from municipality, 10% (*frequency* = 3); and establishment of new as-built drawings from the scratch, 3.33% (*frequency* = 1).

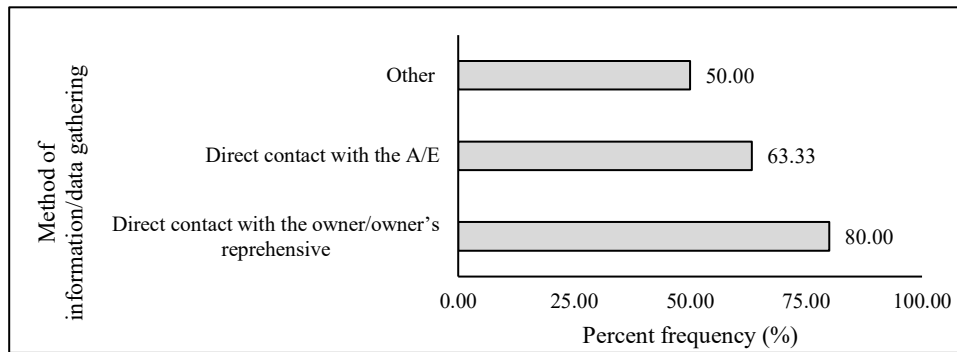


Figure 3.31: FMs' responses to the followed methods for obtaining data and information needed during the O&M phase in adaptively reused buildings

3.5.4 Applicable Challenges that Possibly Face Facilities Management Team during the O&M of Adaptively Reused Buildings

There are different challenges facing the FM personnel who are involved in the operation of adaptively reused buildings. Thus, this question aimed to investigate the applicable challenges that face the FM/O&M personnel who are involved in the operation and management of the adaptively reused buildings. Respondents ($n = 30$) were asked to choose all applicable challenges facing the FM team during the O&M of these projects. Nine challenges were listed in this question, namely: misfits between the function of the spaces and the design of the building, inefficient space utilization, inadequate performance of the technical systems in the building, lack of continuous compliance with health and safety measures, lack of compatibility between old and new MEP systems and components, inefficient control over the operational characteristics of building systems and components, inefficient of smooth workflow of operational activities, lack of users' satisfaction with the design of the building, and lack of control over the inventory of assets in the building. **Figure 3.32** illustrates the FMs' responses to the applicable challenges that possibly face facilities management team during the O&M of adaptively reused buildings.

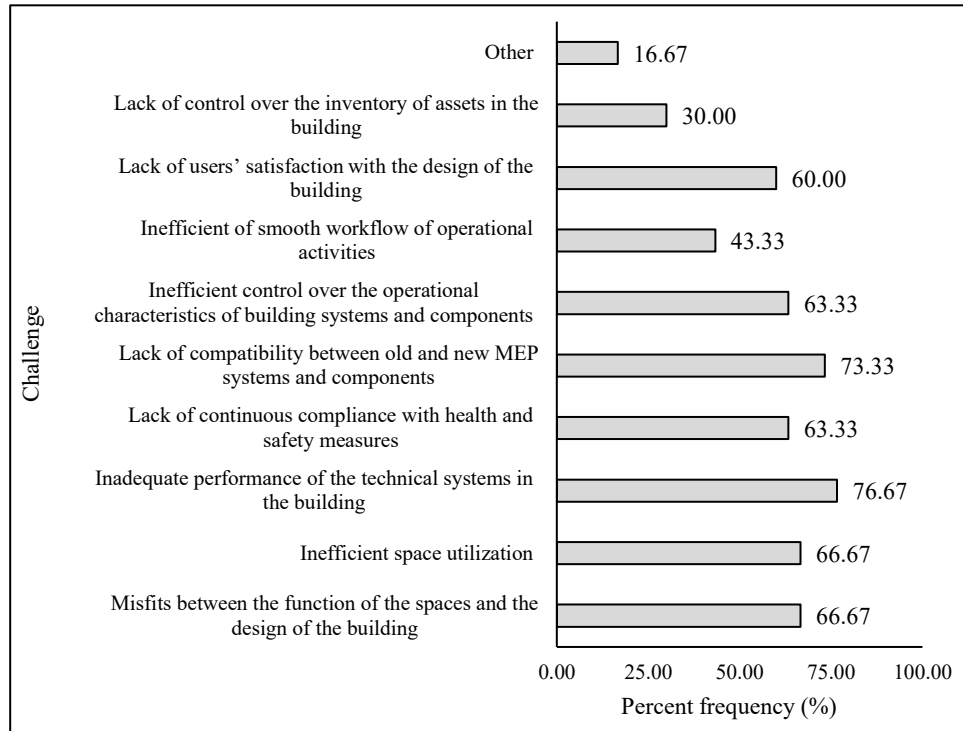


Figure 3.32: FMs' responses to the applicable challenges that possibly face facilities management team during the O&M of adaptively reused buildings

From the results, it can be noticed that the follows are the applicable challenges that possibly face the FM team of adaptively reused buildings: inadequate performance of the technical systems in the building, 76.67% (*frequency* = 23); lack of compatibility between old and new MEP systems and components, 73.33% (*frequency* = 22); misfits between the function of the spaces and the design of the building, 66.67% (*frequency* = 20); inefficient space utilization, 66.67% (*frequency* = 20); lack of continuous compliance with health and safety measures, 63.33% (*frequency* = 19); inefficient control over the operational characteristics of building systems and components, 63.33% (*frequency* = 19); and lack of users' satisfaction with the design of the building, 60% (*frequency* = 18). However, the rest two challenges, 'incident of smooth workflow of operational activities' and 'lack of control over the inventory of assets in the building', appear to be not possibly applicable as revealed in the results. Their percent frequencies were 43.33% (*frequency* = 13) and 30%

(*frequency* = 9), respectively. However, 16.67 % of the respondents (*frequency* = 5) chose “other”, and thus, they mentioned further challenges, namely: unavailability of identical materials and spare parts of the kept systems/components from the previous function, 6.67% (*frequency* = 2); difficulty to establish record of the kept assts in the building, 3.33% (*frequency* = 1); users intervention comprises the compliance with health and safety requirements, 3.33% (*frequency* = 1); providing sufficient car parking to the end users, 3.33% (*frequency* = 1).

3.5.5 Systems and Components that Frequently Require Maintenance and Repair (M&R) Works in Adaptively Reused Buildings

It was revealed in the literature that one of the major concerns of implementing adaptive reuse projects is the condition of the building structure and its systems. This is due to the fact that adaptive reuse projects usually implemented in old buildings, where the systems and structure might be obsolete and/or deteriorated. Thus, this might have an impact on the maintenance performance, where some systems and components would require frequent repair works. Hence, the FM personnel will be called by a tremendous number of work orders. Accordingly, this question aimed to investigate the systems and components that frequently require maintenance and repair (M&R) works in adaptively reused buildings. Respondents ($n = 30$) were asked to choose the building systems that require frequent M&R works in this kind of buildings. Six systems and components were listed in this question, namely: construction elements, structural elements, interior finishes, exterior finishes, MEP systems, and information technology systems. **Figure 3.33** illustrates the FMs’ responses to the systems and components that frequently require maintenance and repair (M&R) works in adaptively reused buildings.

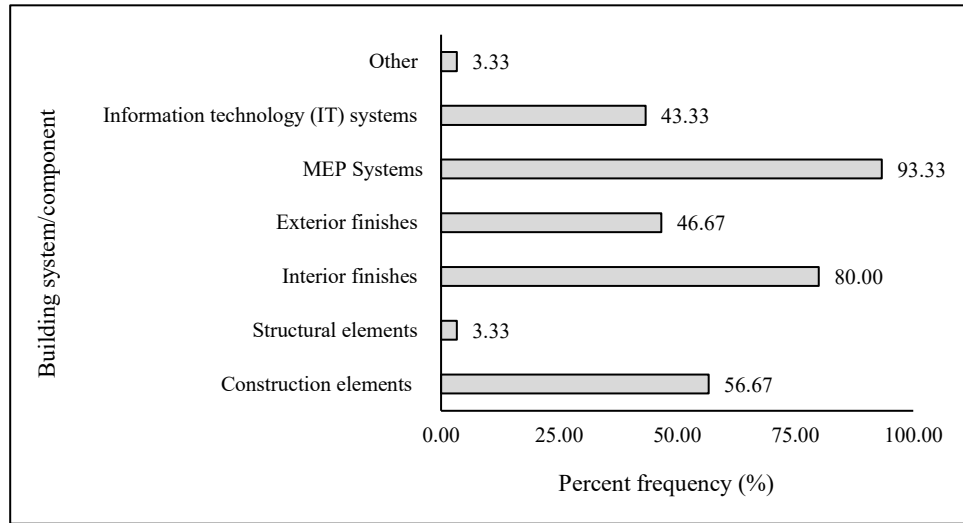


Figure 3.33: FMs' responses to the systems and components that frequently require maintenance and repair (M&R) works in adaptively reused buildings

From the results, it is noticed that MEP systems and interior finishes are the elements that mostly require frequent M&R works in adaptively reused buildings. They received percent frequencies of 93.33% (*frequency* = 28); and 80% (*frequency* = 24), respectively. However, results indicate that the rest systems and components do not require frequent M&R works. The follows are their received percent frequencies: construction elements, 56.67% (*frequency* = 17); exterior finishes, 46.67% (*frequency* = 14); information technology (IT) systems, 43.33% (*frequency* = 13); and structural elements, 3.33% (*frequency* = 1). However, one respondent, accounting for 3.33%, chose "other" and mentioned that the water drainage piping is among the systems that require frequent M&R works in adaptively reused building.

3.5.6 Methods Suggested for Improving the Performance of Adaptively Reused Buildings

There are many possible methods that can be considered and carried out to improve the performance of the adaptively reused buildings. Thus, this question aimed to investigate all possible methods that can be proposed for enhancing the performance of adaptively reused buildings. Five suggested methods were listed in this question, namely: conduct commissioning process, assign spaces in a manner that supports the workflow of activities, develop a maintenance program of the adaptively reused buildings, record all assets and systems of the building, and carry out periodic building performance assessment. **Figure 3.34** illustrates the FMs' responses to the methods suggested for improving the performance of adaptively reused buildings.

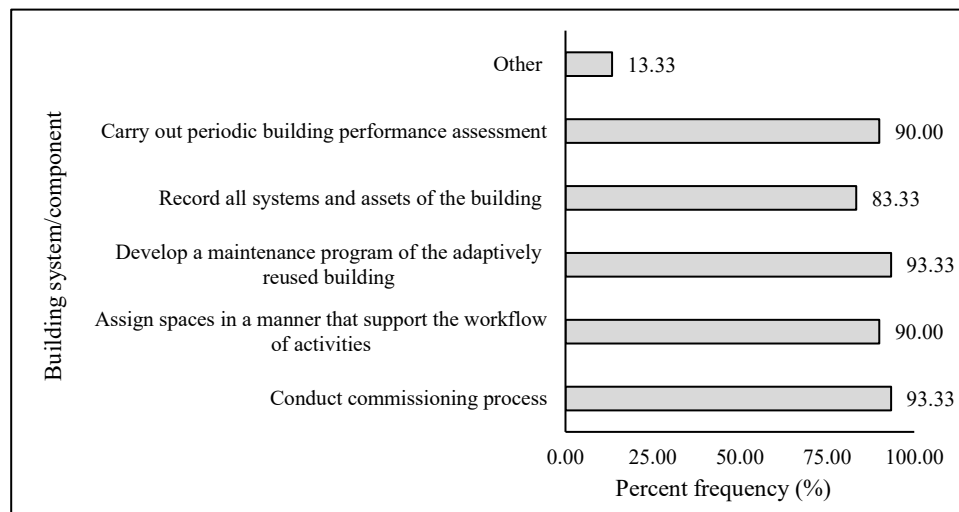


Figure 3.34: FMs' responses to the methods suggested for improving the performance of adaptively reused buildings

As shown in **Figure 3.34**, all the suggested methods received high percent frequencies. This implies that these methods can be considered and proposed for improving the and performance of adaptively reused buildings. The follows are the received percent frequencies to the these methods: conduct commissioning process, 93.33% (*frequency* = 28); develop a maintenance program of the adaptively reused building, 93.33% (*frequency* = 28); assign spaces in a manner that supports the workflow of activities, 90% (*frequency* = 27); carry out periodic building performance assessment, 90% (*frequency* = 27); and record all assets and systems of the building, 83.33% (*frequency* = 25). However, 13.33% (*frequency* = 4) of the respondents chose “other”, and thus, they mentioned further methods, namely: establish a record of the old assets in the building that have not been changed, 3.33% (*frequency* = 1); develop a record of all items in the building including their predicted life-span, 3.33% (*frequency* = 1); take the feedback of the end users for all changes that may take place, 3.33% (*frequency* = 1); and conduct AD HOC inspections (method for unplanned inspections), 3.33% (*frequency* = 1).

3.5.7 Concluding Remarks of FMs’ Responses

This subsection summarizes the main conclusions of the discussed findings of investigation of the local practice of building adaptive reuse in the FM industry in Saudi Arabia. The followings are the concluding remarks of this section:

- Facilities managers of adaptively reused buildings need to carry out managerial activities, including assignment of operation personnel, management of the daily O&M works, and inspection of overall condition of the systems.

- Many information and data should to be provided to the FM personnel during O&M of adaptively reused buildings, namely: as-built technical blueprints of the architectural layout of the new function of the project, inventory of all assets in the building, reports of the commissioning tests of all systems and components, as-built structural drawings of the new function of the project, as-built blueprints of the MEP systems of the new function of the project, contact information of suppliers of building services and systems, records of space utilization, as-built construction details drawings of the new function of the project, construction specifications of the new function of the project, systems and equipment manuals of the new function of the project, as-built architectural blueprints for the previous function of the project, as-built structural blueprints for the previous function of the project, and as-built blueprints for the MEP systems for the previous function of the project.
- The most followed methods for gathering these information are: direct contact with the owner, direct contact with the A/E and direct contact with the contractor.
- The follows are the applicable challenges facing the facilities managers of adaptively reused buildings: inadequate performance of the technical systems in the building, lack of compatibility between old and new MEP systems and components, misfits between the function of the spaces and the design of the building, inefficient space utilization, lack of continuous compliance with health and safety measures, inefficient control over the operational characteristics of building systems and components, and lack of users' satisfaction with the design of the building.
- MEP systems and interior finishes are the most elements that require frequent M&R works in adaptively reuse buildings.

- There are five proposed methods for improving the performance and management of adaptively reused buildings, namely: conducting commissioning process, developing a maintenance program of the adaptively reused building, assigning spaces in a manner that supports the workflow of activities, carrying out periodic building performance assessment, and recording all assets and systems of the building.

3.6 Summary and Discussion

This chapter covered four main topics, namely: respondents' demographic information, the local practice of planning and design of adaptive reuse projects, the local practice of constructing adaptive reuse projects, and the local practice managing and operating adaptively reused buildings.

In the section of respondents' demographic information, the author presented statistics pertaining to the profile of the respondents who were involved in the three questionnaire surveys. It covered five types of demographic information, namely: spatial distribution of the overall respondents, respondents' scope of work, respondents' years of experience, number of adaptive reuse projects in which respondents were involved in, and types of projects in which respondents were involved in.

In the section of the local practice of planning and design of adaptive reuse projects, the author presented a discussion of the findings of the performed investigation on the practice of these project at the A/E profession. Ten aspects were discussed in this section, namely: (1) common scenarios of adaptive reuse projects in Saudi Arabia, (2) A/Es' perception about the process of implementing adaptive reuse projects, (3) drivers/causes of

implementing adaptive reuse projects in Saudi Arabia, (4) methods used in the communication among the parties during the design and documents preparation of adaptive reuse projects, (5) information and data needed during the design process and documents preparation of adaptive reuse projects, (6) followed methods for obtaining data and information needed during the design process and documents preparation of adaptive reuse projects, (7) utilized tools in the design process and documents preparation of adaptive reuse projects, (8) applicable challenges that possibly face A/E professionals during the design process and documents preparation of adaptive reuse projects, systems affected by the requirements of the new function in adaptive reuse projects, and (10) methods suggested for improving the implementation process of adaptive reuse projects.

In the section of the local practice of constructing adaptive reuse projects, the author presented a discussion of the findings of the performed investigation on the practice of these project at the construction industry. Eight aspects were discussed in this section, namely: (1) common scenarios of adaptive reuse projects in Saudi Arabia, (2) contractors' perception about the process of implementing adaptive reuse projects, (3) methods used in the communication among the parties during the implementation of adaptive reuse projects, (4) information and data needed during the implementation of adaptive reuse projects, (5) followed methods for obtaining data and information needed during the implementation of adaptive reuse projects, (6) extent of work that usually takes place during the implementation of adaptive reuse projects, (7) applicable challenges that possibly face contractors during the implementation of adaptive reuse projects, and (8) methods suggested for improving the implementation process of adaptive reuse projects.

In the section of the local practice of managing and operating adaptively reused buildings, the author presented a discussion of the findings of the performed investigation on the practice of these project at the FM industry. Six aspects were discussed in this section, namely: (1) perception of FM practitioners about the practice of operating adaptively reused buildings, (2) information and data needed during the operation and maintenance (O&M) of adaptively reused buildings, (3) followed methods for obtaining data and information needed during the O&M phase of the adaptively reused buildings, (4) applicable challenges that possibly face facilities management team during the O&M of adaptively reused buildings, (5) systems and components that frequently require maintenance and repair (M&R) works in adaptively reused buildings, and (6) methods suggested for improving the performance of adaptively reused buildings.

In the end of each of the local practice sections, the author developed a sub-section to highlight a set of remarks concluded from the performed investigation at each of the three professional industries. This chapter contributed to expands the boundaries of knowledge about the issues associated with the practice of building adaptive reuse, within the context of AEC/FM industries and project life-cycle.

CHAPTER 4:

DESCRIPTION OF THE FACTORS AFFECTING BUILDING ADAPTIVE REUSE THROUGHOUT THE PROJECT LIFE-CYCLE

4.1 Overview

This chapter covers the description of the identified 38 factors in Chapter 2 (see section 2.7). The description of the factors present in this chapter was developed based on the performed review of literature and pilot study. The conducted pilot study revealed that there was no additional factors could be added to the identified list. In addition, it revealed that there was no identified factor could be removed from the list or reformulated. **Figure 4.1** presents the list of the identified factors that affect building adaptive reuse throughout the project life-cycle. Finally, the chapter concludes with a summary and discussion about the presented content.

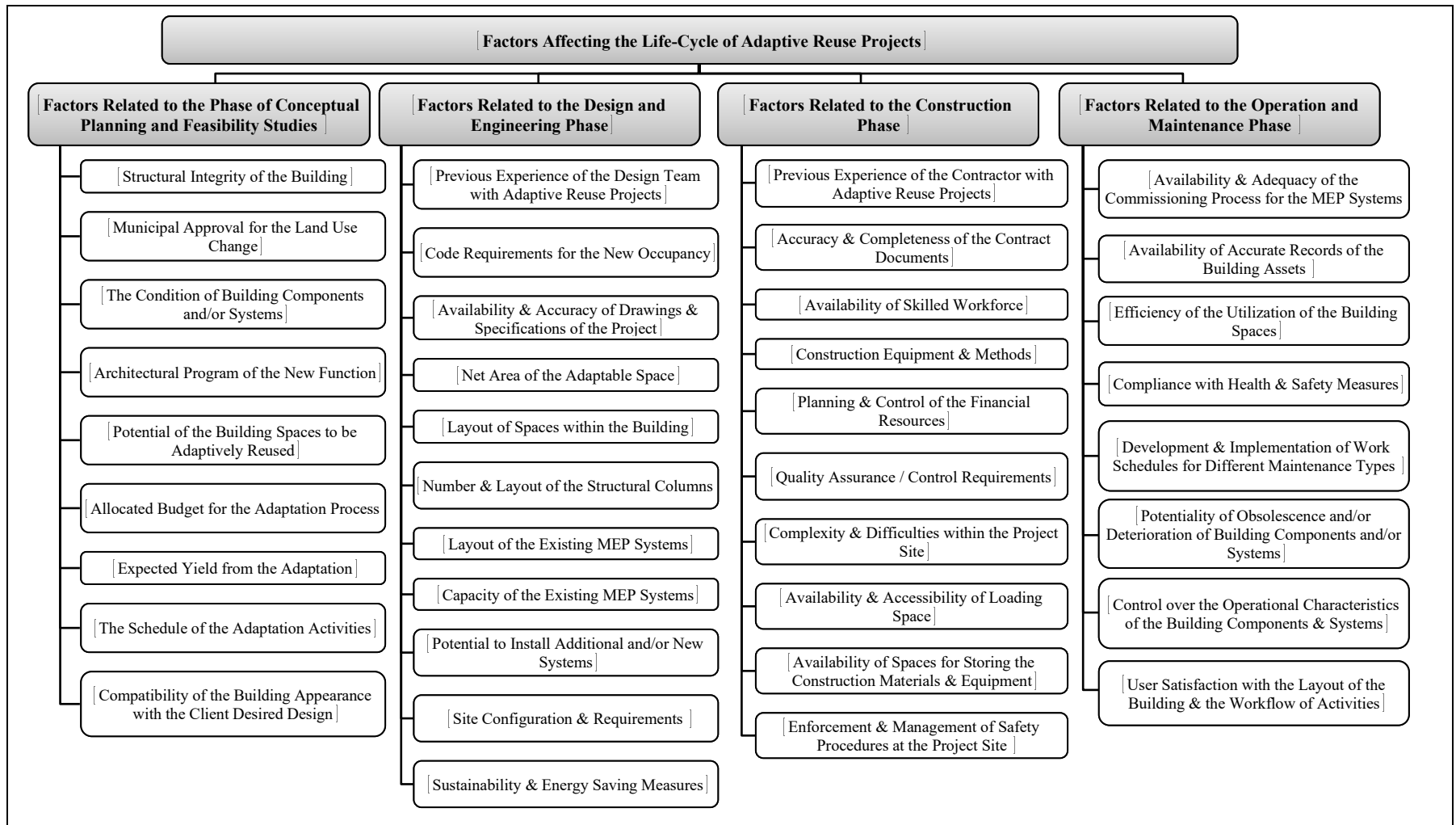


Figure 4.1: List of the identified factors that affect the building adaptive reuse throughout the project life-cycle

4.2 Factors Related to the Phase of Conceptual Planning and Feasibility Studies

4.2.1 Structural Integrity of the Building

When the condition of the building is highly deteriorated, extensive expenditures would be needed to restore the building condition to the situation that can accommodate the new function (Wilkinson et al., 2014). Moreover, this kind of deterioration could lead to high maintenance and repair (M&R) costs, which will negatively impact the day-to-day use of the building (Bullen and Love, 2011c). Accordingly, condition of the building structure is a major concern in adaptive reuse projects, since the structural elements might be in a poor situation (Hong and Chen, 2017; Remøy and Voordt, 2014). In this regard, detailed assessment of the structural strength of the building and its potential to accommodate the new loads is a recommended during the feasibility analysis of the adaptive reuse (Bullen and Love, 2011c; Hein and Houck, 2008; Naidu, 2008). Many techniques and procedures are employed to evaluate the structural integrity of the building, including: field survey of the building, observation and documentation of defects, and field and laboratories tests (Ilozor, 2008). Assessment of the structural integrity of the existing building is carried out to serve the following aspects (Shah, 2014):

- Enhance the design of future buildings, through ensuring their integrity during the design phase.
- Examination of the integrity of the in-service buildings, to predict their rest of life.
- Examination of the integrity of the in-service buildings after the occurrence of damage(s).

- Examination of the reliability of buildings in term of their usage beyond their life span.

4.2.2 Municipal Approval for the Land Use Change

The change of the land use is a regulatory barrier for implementing building adaptive reuse. This is due to the fact that the practicing this kind of alterations have a direct bearing on the planning strategies and policies of the built environment, which are adopted by the municipalities (Wilkinson et al., 2014). Accordingly, obtaining the approval of the municipality for implementing the change of use is among the obstructing factors of building adaptive reuse in many situations (Kincaid, 2002). This kind of approvals might be influenced by other technical design requirements demanded by the municipality (Artés et al., 2017; Mİsİrlİsoy and Günçe, 2016). Consequently, it is essential to investigate the potential and requirements of obtaining the municipal approval on changing the land use in the zone where the building is located (Wilkinson et al., 2014).

4.2.3 The Condition of Building Components and/or Systems

The decision of implementing adaptive reuse will be a critical when the physical condition of the building fabric and finishes is deteriorated. This is due to the fact that this kind of defects will require high maintenance and repairs (M&R) costs to restore the condition of the building (Bullen and Love, 2011c). Further, adaptive reuse projects could require the installation of modern systems instead of the existing systems, in order to increase the efficiency and overall condition of the buildings (Mehr and Wilkinson, 2018). Consequently, a careful consideration about the physical aspects pertaining to the building condition should be made during the decision-making process of implementing adaptive reuse projects (Al-obaidi et al., 2017; Kincaid, 2002; Langston et al., 2008). In this regard,

it is highly recommended that an accurate record of the existing status of all building assets is developed by the project A/E (Eray et al., 2019).

4.2.4 Architectural Program of the New Function

Users' needs should be considered during the decision-making of adapting an existing building (Rockow et al., 2019). Therefore, planners need to adequately program for the new function, in order to facilitate the design development process for the new use, accordingly (Beck, 2014). This process will also facilitate the fulfillment of the requirements of the new function, within the available space in the building (Eyüce and Eyüce, 2010). In this regard, different requirements should be taken into account in the context of the architectural programming of building adaptive reuse, namely: spatial, functional, technical, technological, economic, legal, environmental, and social requirements (Yaldiz and Asatekin, 2013).

4.2.5 Potential of the Building Spaces to be Adaptively Reused

The ability of the architectural configuration of the building to be adaptively reused is a key factor that need to be considered during the planning phase of these projects. This determinant can be verified by investigating different features and measures in the building context, including: dimensional, spatial, environmental, economic and social parameters (Conejos et al., 2016; Langston et al., 2008; Wilkinson et al., 2014). In this regard, distances, layout, organization and modularity of the spaces and the overall floor plan should be investigated (Arge, 2005; Kincaid, 2000). Additionally, the potential of rooms to be expanded and/or divided are other indicators that should be investigated in the context of the potential of spaces for the change of use (Geraedts et al., 2014; Heidrich et al., 2017).

4.2.6 Allocated Budget for the Adaptation Process

The cost of adaptation itself is highly considered in the decision of implementing building adaptive reuse (Bullen and Love, 2011c, 2011a). In this regard, the budgetary constraints would have an influential role in the decision of implementing the change of building use (Heidrich et al., 2017). Different aspects would be considered in this context, including possibility of budget overrun and high M&R costs (Remøy and Voordt, 2014; Wilkinson et al., 2014). Accordingly, it is highly recommended that stakeholders involved in the planning phase of building adaptive reuse should consider the available budget for the complete project, in comprehensive manner.

4.2.7 Expected Yield from the Adaptation

The decision of implementing an alteration in the use of existing properties is highly influenced by the profitability indicators (Aigwi et al., 2018; Olivadese et al., 2017). This implies that possible profits that might be gained through the adaptation is a major aspect that is considered during the identification of the adaptive reuse feasibility (Mİsİrlİsoy and Günçe, 2016). In this regard, market trend and financial affairs are considered in the process of estimating the yield of the proposed new function (Bullen and Love, 2011a; Wilkinson et al., 2014). The judgement on the economic feasibility of the adaptive reuse will be drawn upon the analysis of all of these indicators.

4.2.8 The Schedule of the Adaptation Activities

Adaptive reuse project is similar to the other construction projects, since it requires the implementation of a set of executional activities that need to be planned properly. This is due to the fact that planning of the these activities has the potential of mitigating the negative impact of the of project delay and cost overrun (Hein and Houck, 2008). In other

word, visualizing the process of transferring the adaptive reuse design to a real constructed project is an important task that need to be considered during the planning phase, as such as performed in the other building projects (Kincaid, 2002). In this regard, schedule and timelines of all activities of the building adaptive reuse should be considered and identified in crucial manner (Alauddin, 2014; Eray et al., 2019). Moreover, the selection of the level and strategy of the adaptive reuse is important task that need to be performed in this context (Mİslirlişoy and Günçe, 2016)

4.2.9 Compatibility of the Building Appearance with the Client Desired Design

The exterior appearance of the building is one of the important characteristics that need to be considered during the planning phase of adaptive reuse projects (Wilkinson et al., 2014). This is due to the fact that the building appearance is among the influential factors on the social desirability and attractiveness of the adaptively reused buildings during the occupancy phase (Wilkinson and Reed, 2011). However, incompatibility between the old and new materials is among the issues that compromise the appearance of the adapted and rehabilitated buildings (Carvalho et al., 2015). Consequently, the compatibility of the building appearance with the new function need to be achieved in a modern and aesthetic basis (Wilkinson, 2012b).

4.3 Factors Related to the Design and Engineering Phase

4.3.1 Previous Experience of the Design Team with Adaptive Reuse Projects

Knowledge and experience of the design consultant team are important for effective design judgements in adaptive reuse projects (Wilkinson et al., 2014). They are characterized as key success factors which have a vital role on the accomplishment of adaptive reuse

projects (Alauddin, 2014). This is due to the fact that owners of adaptive reuse projects may sometimes end up with unsuccessful decisions on their properties, which resulted from the lack of knowledgeable and expert professional consultants (Wilkinson, 2014). In Saudi Arabia, adaptive reuse projects also face a lack on the experienced and skilled specialists (Al-ghamdi, 2011).

4.3.2 Code Requirements for the New Occupancy

Technical requirements of the new occupancy is among the critical factors that affect the design accomplishment in adaptive reuse projects (Mehr and Wilkinson, 2018; Wilkinson et al., 2014). In this context, health and safety requirements are among the major considerations that need to be taken into account in these projects (Lardner et al., 2013). Critical consideration of both requirements would facilitate the potential of getting the approval on the design documents from the regulatory agencies (Conejos et al., 2016). Accordingly, designers of adaptive reuse projects should always work in line with all code requirements of the new occupancy.

4.3.3 Availability and Accuracy of the Drawings and Specifications of the Existing Project

Original drawings and records of the previous use of the building might not be available during the design of adaptive reuse projects (Wilkinson et al., 2014). Even if they were available to the design team, their completeness and accuracy might be lacking due to factor of the building age (Conejos et al., 2016; Oppong and Masahudu, 2014). Consequently, it is highly recommended that an investigation of the accuracy and adequacy of these records is made by the design team before starting the design development process for the new project (Eray et al., 2019).

4.3.4 Net Area of the Adaptable Space

The area of the convertible space in the building is one of the key factors that affect the adaptive reuse design (Wilkinson et al., 2014). In this regard, designers need to consider and overcome all functional challenges that are associated with the requirements of the adaptive reuse projects (Bullen and Love, 2010). This implies that satisfying the new users' needs in term of spaces is essential during the design of these projects. Additionally, spatial design solutions need to be developed within the amount of usable space in the building, without compromising the new functional requirements (Yaldiz and Asatekin, 2013).

4.3.5 Layout of Spaces within the Building

Layout of the interior spaces of the building are among the major characteristics and measures of the its convertibility (Arge, 2005; Wilkinson et al., 2014). This measure impacts the generation of the solutions and judgments during the design of adaptive reuse (Bullen and Love, 2011c). In this regard, designer of adaptive reuse projects should carefully study the building layout and its potential for alterations that fit the new requirements (Bullen and Love, 2010). This is due to the fact that analyzing these aspects will ensure that the design solutions are developed in line with the spatial and physical restrictions of the building (Eray et al., 2019).

4.3.6 Number and Layout of the Structural Columns

Layout structural columns is among the factors that need to be considered during the design for adaptive reuse, due to its direct impact on the ease and efficiency of the floor plan utilization (Wilkinson and Reed, 2011; Wilkinson et al., 2014). In other words, technical span of the structural columns is one of the parameters that affects the architectural design of building adaptive reuse (Manewa et al., 2016; Wilkinson and Remøy, 2017), since it has

the potential to interrupt the floor plan of the new use (Al-ghamdi, 2011; Remøy and Voordt, 2014). Consequently, designers of building adaptive reuse need to effectively cop with this factor, through integrating the functional design of the new use with the existing structural layout of columns (Yaldiz and Asatekin, 2013).

4.3.7 Layout of the Existing MEP Systems

Existing location of the vertical circulation services and technical systems are critical factors that need to be considered during the design for building adaptive reuse (Remøy et al., 2011; Wilkinson et al., 2014). In this context, flexibility of the existing HVAC, electrical, and plumbing systems should be investigated during the design of adaptive reuse project (Halvitigala and Reed, 2015). Further, it is highly recommended that an investigation of the actual condition and layout of all MEP systems is made by the adaptive reuse designer. This is due to the fact that this process facilitates the design development of the new systems, accordingly (Eray et al., 2019).

4.3.8 Capacity of the Existing MEP Systems

Adaptive reuse projects requires considering the operational requirements of the new function (Halvitigala and Reed, 2015). In this regard, the condition of the existing MEP systems and their capacities to serve the new operational requirements should be considered in this context (Bullen and Love, 2011a; Geraedts et al., 2014). In most cases, MEP systems are subjected to replacement/refurbishment in adaptive reuse projects, in order to meet the new demands (Agha and Kamara, 2017). Accordingly, the involved A/E in the design of building adaptive reuse projects should consider all these aspects in an integrated manner, to satisfy the operational demands of the new occupancy (Eray et al., 2019).

4.3.9 Potential to Install Additional and/or New Systems

The design team of adaptive reuse projects should be aware about the measures and indicators of the potential of installing new systems to the building (Arge, 2005). This is due to the fact that the process of installing new systems in adaptive reuse projects might encounter a set of technical challenges (Kincaid, 2002; Mehr and Wilkinson, 2018). Consequently, designers of these projects need to critically examine this determinant, so that end up with effective design judgments, accordingly (Bullen and Love, 2010).

4.3.10 Site Configuration and Requirements

Regulatory requirements and configuration of the site for the new use are major aspects that need to be considered in a holistic manner during the design of adaptive reuse projects (Wilkinson et al., 2014; Yaldiz and Asatekin, 2013). These aspects comprise car parking, boundary, amenities, accessibility and density of the site (Kincaid, 2002). Moreover, design strategies for shading, aestheticism and noise control through the project site plan are other aspects that should be taken into account within this context (Wilkinson and Remøy, 2015).

4.3.11 Sustainability and Energy Saving Measures

Sustainable design strategies are among the factors that need to be considered during the design of adaptive reuse projects (Yaldiz and Asatekin, 2013). They entail considering the reduction of the greenhouse gas emissions, and the installation of efficient systems in term of energy consumption (Mehr and Wilkinson, 2018; Wilkinson et al., 2014). Furthermore, sustainability criteria pertaining to the IEQ should be considered in this context, including thermal, visual, and acoustic comforts for the new users (Wilkinson and Remøy, 2017).

4.4 Factors Related to the Construction Phase

4.4.1 Previous Experience of the Contractor with Adaptive Reuse Projects

Experience of the adaptive reuse implementers is an important factor for a successful completion of the change of use process (Hein and Houck, 2008). In fact, implementing adaptive reuse projects is considered to be one of the complex processes in the construction industry. This is due to the fact that this process requires the implementation of a set of the managerial efforts for integrating different types of construction activities, including the management of supply chain, logistics and subcontractors of other work packages (Eray et al., 2019). Since the adaptive reuse projects require the implementation of renovation works, the contractor needs to be experienced on the way of implementing this kind of work packages (Yung and Chan, 2012). Accordingly, the selection of experienced contractor with adaptive reuse projects is essential for a successful building adaptation (Kincaid, 2002).

4.4.2 Accuracy and Completeness of the Contract Documents

The accuracy of the project documents is one of the barriers facing the process of implementing building adaptive reuse (Conejos et al., 2016). The adequacy and accuracy of these documents is a key factor for a successful implementation of building adaptive reuse (Fournier and Zimnicki, 2004). In many cases, adaptive reuse contractors could struggle with deficiencies in the specifications, roles and responsibilities that are included in the project contract document. Accordingly, contractor and A/E should make sure that the project documents are completed, accurate and efficient to be followed during the implementation of the change of use (Eray et al., 2019).

4.4.3 Availability of Skilled Workforce

Efficiency of the workers involved in the implementation of building adaptive reuse is among the key factors that need to be taken into account in this kind of projects (Bullen and Love, 2011c; Eray et al., 2019). This is due to the fact that most of the renovation and refurbishment works implemented in these projects should be carried out by skilled workers. On the other hand, this need may increase the labor costs in this kind of projects (Mui et al., 2016). Generally, many studies concluded that the recruitment of skilled workforces would ensure the successful implementation of the building adaptive reuse (Alauddin, 2014).

4.4.4 Construction Equipment and Methods

Construction equipment and methods are among the critical factors that has a direct bearing on the process of implementing building adaptive reuse. The contractor needs to be aware about the applicable methods in the construction of building adaptive reuse, since the site of these projects may include a set of spatial and physical limitations (Hein and Houck, 2008). Sometimes, the contractor will be forced to preserve some physical assets during the construction of building adaptive reuse. In this case, employment of special construction techniques and equipment will be necessary (Alauddin, 2014). In this regard, the contractor need to consider all technical aspects pertaining to the construction methods used in adaptive reuse projects (Mehr and Wilkinson, 2018; Olivadese et al., 2017).

4.4.5 Planning and Control of the Financial Resources

Adaptive reuse projects require the development and control of a financial plan, as such as performed in any construction projects (Alauddin, 2014; Hein and Houck, 2008; Wilkinson et al., 2014). In this regard, effective cost management should be carried out during the implementation of these projects, since it contributes to the adaptation completion within the targeted budget, time and quality (Kincaid, 2002). In this context, contractors of adaptive reuse projects should effectively coordinate the related executional activities, including the management of material delivery among the suppliers (Eray et al., 2019).

4.4.6 Quality Assurance / Control Requirements

Adaptive reuse projects require a careful consideration about the quality aspects during the implementation phase (Al-ghamdi, 2011). In this regard, adaptive reuse contractors need to be aware and in compliance with the state-of-the-art quality control measures (Hein and Houck, 2008). This is due to the fact that the complying to these measures will contribute to the fulfilment of the desired needs of the client, and thus, successful project completion (Kincaid, 2002). In this context, information and data exchange among the parties should be effectively undertaken throughout the implementation process of building adaptive reuse, since it contribute to the quality assurance (Eray et al., 2019).

4.4.7 Complexity and Difficulties within the Project Site

Adaptive reuse projects are considered as one of the complex projects in the construction industry, since they encounter many on-site challenges (Geraedts et al., 2014). Limitations of the space available for the equipment passage (Mehr and Wilkinson, 2018), and unsmooth workflow of the construction activities (Hein and Houck, 2008), are among the construction challenges of building adaptive reuse. Accordingly, the contractor needs to be

skillful at coping with such kind of challenges (Kincaid, 2002). In this regard, it is recommended that the contractor of adaptive reuse projects would report all physical restrictions and issues to the consultant, before proceeding the actual work (Eray et al., 2019).

4.4.8 Availability and Accessibility of Loading Space

Locations of adaptive reuse projects might be not accessible to the public (Yung and Chan, 2012). Hence, the availability of space for uploading and loading the construction materials and equipment would be lacking in these locations (Wilkinson et al., 2014). In this case, movement of materials, equipment, and even the workers will be not smooth, accordingly (Hein and Houck, 2008).

4.4.9 Availability of Spaces for Storing the Construction Materials and Equipment

Contractors of building adaptive reuse should manage the delivery, storage and use of all materials and equipment, throughout the implementation process of these projects. However, providing a temporary structure, used as a storage of construction materials and equipment, is among the major challenges that face the contractors of adaptive reuse projects (Hein and Houck, 2008). To overcome this kind of limitations, the contractor would need to allocate a space within the building, used as a storage for the all materials and equipment during the adaptation process (Douglas, 2006). Since the adaptive reuse projects entail the implementation of refurbishment works, effective coordination of the delivery and consumption of all materials is a necessary task that needs to be carried out throughout the implementation processes (Egbu, 1997)

4.4.10 Enforcement and Management of Safety Procedures at the Project Site

Ensuring an appropriate level of safety in the site of construction project is a fundamental requirement the needs to be adequately fulfilled, to protect the people life and properties (Manu et al., 2010). This is due to the fact that the construction sites are characterized as a very hazardous workplace, since there is a high possibility for the occurrence of fatal accidents at this kind of working environments (Manu et al., 2012). Consequently, enforcement and management of the safety protection procedures at these areas are primary actions that should be adequately carried out (Dedobbeleer and Béland, 1991; Sanni-Anibire et al., 2020). In this context, it is also important to perform such procedures in the building sites that accommodate the implementation of refurbishment, adaptation, upgrading or renovation works (Egbu et al., 2002). This is due to the fact that workplaces of these projects also contain risky elements, in which they can lead as well to fatal accidents and losses in the material possessions (Danso et al., 2015).

4.5 Factors Related to the Operation and Maintenance Phase

4.5.1 Availability and Adequacy of the Commissioning Process for the MEP Systems

It is essential to conduct commissioning process on buildings that have been adaptively reused, in order to ensure that the building services systems (MEPs) are ready to serve the new occupancy (Douglas, 2006). In fact, this process is among the sustainability criteria pertaining to the management of adaptively reused buildings, according to the Green Star rating tool (Wilkinson and Remøy, 2017). Implementing this kind of processes would be useful for the new users, since they offer a full documentation of the reused facility,

including: as-built drawings, report on the performance conditions, operational manuals and specification of the building systems (Fournier and Zimnicki, 2004; Wilkinson et al., 2014).

4.5.2 Availability of Accurate Records of the Building Assets

Assets management is among the important tasks that needs to be considered and accomplished in the adaptive reuse projects. Despite the significance of this kind of managerial processes, few studies mentioned it in the context of building adaptation (Wilkinson et al., 2014). In fact, implementing this process has the potential to enhance the spaces utilization (Ladinski, 2017), as well as improvement in the O&M performance in the adaptively reused building (Fournier and Zimnicki, 2004). In this context, records pertaining to the adaptively reused building should be kept, to facilitate the other daily activities of property management (Alauddin, 2014).

4.5.3 Efficiency of the Utilization of the Building Spaces

Space management is an essential process that should be performed in adaptively reused buildings, as such as in the other built-facilities. In this context, a workplace strategy needs to be developed and followed in this kind of projects, in order to ensure the efficiency and productivity of the building spaces in a daily basis, after the change of use (Ladinski, 2017). This entails a careful consideration about the method and parameters used in the calculation and assessment of the space efficiency (Douglas, 2006). Over the time, adaptively reused buildings might be subjected to frequent changes in terms of the utilization and organization of their interior spaces, in response to supply and demand factors. In this case, facilities managers should ensure an efficient allocation of the spaces (Brown and Cresciani, 2017; Fieldson, 2017).

4.5.4 Compliance with Health and Safety Measures

In adaptively reused buildings, health and safety requirements of the occupants should be assured in an acceptable level, throughout the new life-span (Mehr and Wilkinson, 2018). This is due to the fact that these requirements are among the factors that may constitute an obstacle to the achievement of the resilience and sustainability of the adaptive reuse (Aigwi et al., 2018; Bullen and Love, 2010). Effective identification and enforcement of the new occupational health and safety measures should be performed, accordingly (Jin, 1996).

4.5.5 Development and Implementation of Work Schedules for Different Maintenance Types (e.g. Planned, Unplanned)

Maintenance management in adaptively reused buildings is one of the sustainability criteria in the BREEAM rating tool (Wilkinson and Remøy, 2017). This is due to the fact that adopting planned maintenance procedures is important for the performance efficiency of the adaptively reused building (Douglas, 2006). Moreover, these actions would mitigate the risk of financial losses resulted from occurrence of failures, and hence, avoid the potential of the acceleration of building obsolescence (Fournier and Zimnicki, 2004; Wilkinson et al., 2014).

4.5.6 Potentiality of Obsolescence and/or Deterioration of Building Components and/or Systems

Overcoming the obsolescence of existing properties is among the expected achievements of building adaptive reuse (Bullen and Love, 2009). During the occupancy phase of the adaptively reused buildings, the FM personnel should make sure that they maintain the whole building in the condition as it was reused for, accordingly. This process entails a

holistic care of all building components (Fournier and Zimnicki, 2004). In this context, the FM personnel should consider the availability of state-of-the-art systems that are compatible with the new function (Z. Ali et al., 2018).

4.5.7 Control over the Operational Characteristics of the Building Components and Systems

A control over the internal condition has an influence at improving the performance of the adaptively reused buildings, throughout their occupancy phase (Brown and Cresciani, 2017). However, there might be problems in the IEQ conditions in the new use, due to the lack of knowledge among some owners of adaptively reused projects about the necessity of maintaining these parameters (Al-obaidi et al., 2017). In order to provide an acceptable level of IEQ for the new users, the FM personnel should conduct continues tuning and calibration of all systems in the building (Fournier and Zimnicki, 2004).

4.5.8 User Satisfaction with the Layout of the Building as well as the Workflow of Activities

Occupant satisfaction is important factor that needs to be investigated during the post-adaptation phase (Remøy, 2010). This is due to the fact that investigating this factor contributes to explore and comprehend several issues within the context of the performance of building adaptive reuse (Douglas, 2006). For instance, assessment of occupant satisfaction can be used to explore the performance of different determinants, namely: IEQ (Al-obaidi et al., 2017), efficiency of space utilization and workflow of activities (Hamida and Hassanain, 2020), and quality of service and activities within the building context (Z.

Ali et al., 2018). In fact, responding to the feedback of users of adaptively reused buildings is a crucial step for the continuity of the new use (Günçe and Misirlisoy, 2019).

4.6 Summary and Discussion

This chapter covered the description of the identified factors through the reviewed literature and the conducted pilot study. The pilot study was performed to test the validity, readability, adequacy and applicability of the identified factors. Additionally, it served to gain a further explanation of the identified factors.

The pilot study revealed that there were no further factors could be added to the identified list. Further, it indicated that the adopted categorization of the factors was logical, since it grouped the factors in accordance with the genetic life-cycle of adaptive reuse projects. Based on the presented content, this chapter provided a clear explanation of the identified 38 factors that have a bearing on adaptive reuse projects throughout their life-cycle.

CHAPTER 5:

ASSESSMENT OF THE FACTORS AFFECTING BUILDING ADAPTIVE REUSE THROUGHOUT THE PROJECT LIFE-CYCLE

5.1 Overview

This chapter covers a discussion of the findings of the performed assessment on the importance of the identified factors that affect the practice of building adaptive reuse throughout the project life-cycle. It presents the responses received in the third section (Section C) of each of the three questionnaire surveys. The three questionnaire surveys were conducted on 90 AEC/FM practitioners (30 A/Es, 30 contractors and 30 facilities managers) of building adaptive reuse in the Eastern Province of Saudi Arabia. First, the chapter presents a section for the overall assessment of the factors by the three groups of respondents. The determined RII, importance rate, in group rank, and overall rank for each factor are demonstrated in this section. Second, the chapter presents a section for the individual assessment of the factors, which was received by each of the three groups of respondents. Third, the chapter presents a section for the assessment of the factors' groups, which was received by the overall respondents as well as the three groups of professionals. Fourth, findings of the performed analysis on the agreement among the three groups of respondents are presented in a section within this chapter. Finally, the chapter concludes with a summary and discussion of the key findings.

5.2 Overall Findings of the Assessment of the Factors by the Three Groups of Respondents

Table 5.1 illustrates the overall findings of the received assessment of the factors by the involved three groups of respondents ($n = 90$). For each group of respondents, **Table 5.1** illustrates the mean, RII, rate of importance, in group rank and overall rank for each factor. **Equation 1.4** (see section 1.8.2) was employed to calculate the RII for each factor, using Microsoft Excel 365 (Version 2016). An overall assessment of the factors, by the total respondents, is presented in **Table 5.1**.

In overview, the overall assessment of the factors indicated that the importance rate of the factors ranged between “Important” and “Extremely Important”, according to the calculated average RII of the three groups of respondents. Findings revealed that the importance rate of the four groups of factors was “Very Important”.

According to the overall assessment, findings revealed that the fourth group of factors “operation and maintenance phase” was ranked first in term of its importance in the life-cycle of building adaptive reuse. In the second rank, the third group of factors “construction phase” was listed, accordingly. Finally, the rest two groups of factors, “phase of conceptual planning and feasibility studies” and “design and engineering phase”, were ranked third and fourth amongst the others, respectively.

5.2.1 Factors Related to the Phase of Conceptual Planning and Feasibility Studies

This group included nine factors as presented in **Table 5.1**. Overall responses indicated that ‘structural integrity of the building’ and ‘municipal approval for the land use change’ were the most important factors in this phase. They received average RII values of 96.94% and 89.72%, respectively. Both factors received an importance rate of “Extremely Important”. This is due to the fact that both factors are correlated, in which they play a vital role in the building adaptability. Overall responses indicated that ‘allocated budget for the adaptation process’ was ranked third in this group, according to the received average value of the relative importance index (RII = 87.22%). This factor received an importance rate of “Very Important”. The other five factors in this group, namely: ‘potential of the building spaces to be adaptively reused’, ‘expected yield from the adaptation’, ‘architectural program of the new function’, ‘compatibility of the building appearance with the client desired design’, and ‘the schedule of the adaptation activities’, received an equal importance rate “Very Important”. Their average RII values were 81.94%, 81.11%, 78.06%, 69.72% and 68.61%, respectively.

5.2.2 Factors Related to the Design and Engineering Phase

This group included eleven factors as presented in **Table 5.1**. Overall, all factors in this group received an importance rate of “Very Important”. However, ‘code requirements for the new occupancy’, ‘previous experience of the design team with adaptive reuse projects’, ‘number and layout of the structural columns’, and ‘availability and accuracy of drawings and specifications of the existing project’ were ranked the top four important factors in this group, according to their average RII values. Their average RII values were 86.36%,

84.44%, 84.44% and 83.61%, respectively. This is logical, since all these factors are crucial, and have a direct bearing on the accomplishment of the design process in adaptive reused projects. The average RII values and ranks of the other seven factors were as follows: net area of the adaptable space, 80.56% (*rank* = 4); site configuration and requirements, 80.28%, (*rank* = 5); layout of spaces within the building, 77.50% (*rank* = 6); capacity of the existing MEP systems, 77.50% (*rank* = 6); sustainability and energy saving measures, 74.17% (*rank* = 7); potential to install additional and/or new systems, 73.06% (*rank* = 8); and layout of the existing MEP systems, 72.50% (*rank* = 9).

5.2.3 Factors Related to the Construction Phase

This group included ten factors as presented in **Table 5.1**. Overall responses indicated that ‘enforcement and management of the safety procedures at the project site’ and ‘accuracy and completeness of the contract documents’ are the most important factors in the construction phase of adaptive reuse projects. Both factors received average RII values of 89.72% and 87.78%, respectively, with an importance rate of “Extremely Important”. This due to the fact that both factors constitute major elements for the success of any building project. However, they might be ignored in building adaptive reuse practices, due to the lack of experience of the contractors involved in this kind of projects about the significance of both factors. The factor ‘quality assurance/control requirements’ was ranked third in this group of factors, according to its average RII value (RII = 86.67%). It received an importance rate of “Very Important”. Further, the other six factors received an importance rate of “Very Important”, as well. Their average RII values and ranks were as follows: planning and control of the financial resources, 85.28% (*rank* = 4); previous experience of the contractor with adaptive reuse projects, 85% (*rank* = 5); availability of skilled

workforce, 84.44% (*rank* = 6); construction equipment and methods, 81.94% (*rank* = 7); complexity and difficulties within the project site, 73.89% (*rank* = 8); availability and accessibility of loading space, 70.28% (*rank* = 9); and availability of space for storing the construction materials and equipment, 66.39% (*rank* = 10).

5.2.4 Factors Related to the Operation and Maintenance Phase

This group included eight factors as presented in **Table 5.1**. Overall responses indicated that the most important two factors in this phase are ‘compliance with health and safety measures’ and ‘availability and adequacy of commission process for the MEP systems’. They received average RII values of 88.06% and 87.50%, respectively. Based on these RII values, both factors were rated “Extremely Important”. These assessments are logical, since both factors are crucial for the day-to-day operational activities as well as the overall building performance after the change of use. Overall responses indicated that ‘user satisfaction with the layout of the building as well as the workflow of activities’ was the third important factor in this phase, according to its average RII value (RII = 83.89%). This factor received an importance rate of “Very Important”. However, the other five factors received also an importance rate of “Very Important”. Their average RII values and ranks are as follows: availability of accurate records of the building assets, 83.33% (*rank* = 4); development and implementation of work schedules for different maintenance types, 79.72% (*rank* = 5); efficiency of the utilization of the building spaces, 79.44% (*rank* = 6); control over the operational characteristics of the building components and systems, 76.11% (*rank* = 7); and potentiality of obsolescence and/or deterioration of building components and/or systems, 71.67% (*rank* = 8).

Table 5.1: Overall findings of the received assessment of the factors by the involved three groups of respondents

#	Factors influencing the implementation of building adaptive reuse	A/E responses					Contractors responses					FM responses					Overall responses			
		Mean	RII (%)	Rate	In group rank	Overall rank	Mean	RII (%)	Rate	In group rank	Overall rank	Mean	RII (%)	Rate	In group rank	Overall rank	RII (%)	Rate	In group rank	Overall rank
	Factors related to the phase of conceptual planning and feasibility studies	3.08	77.04	VI	-	3	3.20	80.00	VI	-	1	3.28	82.04	VI	-	4	79.69	VI	-	3
1.	Structural integrity of the building	3.90	97.50	EI	1	1	3.77	94.17	EI	1	1	3.97	99.17	EI	1	1	96.94	EI	1	1
2.	Municipal approval for the land use change	3.87	96.67	EI	2	2	3.57	89.17	EI	3	3	3.33	83.33	VI	4	13	89.72	EI	2	2
3.	The condition of building components and/or systems	2.33	58.33	I	9	24	2.70	67.50	VI	8	22	2.63	65.83	VI	7	22	63.89	I	9	34
4.	Architectural program of the new function	3.03	75.83	VI	5	14	2.97	74.17	VI	6	16	3.37	84.17	VI	3	12	78.06	VI	6	22
5.	Potential of the building spaces to be adaptively reused	3.20	80.00	VI	4	11	3.27	81.67	VI	5	9	3.37	84.17	VI	3	12	81.94	VI	4	16
6.	Allocated budget for the adaptation process	3.27	81.67	VI	3	9	3.60	90.00	EI	2	2	3.60	90.00	EI	2	6	87.22	VI	3	7
7.	Expected yield from the adaptation	2.93	73.33	VI	6	17	3.47	86.67	VI	4	5	3.33	83.33	VI	4	13	81.11	VI	5	17
8.	The schedule of the adaptation activities	2.47	61.67	I	8	23	2.73	68.33	VI	7	21	3.03	75.83	VI	5	18	68.61	VI	8	32
9.	Compatibility of the building appearance with the client desired design	2.73	68.33	VI	7	20	2.73	68.33	VI	7	21	2.90	72.50	VI	6	20	69.72	VI	7	31

Notes: EI, extremely important; VI, very important; I, important; SI, somewhat important; NI, not important

Table 5.1: Overall findings of the received assessment of the factors by the involved three groups of respondents (Cont.)

#	Factors influencing the implementation of building adaptive reuse	A/E responses					Contractors responses					FM responses					Overall responses			
		Mean	RII (%)	Rate	In group rank	Overall rank	Mean	RII (%)	Rate	In group rank	Overall rank	Mean	RII (%)	Rate	In group rank	Overall rank	RII (%)	Rate	In group rank	Overall rank
Factors related to the design and engineering phase		3.00	74.92	VI	-	4	3.14	78.56	VI	-	2	3.40	85.00	VI	-	3	79.49	VI	-	4
10.	Previous experience of the design team with adaptive reuse projects	3.27	81.67	VI	4	9	3.37	84.17	VI	2	6	3.50	87.50	EI	4	9	84.44	VI	2	12
11.	Code requirements for the new occupancy	3.33	83.33	VI	2	7	3.47	86.67	VI	1	5	3.57	89.17	EI	2	7	86.39	VI	1	9
12.	Availability and accuracy of the drawings and specifications of the existing project	3.23	80.83	VI	5	10	3.17	79.17	VI	5	11	3.63	90.83	EI	1	5	83.61	VI	3	14
13.	Net area of the adaptable space	2.77	69.17	VI	6	19	3.33	83.33	VI	3	7	3.57	89.17	EI	2	7	80.56	VI	4	18
14.	Layout of spaces within the building	2.77	69.17	VI	6	19	3.07	76.67	VI	8	14	3.47	86.67	VI	5	10	77.50	VI	6	23
15.	Number and layout of the structural columns	3.43	85.83	VI	1	5	3.30	82.50	VI	4	8	3.40	85.00	VI	6	11	84.44	VI	2	12
16.	Layout of the existing MEP systems	2.70	67.50	VI	7	21	2.83	70.83	VI	10	19	3.17	79.17	VI	8	16	72.50	VI	9	28
17.	Capacity of the existing MEP systems	2.63	65.83	VI	8	22	3.13	78.33	VI	6	12	3.53	88.33	EI	3	8	77.50	VI	6	23
18.	Potential to install additional and/or new systems	2.77	69.17	VI	6	19	2.90	72.50	VI	9	17	3.10	77.50	VI	9	17	73.06	VI	8	27
19.	Site configuration and requirements	3.30	82.50	VI	3	8	3.10	77.50	VI	7	13	3.23	80.83	VI	7	15	80.28	VI	5	19
20.	Sustainability and energy saving measures	2.77	69.17	VI	6	19	2.90	72.50	VI	9	17	3.23	80.83	VI	7	15	74.17	VI	7	25

Notes: EI, extremely important; VI, very important; I, important; SI, somewhat important; NI, not important

Table 5.1: Overall findings of the received assessment of the factors by the involved three groups of respondents (Cont.)

#	Factors influencing the implementation of building adaptive reuse	A/E responses					Contractors responses					FM responses					Overall responses			
		Mean	RII (%)	Rate	In group rank	Overall rank	Mean	RII (%)	Rate	In group rank	Overall rank	Mean	RII (%)	Rate	In group rank	Overall rank	RII (%)	Rate	In group rank	Overall rank
	Factors related to the construction phase	3.16	78.92	VI	-	2	3.14	78.50	VI	-	3	3.44	86.00	VI	-	2	81.14	VI	-	2
21.	Previous experience of the contractor with adaptive reuse projects	3.27	81.67	VI	4	9	3.33	83.33	VI	4	7	3.60	90.00	EI	4	6	85.00	VI	5	11
22.	Accuracy and completeness of the contract documents	3.50	87.50	EI	2	4	3.37	84.17	VI	3	6	3.67	91.67	EI	2	4	87.78	EI	2	5
23.	Availability of skilled workforce	3.13	78.33	VI	6	12	3.33	83.33	VI	4	7	3.67	91.67	EI	2	4	84.44	VI	6	12
24.	Construction equipment and methods	3.07	76.67	VI	7	13	3.17	79.17	VI	6	11	3.60	90.00	EI	4	6	81.94	VI	7	16
25.	Planning and control of the financial resources	3.30	82.50	VI	3	8	3.30	82.50	VI	5	8	3.63	90.83	EI	3	5	85.28	VI	4	10
26.	Quality assurance / control requirements	3.20	80.00	VI	5	11	3.47	86.67	VI	2	5	3.73	93.33	EI	1	3	86.67	VI	3	8
27.	Complexity and difficulties within the project site	2.90	72.50	VI	8	18	2.87	71.67	VI	7	18	3.10	77.50	VI	5	17	73.89	VI	8	26
28.	Availability and accessibility of loading space	2.77	69.17	VI	9	19	2.70	67.50	VI	8	22	2.97	74.17	VI	6	19	70.28	VI	9	30
29.	Availability of spaces for storing the construction materials and equipment	2.90	72.50	VI	8	18	2.37	59.17	I	9	24	2.70	67.50	VI	7	21	66.39	VI	10	33
30.	Enforcement and management of safety procedures at the project site	3.53	88.33	EI	1	3	3.50	87.50	EI	1	4	3.73	93.33	EI	1	3	89.72	EI	1	3

Notes: EI, extremely important; VI, very important; I, important; SI, somewhat important; NI, not important

Table 5.1: Overall findings of the received assessment of the factors by the involved three groups of respondents (Cont.)

#	Factors influencing the implementation of building adaptive reuse	A/E responses					Contractors responses					FM responses					Overall responses			
		Mean	RII (%)	Rate	In group rank	Overall rank	Mean	RII (%)	Rate	In group rank	Overall rank	Mean	RII (%)	Rate	In group rank	Overall rank	RII (%)	Rate	In group rank	Overall rank
	Factors related to the operation and maintenance phase	3.23	80.63	VI	-	1	3.04	75.94	VI	-	4	3.48	87.08	VI	-	1	81.22	VI	-	1
31.	Availability and adequacy of the commissioning process for the MEP systems	3.40	85.00	VI	2	6	3.50	87.50	EI	1	4	3.60	90.00	EI	2	6	87.50	EI	2	6
32.	Availability of accurate records of the building assets	3.33	83.33	VI	3	7	3.10	77.50	VI	4	13	3.57	89.17	EI	3	7	83.33	VI	4	15
33.	Efficiency of the utilization of the building spaces	3.23	80.83	VI	4	10	3.00	75.00	VI	5	15	3.30	82.50	VI	6	14	79.44	VI	6	21
34.	Compliance with health and safety measures	3.50	87.50	EI	1	4	3.27	81.67	VI	2	9	3.80	95.00	EI	1	2	88.06	EI	1	4
35.	Development and implementation of work schedules for different maintenance types	3.03	75.83	VI	5	14	2.97	74.17	VI	6	16	3.57	89.17	EI	3	7	79.72	VI	5	20
36.	Potentiality of obsolescence and/or deterioration of building components and/or systems	2.97	74.17	VI	7	16	2.47	61.67	I	8	23	3.17	79.17	VI	7	16	71.67	VI	8	29
37.	Control over the operational characteristics of the building components and systems	3.00	75.00	VI	6	15	2.80	70.00	VI	7	20	3.33	83.33	VI	5	13	76.11	VI	7	24
38.	User satisfaction with the layout of the building as well as the workflow of activities	3.33	83.33	VI	3	7	3.20	80.00	VI	3	10	3.53	88.33	EI	4	8	83.89	VI	3	13

Notes: EI, extremely important; VI, very important; I, important; SI, somewhat important; NI, not important

5.3 Assessment of the Factors by A/Es

This section presents a discussion of the findings of the performed assessment on the factors, according to the received responses from the involved three groups of respondents.

5.3.1 Assessment of the Factors by Respondents from the A/Es

This section discusses findings of the received assessment on the importance of the 38 factors, according to perspective of the respondents from the A/Es' group ($n = 30$).

5.3.1.1 Factors Related to the Phase of Conceptual Planning and Feasibility Studies

A/Es perceived 'structural integrity of the building' and 'municipal approval for the land use change' as the most important factors in this phase. Both factors received RII values of 97.50% and 96.67%, respectively (**Table 5.1**), with an importance rate of "Extremely Important". This is due to the fact that both factors are correlated and play a vital role in the potential of implementing building adaptive reuse. A/Es' assessment indicated that 'allocated budget for the adaptation process' was the third important factor in this phase. This factor received RII value of 81.67% with an importance rate of "Very Important". Another four factors, namely: 'potential of the building spaces to be adaptively reused', 'architectural program of the new function', 'expected yield from the adaptation' and 'compatibility of the building appearance with the client desired design', also received an importance rate of "Very Important". Their RII values were 80.00%, 75.83%, 73.33% and 68.33%, respectively. The rest two factors, namely: 'the schedule of the adaptation activities' and 'the condition of building components and/or systems', received an

importance rate of “Important” with RII values of 61.67% and 58.33%, respectively.

5.3.1.2 Factors Related to the Design and Engineering Phase

A/Es perceived all factors in this phase as “Very Important”. Their responses indicated that ‘number and layout of the structural columns’, ‘code requirements for the new occupancy’ and ‘site configuration and requirements’ are the most top three influential factors in this phase. These factors received RII values of 85.83%, 83.33% and 82.50%, respectively (**Table 5.1**). This implies that the regulatory requirements and the physical attributes of the structural system are significant influences on the design process of adaptive reuse projects. However, RII values and ranks of the other eight factors were as follows: previous experience of the design team with adaptive reuse projects, 81.67% (*rank* = 4); availability and accuracy of the drawings and specifications of the existing project, 80.83% (*rank* = 5); net area of the adaptable space, 69.17% (*rank* = 6); layout of spaces within the building, 69.17% (*rank* = 6); potential to install additional and/or new systems, 69.17% (*rank* = 6); sustainability and energy saving measures, 69.17% (*rank* = 6); layout of the existing MEP systems, 67.50% (*rank* = 7); and capacity of the existing MEP systems, 65.83% (*rank* = 8).

5.3.1.3 Factors Related to the Construction Phase

A/Es perceived ‘enforcement and management of safety procedures at the project site’ and ‘accuracy and completeness of the contract documents’ as the most important factors that affect the building adaptive reuse during the construction phase. Both factors received RII values of 88.33% and 87.50%, respectively, and an importance rate of “Extremely Important” (**Table 5.1**). It was noted that these findings were in accordance with the overall assessment of the factors, which was received by all respondents of the three questionnaire surveys. Findings revealed that ‘planning and control of the financial resources’ was ranked the third important factor in this phase by the A/Es. This factor received RII value of 82.50%, with an importance rate of “Very Important”. Further, it was noted that the other seven factors also received an importance rate of “Very Important”, according to their calculated RII values. Their RII values and ranks were as follows: previous experience of the contractor with adaptive reuse projects, 81.67% (*rank* = 4); quality assurance / control requirements, 80.00% (*rank* = 5); availability of skilled workforce, 78.33% (*rank* = 6); construction equipment and methods, 76.67% (*rank* = 7); complexity and difficulties within the project site, 72.50% (*rank* = 8); availability of spaces for storing the construction materials and equipment, 72.50% (*rank* = 8); and availability and accessibility of loading space, 69.17% (*rank* = 9).

5.3.1.4 Factors Related to the Operation and Maintenance Phase

A/Es perceived ‘compliance with health and safety measures’ as the most important factor in the O&M phase of adaptive reuse projects. This factor received an RII value of 87.50%, with an importance rate of “Extremely Important” (**Table 5.1**). In fact, achieving the required level of health and safety in the adaptively reused buildings might be a challenge, since there is somewhat an adverse impact of the adaptation process on the environmental conditions. Findings indicated that ‘availability and adequacy of the commissioning process for the MEP systems’, ‘availability of accurate records of the building assets’ and ‘user satisfaction with the layout of the building as well as the workflow of activities’ were also among the top important factors in this phase. They received RII values of 85.00%, 83.33% and 83.33%, respectively, with an importance rate of “Very Important”. Further, the rest four factors also received an importance rate of “Very Important. Their RII values and ranks were as follows: efficiency of the utilization of the building spaces, 80.83% (*rank* = 4); development and implementation of work schedules for different maintenance types, 75.83% (*rank* = 5); control over the operational characteristics of the building components and systems, 75.00% (*rank* = 6); and potentiality of obsolescence and/or deterioration of building components and/or systems, 74.17% (*rank* = 7)

5.3.2 Assessment of the Factors by Contractors

This section discusses findings of the received assessment on the importance of the 38 factors, according to perspective of the respondents from the contractors' group ($n = 30$).

5.3.2.1 Factors Related to the Phase of Conceptual Planning and Feasibility Studies

Contractors perceived 'structural integrity of the building', 'allocated budget for the adaptation process' and 'municipal approval for the land use change' as the top three influential factors on building adaptive reuse during the phase of conceptual planning and feasibility studies (**Table 5.1**). These factors received RII values of 94.17%, 90.00% and 89.17%, respectively, with an importance rate of "Extremely Important". These findings are logical, since these factors have a vital role in the determination of the viability and constructability of the building adaptive reuse. The other six factors received an importance rate of "Very Important" Their RII values and ranks were as follows: expected yield from the adaptation, 86.67% ($rank = 4$); potential of the building spaces to be adaptively reused, 81.67% ($rank = 5$); architectural program of the new function, 74.17% ($rank = 6$); the schedule of the adaptation activities, 68.33% ($rank = 7$); compatibility of the building appearance with the client desired design, 68.33% ($rank = 7$); and the condition of building components and/or systems, 67.50% ($rank = 8$).

5.3.2.2 Factors Related to the Design and Engineering Phase

Contractors perceived all factors in this phase as “Very Important”. Their responses revealed that ‘code requirements for the new occupancy’, ‘previous experience of the design team with adaptive reuse projects’ and ‘net area of the adaptable space’ are the most important factors that affect building adaptive reuse during the design and engineering phase. These factors received RII values of 86.67%, 84.17% and 83.33%, respectively (**Table 5.1**). RII values and ranks of the other eight factors were as follows: number and layout of the structural columns, 82.50% (*rank* = 4); availability and accuracy of the drawings and specifications of the existing project, 79.17% (*rank* = 5); capacity of the existing MEP systems, 78.33% (*rank* = 6); site configuration and requirements, 77.50% (*rank* = 7); layout of spaces within the building, 76.67% (*rank* = 8); potential to install additional and/or new systems, 72.50% (*rank* = 9); sustainability and energy saving measures, 72.50% (*rank* = 9); and layout of the existing MEP systems, 70.83% (*rank* = 10).

5.3.2.3 Factors Related to the Construction Phase

Contractors perceived ‘enforcement and management of safety procedures at the project site’ as the most influential factor on the practice of building adaptive reuse during the construction phase (**Table 5.1**). This factor received RII value of 87.50%, with an importance rate of “Extremely Important”. This finding is in accordance with the perspective of all respondents involved in the three questionnaire surveys. Findings indicated that ‘quality assurance/control requirements’ and ‘accuracy and completeness of the contract documents’ were

ranked second and third, respectively, in term of their importance in the adaptive reuse construction. They received RII values of 86.67% and 84.17%, respectively, with an importance rate of “Very Important”. The findings indicated that there are also other six factors received the equal importance rate “Very Important”. The follows are the received RII values and ranks for each of these factors: previous experience of the contractor with adaptive reuse projects, 83.33% (*rank* = 4); availability of skilled workforce, 83.33% (*rank* = 4); planning and control of the financial resources, 82.50% (*rank* = 5); construction equipment and methods, 79.17% (*rank* = 6); complexity and difficulties within the project site, 71.67% (*rank* = 7); and availability and accessibility of loading space, 67.50% (*rank* = 8). One factor, ‘availability of spaces for storing the construction materials and equipment’, received an importance rate of “Important”, as it received RII value of 59.17%.

5.3.2.4 Factors Related to the Operation and Maintenance Phase

Contractors perceived ‘availability and adequacy of the commissioning process for the MEP systems’ as the most influential factor on the adaptive reuse projects during O&M phase (**Table 5.1**). It received RII value of 87.50%, with an importance rate of “Extremely Important”. This assessment is logical, since conducting this process is essential to explore all possible problems in the adaptive reuse implementation, before practicing the day-to-day operational activities. Constructors perceived ‘compliance with health and safety measures’ and ‘user satisfaction with the layout of the building as well as the workflow of activities’ as the second and third important factors in this phase, respectively. They received RII values of 81.67% and 80.00%, respectively, with an importance rate of “Very

Important”. Further, another four factors received the equal importance rate. The RII values and ranks of these factors were as follows: availability of accurate records of the building assets, 77.50% (*rank* = 4); efficiency of the utilization of the building spaces, 75.00% (*rank* = 5); development and implementation of work schedules for different maintenance types, 74.17% (*rank* = 6); and control over the operational characteristics of the building components and systems, 70.00% (*rank* = 7). One factor, ‘potentiality of obsolescence and/or deterioration of building components and/or systems’, received an importance rate of “Important”, as it received RII value of 61.67%.

5.3.3 Assessment of the Factors by Facilities Managers

This section discusses findings of the received assessment on the importance of the 38 factors, according to perspective of the respondents from the FMs’ group ($n = 30$).

5.3.3.1 Factors Related to the Phase of Conceptual Planning and Feasibility Studies

Facilities managers perceived ‘structural integrity of the building’ and ‘allocated budget for the adaptation process’ as the most important factors that affect the adaptive reuse project during the phase of conceptual planning and feasibility studies (**Table 5.1**). These factors received RII values of 99.17% and 90.00%, respectively, with an importance rate of “Extremely Important”. Further, ‘architectural program of the new function’ and ‘potential of the building spaces to be adaptively reused’ were ranked third in term of their importance in this phase. They received RII value of 84.17% ,with an importance rate of “Very Important”.

The rest five factors also received the equal importance rate “Very Important”. Their RII values and ranks were as follows: municipal approval for the land use change, 83.33% (*rank* = 4); expected yield from the adaptation, 83.33% (*rank* = 4); the schedule of the adaptation activities, 75.83% (*rank* = 5); compatibility of the building appearance with the client desired design, 72.50% (*rank* = 6); and the condition of building components and/or systems, 65.83% (*rank* = 7).

5.3.3.2 Factors Related to the Design and Engineering Phase

Facilities managers perceived ‘availability and accuracy of the drawings and specifications of the existing project’, ‘code requirements for the new occupancy’, ‘net area of the adaptable space’, ‘capacity of the existing MEP systems’, and ‘previous experience of the design team with adaptive reuse projects’ as the most important factors in the design and engineering phase in adaptive reuse projects (**Table 5.1**). Their RII values were 90.83%, 89.17%, 89.17%, 88.33% and 87.50%, respectively, with an importance rate of “Extremely Important”. These assessments are logical, since facilities managers may encounter the consequences of the design judgments and their impact on the daily operational activities in adaptively reused building. Yet, the other six factors received an importance rate of “very important”. Their RII values and ranks were as follows: layout of spaces within the building, 86.67% (*rank* = 5); number and layout of the structural columns, 85% (*rank* = 6); site configuration and requirements, 80.83% (*rank* = 7); sustainability and energy saving measures, 80.83% (*rank* = 7); layout of the existing MEP systems, 79.17% (*rank* = 8); and potential to install additional and/or new systems, 77.50% (*rank* = 9).

5.3.3.3 Factors Related to the Construction Phase

Facilities managers perceived ‘quality assurance/control requirements’, ‘enforcement and management of safety procedures at the project site’, ‘accuracy and completeness of the contract documents’, ‘availability of skilled workforce’, ‘planning and control of the financial resources’, ‘previous experience of the contractor with adaptive reuse projects’ and ‘construction equipment and methods’ as the most influential factors on the practice of constructing adaptive reuse projects. They received RII values of 93.33%, 93.33%, 91.67%, 91.67%, 90.83%, 90.00% and 90.00%, respectively, with an importance rate of “Extremely Important” (**Table 5.1**). These findings are convincing, as there is a vital role of these factors on the project success and the effectiveness. Findings revealed that the other three factors have received an importance rate of “Very Important”. The follows are the received RII values and ranks for these factors: complexity and difficulties within the project site, 77.50% (*rank* = 5); availability and accessibility of loading space, 74.17% (*rank* = 6); and availability of spaces for storing the construction materials and equipment, 67.50% (*rank* = 7).

5.3.3.4 Factors Related to the Operation and Maintenance Phase

Facilities managers perceived ‘compliance with health and safety measures’, ‘availability and adequacy of the commissioning process for the MEP systems’, ‘availability of accurate records of the building assets’, ‘development and implementation of work schedules for different maintenance types’, and ‘user satisfaction with the layout of the building as well as the workflow of activities’ as

the most important factors during the O&M phase in adaptively reused buildings (**Table 5.1**). They received RII values of 95.00%, 90.00%, 89.17%, 89.17% and 88.33%, with an importance rate of “Extremely Important”. These findings imply that these factors play a key role in the effectiveness of the occupancy phase of the adaptively reused buildings. Yet, the other three factors received an importance rate of “Very Important”. Their RII values and ranks were as follows: control over the operational characteristics of the building components and systems, 83.33% (*rank* = 5); efficiency of the utilization of the building spaces, 82.50% (*rank* = 6); and potentiality of obsolescence and/or deterioration of building components and/or systems, 79.17% (*rank* = 7).

5.4 Assessment of the Groups of Factors by Each Group of Respondents

This section presents a discussion of performed analysis on the importance and ranking of the groups of factors, according to the perspective of the three groups of respondents.

5.4.1 Assessment of the Groups of Factors by A/Es

Findings indicated that A/Es perceived all groups of factors as “Very Important”, based on the calculated average of RIIs of each group of factors (**Table 5.2**). According to the results, the fourth group of factors “operation and maintenance phase” was ranked first, since it received the highest average of relative importance indices (*Avg. RIIs* = 80.63%). The third group of factors “construction phase” was ranked second, according to the calculated average of its relative importance indices (*Avg. RIIs* = 78.92%). In the third and fourth ranks, the rest groups of factors “phase of conceptual planning and feasibility studies” and “design and engineering phase” were listed, respectively. They received an average of RIIs of 77.04% and 74.92%, respectively.

5.4.2 Assessment of the Groups of Factors by Contractors

Findings indicated that contractors perceived all groups of factors as “Very Important”, based on the calculated average of RIIs of each group of factors (**Table 5.2**). According to the findings, the first group of factors “phase of conceptual planning and feasibility studies” was ranked first, since it received the highest average of relative importance indices (*Avg. RIIs* = 80.00%). The second group of factors “design and engineering phase” was ranked second, according to the calculated average of its relative importance indices (*Avg. RIIs* = 78.56%). In the third and fourth ranks, the rest groups of factors “construction phase” and “operation and maintenance phase” were listed, respectively. They received an average of RIIs of 78.50% and 75.94%, respectively.

5.4.3 Assessment of the Groups of Factors by Facilities Managers

Findings indicated that facilities managers perceived all groups of factors as “Very Important”, based on the calculated average of RIIs of each group of factors (**Table 5.2**). According to the results, the fourth group of factors “operation and maintenance phase” was ranked first, since it received the highest average of relative importance indices (*Avg. RIIs* = 87.08%). The third group of factors “construction phase” was ranked second, according to the calculated average of its relative importance indices (*Avg. RIIs* = 86.00%). In the third and fourth ranks, “design and engineering phase” and “phase of conceptual planning and feasibility studies” were listed, respectively. They received an average of RIIs of 85.00% and 82.04%, respectively.

5.5 Analysis of the Agreement among the Three Groups of Respondents

Spearman's coefficient of rank correlation (**Equation 1.5**) was employed to analyze the agreement among the three groups of respondents. It was calculated on each paired comparison, among the three groups of respondents, as follows: A/Es and contractors, A/Es and facilities managers, and contractors and facilities managers. Microsoft Excel 365 (Version 2016) was used to perform this analysis. **Table 5.2** illustrates the findings of the performed analysis of the agreement among the three group of respondents.

Table 5.2: Findings of the analysis of agreement among the three groups of respondents

Paired comparisons	ΣD^2	p	Interpretation of the level of correlation
A/Es and contractors	836	0.909	Very high positive correlation
A/Es and facilities managers	1035	0.887	High positive correlation
Contractors and facilities managers	667	0.927	Very high positive correlation

From the results, it was noted that the level of agreement, in the three compared relationships, is generally high. The highest level of agreement was observed in the paired comparison between responses of contractors and facilities managers ($p = 0.927$). In the second rank, the paired comparison between responses of A/Es and contractors was listed, according to the determined Spearman's coefficient of rank correlation ($p = 0.909$). Finally, the paired comparison between responses of A/Es and facilities managers revealed a high level of agreement, but lower than the other compared relationships ($p = 0.887$).

5.6 Summary and Discussion

This chapter covered discussion of the findings revealed from the conducted assessment on the importance of factors influencing adaptive reuse projects throughout their life-cycle. Discussion about the overall and individual (groups of respondents) assessments of the importance of the factors, and their grouping, was included in this chapter. Findings of the analysis of the level of agreement among the groups of respondents were presented and discussed in the chapter.

In overall, findings revealed that all the identified factors were important, and have an influence on the effective implementation of adaptive reuse projects throughout their life-cycle. Results indicated that the importance rates of these factors ranged between “Important” and “Very Important”. The overall assessment indicated that the follows were the most influential factors on the practice of building adaptive reuse throughout the project lifecycle: (1) structural integrity of the building, (2) municipal approval for the land use change, (3) enforcement and management of safety procedures at the project site, (4) compliance with health and safety measures, and (5) accuracy and completeness of the contract documents. A high level of agreement was observed among the three groups of respondents, in terms of their assessment of the importance and rank of the factors.

Some interviewees who responded the questionnaire surveys added further factors to the identified list. Nevertheless, the added factors were redundant, since they were already mentioned in another context within the four groups.

CHAPTER 6:

DEVELOPMENT OF A FRAMEWORK FOR THE EFFECTIVE IMPLEMENTATION OF BUILDING ADAPTIVE REUSE THROUGHOUT THE PROJECT LIFE-CYCLE

6.1 Overview

This chapter covers a description and graphical illustration of the developed framework for the effective implementation of building adaptive reuse throughout the project life-cycle. The developed framework aimed at coordinating the managerial and technical activities that are implemented during the life-cycle of these projects. The framework development was performed in accordance with the knowledge obtained from the reviewed literature, investigated local practice and findings of the factors' assessment. IDEF₀ methodology was employed for representing the developed framework in schematic model. This is due to the fact that IDEF₀ methodology has the potential to demonstrate the relation among the engineering processes, and their required inputs, controls, mechanisms and outputs (see section 1.8.3). First, the chapter presents an overview of the framework, including the illustration of its IDEF₀-parent-diagram. Thereafter, the chapter describes the processes and functions involved in the framework, including their IDEF₀-child-diagrams. Finally, the chapter concludes with a summary and discussion about the presented content.

6.2 Generic Life-Cycle Framework for Effective Implementation of Adaptive Reuse Projects

The framework developed consists of four sequential processes, as follows:

1. Assess the feasibility of the adaptive reuse project
2. Design the adaptive reuse project
3. Construct the adaptive reuse project
4. Operate and maintain the adaptive reuse project

Each of these processes is accomplished through the implementation of a set of sequential functions. **Figure 6.1** illustrates the generic framework for the processes involved in the life-cycle of adaptive reuse projects. The following subsections describe these processes and their functions, including their inputs, controls, mechanisms and outputs.

6.2.1 Assess the Feasibility of the Adaptive Reuse Project

The “assess the feasibility of the adaptive reuse project” process (node “P1” which is elaborated in **Figure 6.2**) involves all the required tasks that are in regard to the evaluation of the adaptive reuse effectiveness from the different dimensions, including:

- Assessment of the structural integrity of the building.
- Investigation of the legislative requirements for adaptive reuse implementation.
- Assessment of the condition of the building.
- Development of the architectural program of the new use.
- Assessment of the spaces’ potential for adaptive reuse.
- Assessment of the economic feasibility of the adaptive reuse project.

This process requires conducting a technical study on the potential of the building to accommodate the new use, considering its structural strength, spatial capacity and overall physical condition. In this regard, a review and follow up on the legislative requirements for the adaptive reuse implementation should be performed within this process. Economic feasibility of the change of use is assessed in this phase. Thus, the main inputs of this process include code requirements, as-built drawings of the building, market demand, site configuration and initial cost estimate of project. These inputs would facilitate the accomplishment of the feasibility assessment of the adaptive reuse. Outputs of this process are controlled by the building age and its structural strength, standards of the new use, spatial considerations and requirements of the municipality, construction systems used in the building, and layout of the spaces and structural system, and project budget. Output of this process include report of the structural integrity of the building, documentation of the technical condition of the building, statement of the physical adaptability of the building, and statement of the economic viability of the project.

This process consists of six sequential functions, namely: (1) assess the structural integrity of the building, (2) investigate the requirements for adaptive reuse, (3) assess the building condition, (4) develop the architectural program for the new use, (5) assess the spaces' potential for adaptive reuse, and (6) assess the economic feasibility for the adaptive reuse project.

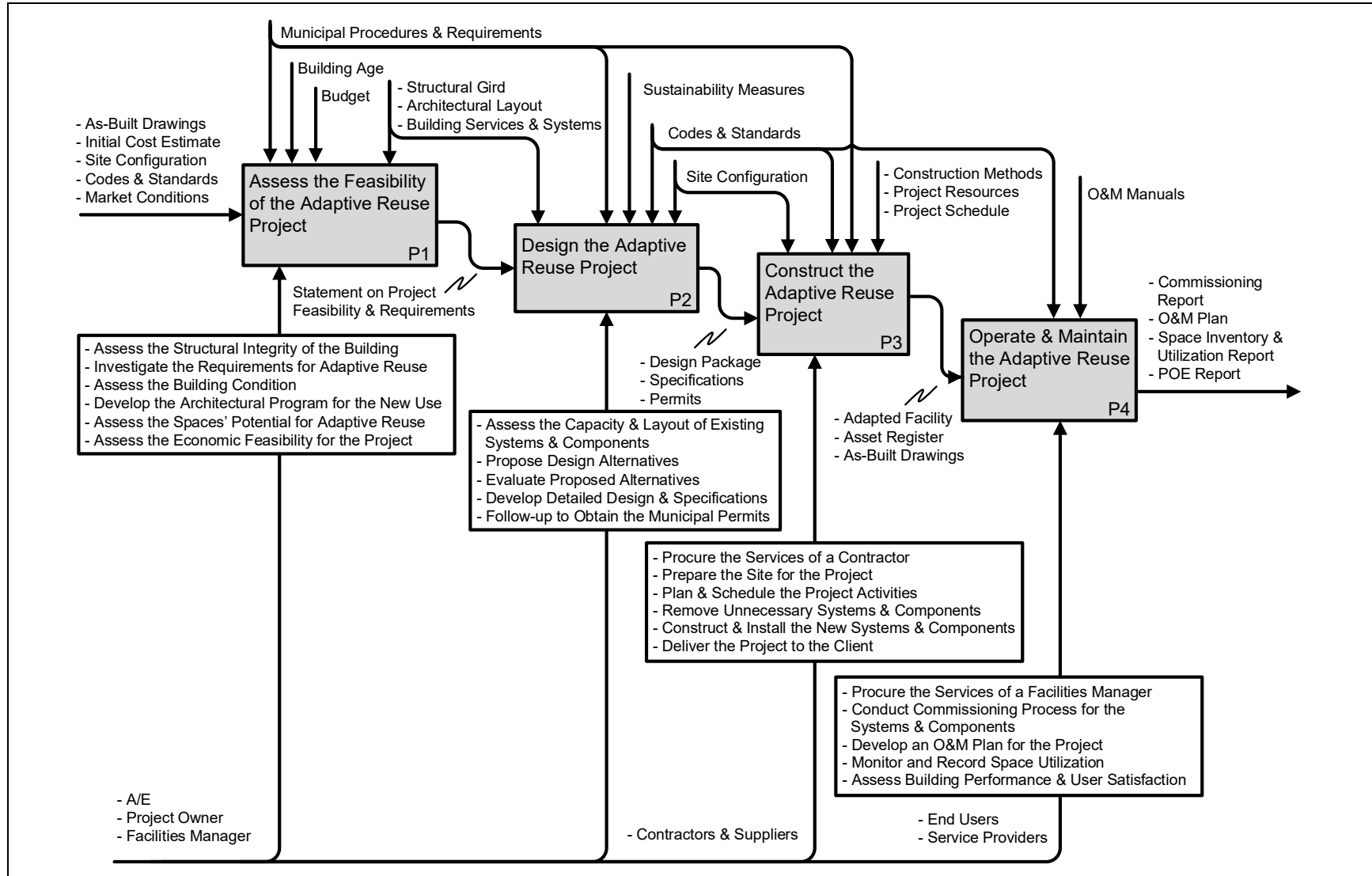


Figure 6.1: Generic framework for the processes involved in the life-cycle of adaptive reuse projects

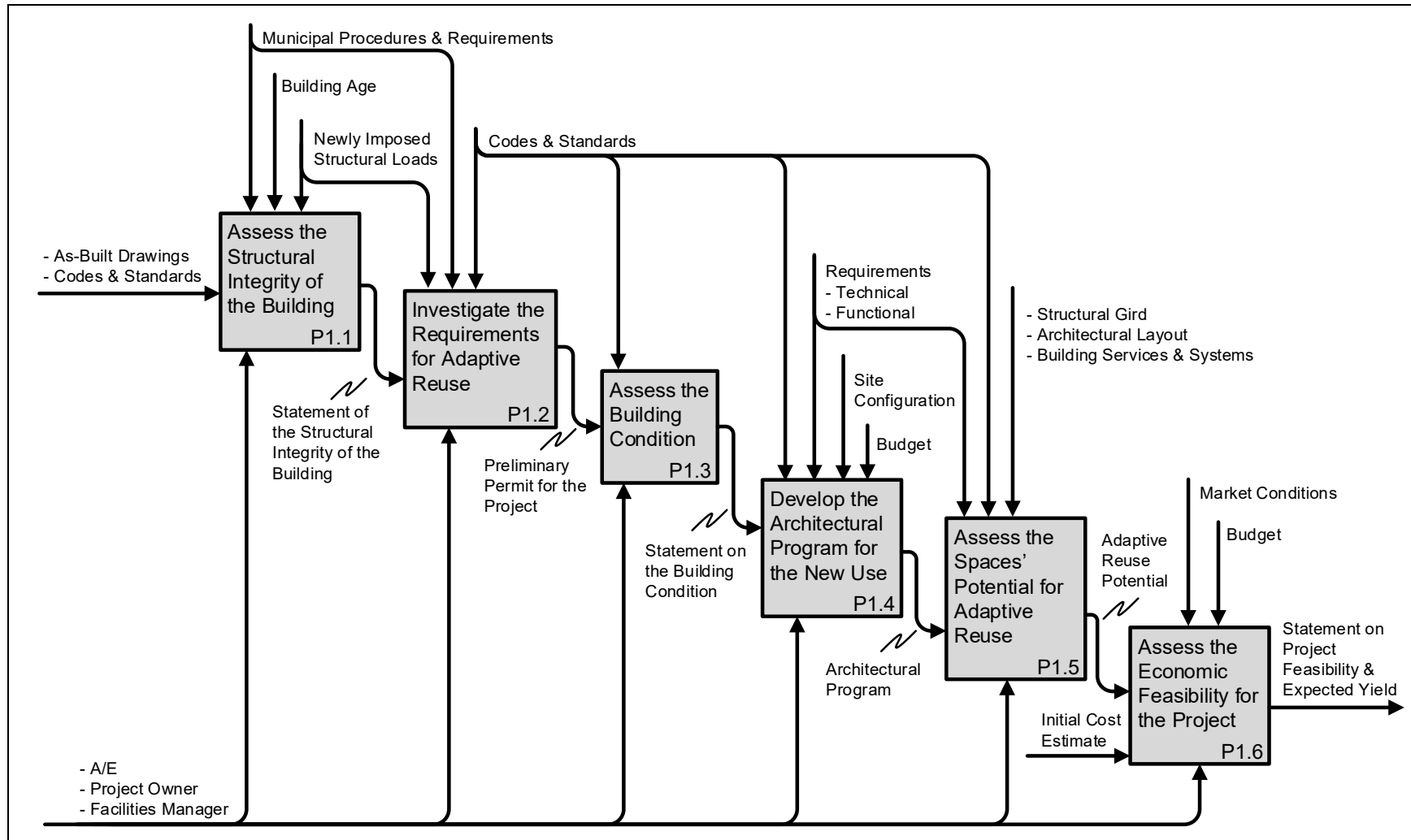


Figure 6.2: Node P1 'assess the feasibility of the adaptive reuse project'

6.2.1.1 Assess the Structural Integrity of the Building (P.1.1)

The “assess the structural integrity of the building” is the first function in this process. It serves the project parties to identify whether the building is structurally stable or not. In this context, A/E and owner should keep in mind the service life of the building structure, during the assessment of the adaptive reuse viability (Bullen and Love, 2010; Wilkinson, 2011). This implies that the capacity of the building structure, in term of its potential to accommodate loads of the new use, should be assessed (Bullen and Love, 2011a; Conejos et al., 2011). Overall condition as well as the age of the building structure should be considered in this regard (Wilkinson and Reed, 2011; Wilkinson et al., 2014). Accordingly, physical investigation of the building is important and highly recommended in this phase (Thuvander et al., 2012). Through considering all of these aspects in an integrated manner, the question of whether the building structural is stable for the new use or not would be answered, accordingly (Bullen, 2007).

6.2.1.2 Investigate the Requirements for Adaptive Reuse (P.1.2)

The “investigate the requirements for adaptive reuse” is the second function in the “assess the feasibility of the adaptive reuse project” process. It serves the parties to ascertain whether the adaptive reuse project can be implemented, in compliance with the regulatory requirements or not. In this regard, parties of building adaptive reuse should carry out a careful review of the requirements and regulations for the implementing this kind of projects (Conejos, 2013a; Muldoon-Smith and Greenhalgh, 2016; Olivadesse et al., 2017). This entails the consideration of all

regulations, requirements, planning guidelines, and procedures needed to obtain the approval for implementing the adaptive reuse (Conejos et al., 2016; Yung and Chan, 2012). Moreover, this might require the review of the design standards of the new use in this context (Langston et al., 2008). Taking into consideration all of these aspects will give an indication about the legitimacy of the adaptive reuse project (Douglas, 2006; Mehr and Wilkinson, 2018).

6.2.1.3 Assess the Building Condition (P.1.3)

The “assess the building condition” is the third function in the first process of the framework “assess the feasibility of the adaptive reuse project”. It serves the project parties to ascertain whether the existing condition of the building is in overall technically feasible or not. In this regard, physical and technical conditions of the facility should be assessed, within the context of the evaluation of project feasibility and building adaptability (Rockow et al., 2019; Wilkinson, 2011). This entails the consideration of all physical and technical attributes of all systems in the building (Douglas, 2006; Mehr and Wilkinson, 2018; Shehada et al., 2015). Further, the physical condition of the external fabric is an extremely important dimension, and thus, it should be taken into consideration as well (Langston et al., 2008; Wilkinson, 2012a). Considering all of these physical aspects, in an integrated context, will support the judgement on whether the building can be functionally reused or not (Bullen and Love, 2011a).

6.2.1.4 Develop the Architectural Program for the New Use (P.1.4)

The “develop the architectural program for the new use” is the fourth function in the first process of the developed framework. It serves the parties do identify and document the project goal and users requirements of the adaptive reuse project (Kurul, 2007; Yaldiz and Asatekin, 2013). In this regard, A/E need to collect and analyze all information and data regarding the objective of the project and its requirements, namely: type of users, end-user’ activities, and amount and number of spaces required (Hassanain and Juaim, 2013). Further, A/E should keep in mind the physical characteristics of the building, as well as the financial constraints of the project. Accordingly, implementation of continuous negotiations with the client is highly recommended in this context (Kurul, 2007). This is due to the fact that keeping in mind all of these aspects will help on providing an insight on the building adaptability and its feasibility, from the functional perspective (Douglas, 2006; Eyüce and Eyüce, 2010).

6.2.1.5 Assess the Spaces’ Potential for Adaptive Reuse (P.1.5)

The “assess the spaces’ potential for adaptive reuse” is the fifth function in the first process of the developed framework. It serves the project parties to verify whether the building has the potential to meet the identified space requirements and users’ needs of the or not. In this regard, A/E should assess the potential of the building to meet the identified project requirements through the architectural programming (Eyüce and Eyüce, 2010). This requires the consideration of different physical attributes of the building (Douglas, 2006), including: size of spaces, building form,

technical grid (module), rooms' organization, and distribution of the building systems (Arge, 2005; Manewa et al., 2016). Further, looking into all physical attributes of the building against the project requirements and goal will facilitate answering the question of whether it is adaptable or not (Shehada et al., 2015)

6.2.1.6 Assess the Economic Feasibility for the Project (P.1.6)

The “assess the economic feasibility for the project” is the sixth function in the first process of the developed framework. It serves the parties to evaluate the economic effectiveness of the project. In this regard, project stakeholders need to study the feasibility of their investment on reusing a building from the economic dimension (Bullen and Love, 2011a). Within this context, many aspects need to be considered and assessed, including of the regional trend of supply and demand (Shen and Langston, 2010; Watson, 2009; Wilkinson, 2012a). There are also other aspects that need to be considered and assessed within the scale of the project, namely: value of assets in the building, cost of adaptation, operation and maintenance costs, and profitability of the adaptive reuse (Douglas, 2006). Taking into account all of these aspects in the assessment of the adaptive reuse feasibility, in an integrated view, will facilitate the ascertainment of the economic viability of the project.

6.2.2 Design the Adaptive Reuse Project

The “design the adaptive reuse project” process (node “P2” which is elaborated in **Figure 6.3**) involves the required tasks that are in regard to the design development of the adaptive reuse projects, including:

- Assessment of the capacity and layout of existing systems and components.
- Proposition of design alternatives.
- Evaluation of the proposed alternatives.
- Development of detailed design and specifications of the project.
- Follow-up of the obtainment of the municipal permits to implement the project.

This process requires the assessment of the size of all existing systems, and their potential to meet the new demands. This assessment should be conducted before developing any design options. Thereafter, the A/E team would be able to suggest the design options accordingly, with the respect of the outputs of first process (node “P1”). The selection of the most effective option, and the finalization of the project documents are carried out in this process, in which they require collaborative efforts among the A/E team, owner and municipality. In this regard, the main inputs of this process include the technical requirements, statement of the project feasibility, architectural program, and as-built drawings. These inputs would facilitate the development of effective design outputs that satisfy the economic, social, environmental, legislative, functional and technical requirements of the project. Outputs of this process are controlled by the, layout of the floor plan, construction and MEP systems, code requirements of the new occupancy, site configuration, spatial requirements of the municipality, structural grid, and sustainability measures. Outputs of this process include report on the serviceability of the existing

systems, detailed design and specification of the selected design option, and municipal permits and building license.

This process consists of five sequential functions, namely: (1) assess the capacity and layout of existing systems and components, (2) propose design alternatives, (3) evaluate proposed alternatives, (4) develop detailed design and specifications, and (5) follow-up to obtain the municipal permits.

6.2.2.1 Assess the Capacity and Layout of Existing Systems and Components (P.2.1)

The “assess the capacity and layout of existing systems and components” is the first function in the second process of the developed framework “design for the adaptive reuse”. It serves the design team to explore which of the building systems and components can meet the performance criteria and requirements of the new use. In this regard, condition of all building systems and components, and their potential to serves the new occupancy, should be considered during the design of adaptive reuse projects (Remøy and Voordt, 2014). Designer of adaptive reuse project should keep in mind the impact of the architectural reconfiguration on the building performance, of the new use (Yaldiz and Asatekin, 2013). Considering all of these aspects, simultaneously, will improve the quality of the design outputs for the new use (Eray et al., 2019).

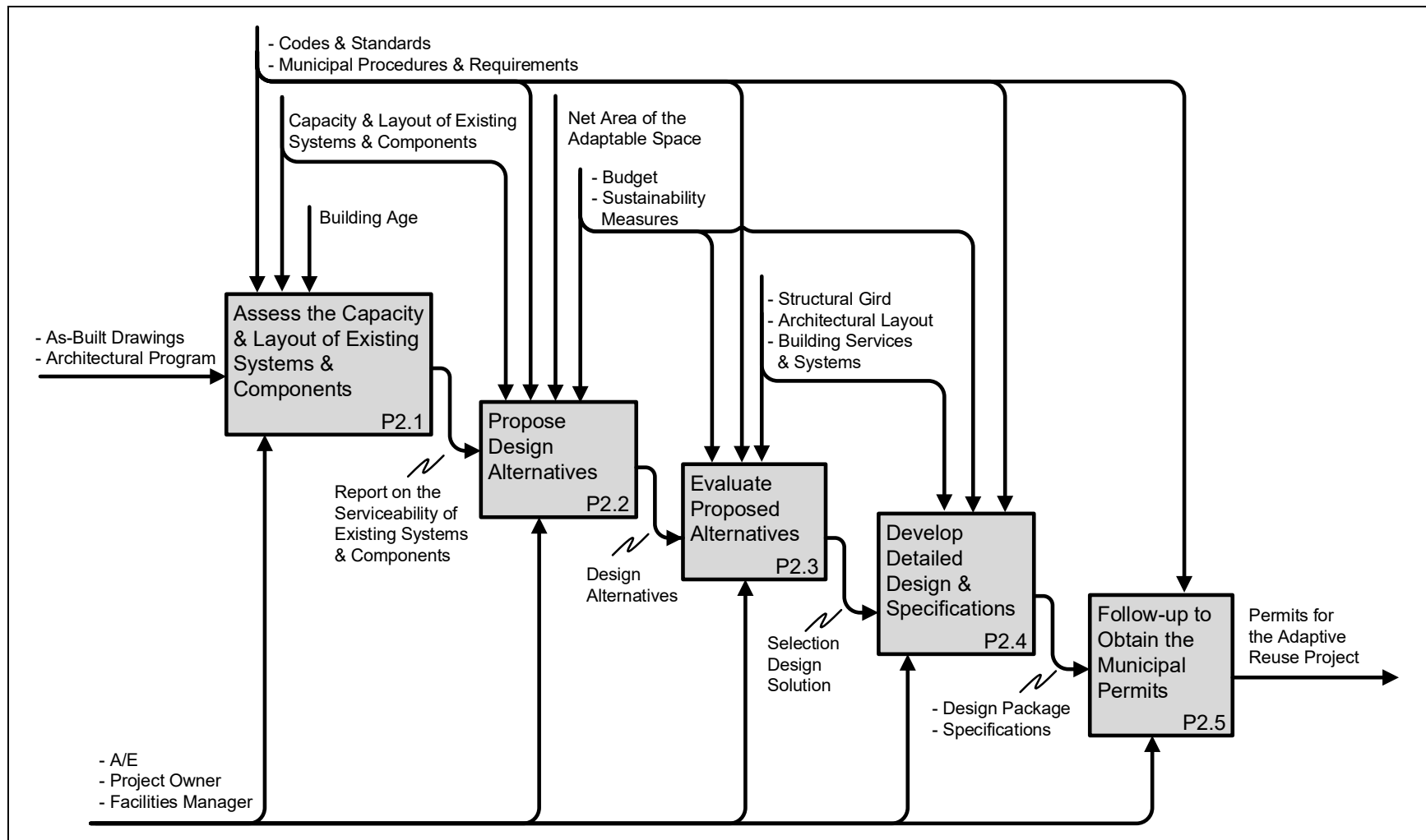


Figure 6.3: Node P2 'design the adaptive reuse project'

6.2.2.2 Propose Design Alternatives (P.2.2)

The “propose design alternatives” is the second function in the second process of the developed framework. It serves the designers and client in adaptive reuse project to have multiple design options and solutions for the new use. In this regard, it is highly recommended that architects of these projects would prepare a set of design alternatives, in line with the new architectural program (Yaldiz and Asatekin, 2013). In this function, different aspects should be crucially considered, including: code and regulatory requirements, sustainable design principles, energy efficiency measures, and serviceability and maintainability of the new design (Eray et al., 2019). Furthermore, financial and physical limitations should be kept in mind during the proposition of the design solutions in adaptive reuse projects (Kurul, 2007; Remøy and Voordt, 2007). Hence, this will lead to the determination of a set of possible design solutions.

6.2.2.3 Evaluate Proposed Alternatives (P.2.3)

The “evaluate proposed alternatives” is the third function in the second process of the framework. It serves the designer as well as the client to come up with the effective design option and solutions for the new project. In this function, the A/E team and the client would evaluate the proposed design alternatives, to select the most effective one for the adaptive reuse. These alternatives are evaluated against the environmental, functional, economic, technical and legal requirements of the new use (Remøy and Voordt, 2007; Sanchez and Ralph, 2018; Yaldiz and Asatekin, 2013). Further, the impact of physical changes and space reconfiguration on the new

use should be considered as well (Eyüce and Eyüce, 2010). Continuous negotiations with the client are important as well in this function (Kurul, 2007). Looking into all these aspects, simultaneously, is important, due to their vital role in the selection of the effective alternative.

6.2.2.4 Develop Detailed Design and Specifications (P.2.4)

The “develop detailed design and specifications” is the fourth function of the second process of the framework. It serves parties of adaptive reuse projects to have a completed engineering design for the selected option. In this regard, it is highly recommended that the final design of these projects is developed in accordance with selected design solutions and client needs (Kurul, 2007). The engineering design of all building systems should be developed, reviewed and revised against any form of conflicts and errors. In this context, the A/E team should keep in mind all physical restrictions present in the original layout of the building (Eray et al., 2019). Furthermore, requirements of codes, standards and regulations of the new occupancy should be kept in mind in this function (Douglas, 2006). Outputs of this function will be the finalized project design (Yaldiz and Asatekin, 2013).

6.2.2.5 Follow-up to Obtain the Municipal Permits (P.2.5)

The “follow-up to obtain the municipal permits” is the last function in the second process of the developed framework. It serves the project parties to get the legal approval on the developed project design, as well as obtaining the building license. In this function, project parties should review and follow the procedure of processing the application of obtaining the permission for implementing the change of use

(Kincaid, 2002; Wilkinson, 2012a). Information required in this function include the building plans, land details, code requirements and requirements of other regulatory entities (if any) (Olivadese et al., 2017). Submitting all required information to the municipality according to applicable instructions will facilitate the obtainment of the legal permits and building license, accordingly (Douglas, 2006).

6.2.3 Construct the Adaptive Reuse Project

The “construct the adaptive reuse project” process (node “P3” which is elaborated in **Figure 6.4**) involves all required tasks that are in regard to the execution of the adaptive reuse project, including:

- Procurement of construction services.
- Preparation of the site for the conversion process.
- Planning and scheduling of the project activities.
- Removal of unnecessary systems and components.
- Construction and installation of the new systems and components.
- Delivery of the project to the client.

This process entails the implementation of managerial and technical efforts, across the pre-construction, construction and post-construction milestones of the adaptive reuse project. In this context, effective collaboration among the project parties is essential in this process. The main inputs of this process include project design and specifications, adaptive reuse permits, and building license. Outputs of this process are controlled by the procurement method, project resources, code requirements, municipal requirements, site configuration,

project schedule, and construction methods. Outputs of this process include adaptively reused facility, as-built drawings, and assets record.

This process consists of six sequential functions, namely: (1) procure the service of a contractor, (2) prepare the site for the project, (3) plan and schedule the project activities, (4) remove unnecessary systems and components, (5) construct and install the new systems and components, and (6) deliver the project to the client.

6.2.3.1 Procure the Service of a Contractor (P.3.1)

The “procure the service of a contractor” is the first function in the third process of the developed framework “construct the adaptive reuse project”. It serves the client to officially bid and sign the contract of the construction services with the selected contractor, to implement the adaptive reuse. The procurement option, and its methodological procedure and requirements, must be determined and followed (Ruan et al., 2012). This function entails a careful consideration of different aspects, including: procurement system used, characteristics of adaptation activities, contract forms, site configuration, time of construction, and capacity reputation, workforce skills of the tenderer (Douglas, 2006). Further, budgetary constraints of the project should be considered across the contractual activities in this kind projects (Eray et al., 2019). Taking into account all these aspects would facilitate the selection of the specialist contractor and sub-contractor, and thus, procurement of the adaptation activities and formulation of the contract document (Kincaid, 2002). Contract documents includes agreement, conditions, drawings plans and specifications (Nunnally, 2014).

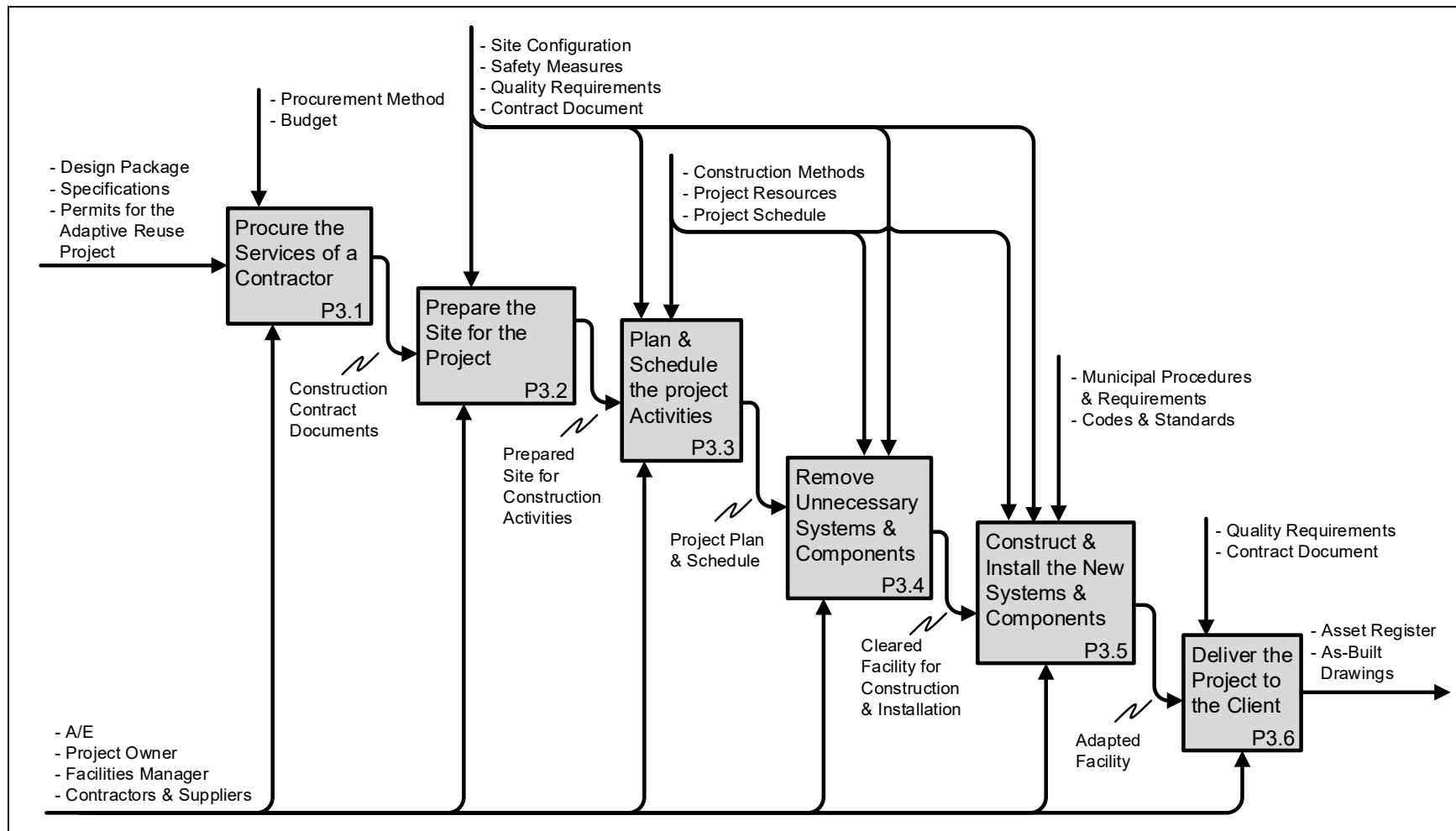


Figure 6.4: Node P3 ‘construct the adaptive reuse project’

6.2.3.2 Prepare the Site for the Project (P.3.2)

The “prepare the site for the project” is the second function of the third process of the developed framework. It serves the contractor and subcontractor to initialize the project site, before implementing the renovation and construction works of the adaptive reuse. In this regard, parties need to make sure that the project site is well prepared for all renovation and construction works required for the change of use (Kincaid, 2002). Site access, loading space and material storage should be considered and adequately provided (Hein and Houck, 2008). Further, project safety measures as well as other applicable municipal requirements should be considered and fulfilled. Compliance with these requirements will maintain the preparedness of project site for all adaptation activities (Douglas, 2006).

6.2.3.3 Plan and Schedule the Project Activities (P.3.3)

The “plan and schedule the project activities” is the third function in the third process of the developed framework. It serves the project parties to have a timeline for all adaption activities. In this regard, contractors of adaptive reuse projects need to develop a project schedule which comprise the time and resources needed for each activity. This entails a careful consideration of the project budget, time limitations, number and skills of workers, and list of the project activities (Douglas, 2006). Further, standards, quality requirements, and performance criteria of the new systems and materials should be considered in this context (Fournier and Zimnicki, 2004). Construction methods used in the adaptation activities are also among the constraints that need to be kept in mind during the planning of the these projects

(Hein and Houck, 2008). Consequently, output of this function will be a completed time schedule of all activities required for the project execution (Nunnally, 2014).

6.2.3.4 Remove Unnecessary Systems and Components (P.3.4)

The “remove unnecessary systems and components” is the fourth function in the third process of the developed framework. It serves the contractor to take off the redundant, obsolete and superfluous elements from the building. Thus, this function will facilitate the construction of new elements as well as installing the new systems, later on. In this regard, contractor needs to remove all systems and components that are going to be replaced or terminated, before starting the implementation of the renovation of construction works (Hassanien and Losekoot, 2002). Appropriate level of safety should be enforced during the implementation of this kind of field work (Danso et al., 2015; Egbu et al., 2002). Quality requirements, time schedule, and project specifications and drawings should be followed in this function (Douglas, 2006). In this context, provision of site accessibility, as well as preservation the reusable assets are other aspects that should be also adequately fulfilled (Hein and Houck, 2008). Effective accomplishment of these tasks will provide a prepared workplace for the other construction and installation activities.

6.2.3.5 Construct and Install the New Systems and Components (P.3.5)

The “construct and install the new systems and components” is the fifth function in the third process of the framework. It serves the project parties to secure a systematic implementation of the construction and installation activities that required for all new systems and components. In this regard, contractor would be responsible to

manage and monitor all these activities, including: material delivery, sub-contractor tasks and installation of the new elements (Eray et al., 2019). Contractors of building adaptive reuse should implement these activities in compliance with several determinants, including: project schedule, safety and security measures, contract document and quality requirements (Douglas, 2006). In this context, accessibility of the project site should be adequately provided for workers and construction equipment (Hein and Houck, 2008). Fulfillment of all these aspects will contribute to the fulfillment of the sustainability and desired quality of the adaptive reuse construction, accordingly (Fournier and Zimnicki, 2004).

6.2.3.6 Deliver the Project to the Client (P.3.6)

The “deliver the project to the client” is the sixth and last function in the third process of the developed framework. It serves the stakeholders to end up with a successful completion and handover of the adaptive reuse project. In this regard, contractors need to initially operate the building, to test the operation of all building systems and components against the performance criteria and quality requirements (Douglas, 2006). Record of all building assets should be developed and submitted to the owner, in this context (Cooper et al., 1998), in addition to the as-built drawings and specifications. Operation manuals and catalogs of all systems should be submitted to the owner as well (Fournier and Zimnicki, 2004). Effective implementation of these activities will ensure that the adaptive reuse project has been successfully delivered to the owner, with all required deliverables (Eray et al., 2019).

6.2.4 Operate and Maintain the Adaptive Reuse Project

The “operate and maintain the adaptive reuse project” process (node “P4” which is elaborated in **Figure 6.5**) involves all required tasks that are in regard to the operation, maintenance and management of the adaptively reused building, including:

- Procurement of the service of a facilities manager.
- Implementation of commissioning process for the systems and components.
- Development of an operation and maintenance plan for the project.
- Monitoring and recording space utilization throughout the building.
- Assessment of the building performance and user satisfaction.

This process requires an integrated coordination among the roles of the project parties, to maintain an efficient facility operation and safe built-environment for the new occupancy.

The main inputs of this process include adaptively reused facility, as-built drawings, and assets record. Outputs of this process are controlled by requirements of codes and standards, and O&M manuals. Outputs of this process include report about the MEP commissioning, planned schedules for all O&M activities, inventory of the space utilization, and report on the performance and user satisfaction in the building.

This process consists of five sequential functions, namely: (1) procure the service of a facilities manager, (2) conduct commissioning process for the systems and components, (3) develop an O&M plan for the project, (4) monitor and record space utilization, and (5) assess building performance and user satisfaction.

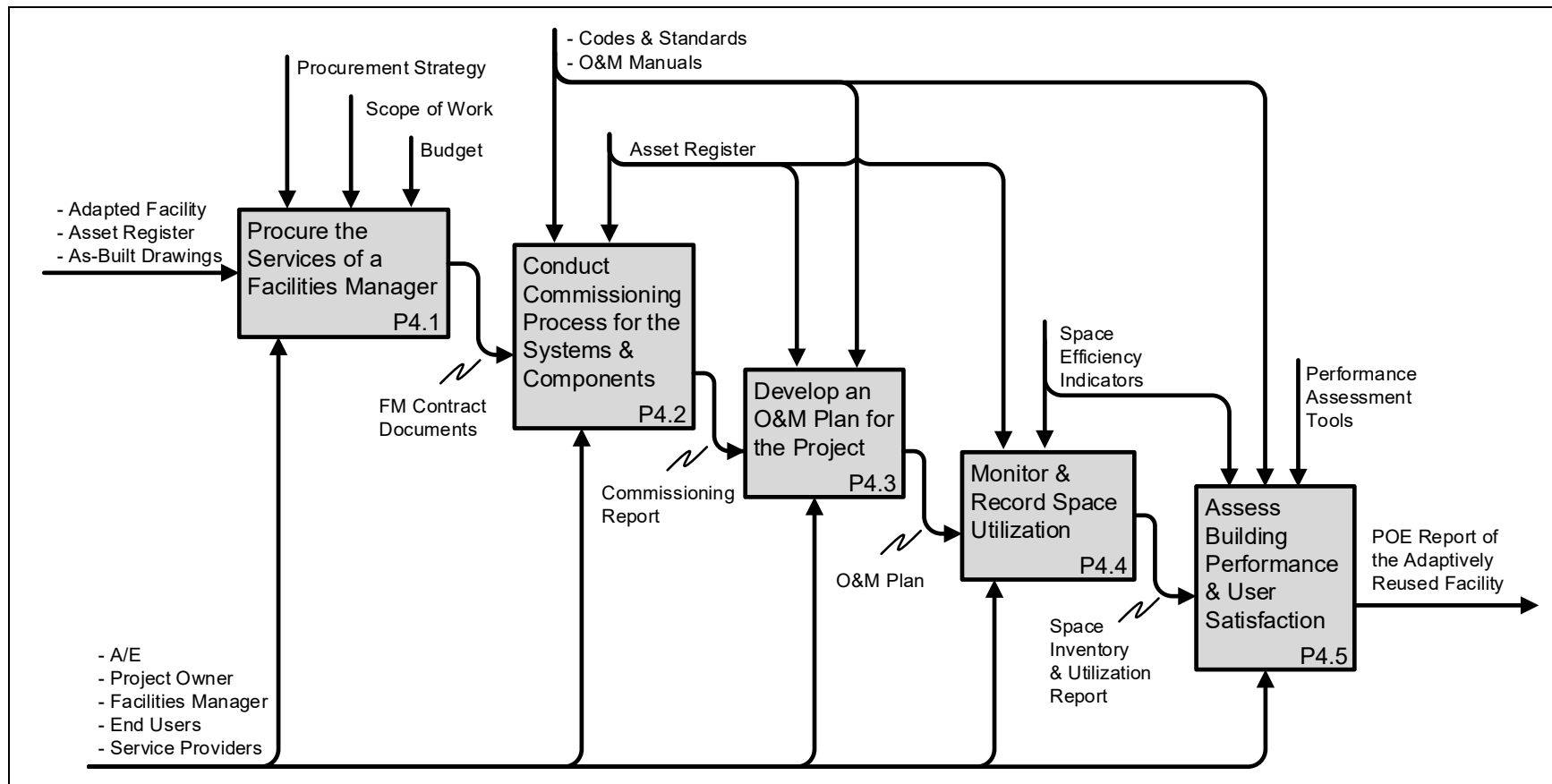


Figure 6.5: Node P4 'operate and maintain the adaptive reuse project'

6.2.4.1 Procure the Service of a Facilities Manager (P.4.1)

The “procure the service of a facilities manager” is the first function in the fourth and last process of the developed framework “operate and maintain the adaptive reuse project”. It serves both parties, owner and the end user, to come up with a procured facilities management service for operating the adaptively reused building. Procurement of the FM service needs to be carried out from the first day, after the delivery of the adaptive reuse project, to assign a specialist personnel at managing the operational activities (Douglas, 2006; Wilkinson et al., 2014). In this regard, parties should determine the followed procurement method , services that are going to be procured (scope of work), and mode and criteria of the selection (Ancarani and Capaldo, 2005; Wordsworth, 2001). In this function, as-built drawings and operation manuals should be adequately provided (Chanter and Swallow, 2007). Records and requirements of assets management should be included in this context (Ikediashi et al., 2012, 2013). A comprehensive consideration of these aspects will prompt to a successful procurement of the FM services.

6.2.4.2 Conduct Commissioning Process for the Systems and Components (P.4.2)

The “conduct commissioning process for the systems and components” is the second process of the fourth function of the developed framework. It serves the owner and facilities manager to test the performance of all systems, as well train the FM personnel on the way of operating the adaptively reused building. In fact, conducting commissioning process on these buildings will enable their FM personnel ascertain that the converted facility and its systems are manageable and ready for the day-to-

day operational activities (Douglas, 2006). In this function, FM team must take into consideration several determinants, including: performance criteria, operation instructions, and building assets (Fournier and Zimnicki, 2004). Further, compliance with the health, safety and quality requirements should be tested within the context of commissioning process (Haasl and Sharp, 1999). Effective implementation of commissioning process will enable the FM personnel to be familiar with the building and its systems, and thus, efficient O&M would be fulfilled, accordingly (Wilkinson et al., 2014).

6.2.4.3 Develop an O&M Plan for the Project (P.4.3)

The “develop an O&M plan for the project” function is the third function in the fourth process of the developed framework. It serves the owner, FM personnel, and end-users to ascertain that the adaptively reused building is operated and maintained according to a planned O&M. Facilities managers of these buildings should schedule, monitor and manage a comprehensive O&M plan, comprising all systems and components in the facility (Douglas, 2006). It is essential to keep in mind that the implementation of proper maintenance in these buildings has the potential to achieve the desired outcomes from the change of use (Günçe and Misirlisoy, 2019). In this regard, the developed O&M plan should aim at sustaining the functionality, sustainability, performance, and occupational health and safety (OH&S) throughout the spaces of the adaptively reused facility (Fournier and Zimnicki, 2004). This plan should be developed based on the building information, including as-built drawings, assets records, and O&M manuals of all systems and components. Further, it should be developed based on the performance requirements as well as the actual condition

of all systems and components in the building (Chanter and Swallow, 2007; Hassanain et al., 2003). Through satisfying all these aspects, a well-planned work schedules for all O&M activities will be secured, accordingly.

6.2.4.4 Monitor and Record Space Utilization (P.4.4)

The “monitor and record space utilization” is the fourth function in the fourth process of the developed framework. It serves the owner, end-user and facilities manager to ensure the availability of updated records on the utilization and efficiency of spaces in the adaptively reused buildings. In this regards, facilities managers should conduct continuous inventory and analysis of the functionality, efficiency and adequacy of the spaces of these buildings, during the occupancy phase (Brown and Cresciani, 2017). This is due to the fact that it is essential to make sure that spaces these buildings are allocated in a manner that satisfy the new functional requirements and activities, throughout their life-span. In this context, space allocation should be managed effectively in these buildings (Douglas, 2006; Günçe and Misirlisoy, 2019; Hamida and Hassanain, 2020). This entails a careful consideration of the integration among the spatial, environmental, economic, social, legislative, occupational and functional aspects in the building spaces (Muir, 2011). Consequently, output of this function will be basically a detailed report on the inventory and analysis of the space utilization in the adaptively reused building.

6.2.4.5 Assess Building Performance and User Satisfaction (P.4.5)

The “assess building performance and user satisfaction” is the fifth and last function in the last process of the developed framework. It serves parties of adaptive reuse project to gain an insight on the overall performance, condition and user satisfaction in the building, after the implementation of the change of use. Performance requirements, and their assessment tools should be considered in this regard. POE is among the effective methods for the project parties to gain an insight on the impact of design judgments on the building performance (Loftness et al., 2009). It is a valuable tool also that can be used for assessing the building performance and user satisfaction in the adaptively reused facilities (Douglas, 2006; Hamida and Hassanain, 2020). Many technical aspects should be considered within this context, including: performance of building systems, environmental indoor quality (IEQ), health and safety measures (Al-obaidi et al., 2017). It is also important to consider other functional aspects, including: efficiency of space utilization, workflow of activities, quality of assets and services (Hamida and Hassanain, 2020). All of these aspects should be assessed against the recommended performance criteria in the applicable codes and standards (Preiser et al., 1988). Implementing comprehensive assessment of the performance and user satisfaction in the adaptively reused buildings, comprising the mentioned considerations, will provide a clear feedback about the environmental, functional and technical qualities of the facility, after the conversion.

6.3 Summary and Discussion

This chapter covered a description and schematic illustration of the developed framework for the effective implementation of adaptive reuse projects, throughout their life-cycle. The framework was developed according to the knowledge obtained from the reviewed literature, investigated local practice and findings of the factors' assessment. The prime aim of the developed framework is to integrate all managerial and technical activities that are implemented throughout the life-cycle of these projects. IDEF₀ methodology was employed for the schematic representation of the framework, to illustrate the interaction among the inputs, controls, mechanism and outputs of all processes and functions. It facilitated the documentation and presentation of the knowledge obtained in a schematically integrated context.

The proposed framework consists of four main processes, namely: “assess the feasibility of the adaptive reuse project”, “design the adaptive reuse project”, “construct the adaptive reuse project”, and “operate and maintain the adaptive reuse project”. Inputs, controls, mechanisms and outputs of these processes were identified and presented (See **Figure 6.1**).

The first process “assess the feasibility of the adaptive reuse project” consists of six sequential functions, namely: (1) assess the structural integrity of the building, (2) investigate the requirements for adaptive reuse, (3) assess the building condition, (4) develop the architectural program for the new use, (5) assess the spaces' potential for adaptive reuse, and (6) assess the economic feasibility for the project. Inputs, controls, mechanisms and outputs of these functions were identified and presented (See **Figure 6.2**).

The second process “design for the adaptive reuse project” consists of five sequential functions, namely: (1) assess the capacity and layout of existing systems and components, (2) propose design alternatives, (3) evaluate proposed alternatives, (4) develop detailed design and specifications, and (5) follow-up to obtain the municipal permits. Inputs, controls, mechanisms and outputs of these functions were identified and presented (See **Figure 6.3**).

The third process “construct the adaptive reuse project” consists of six sequential functions, namely: (1) procure the service of a contractor, (2) prepare the site for the project, (3) plan and schedule the project activities, (4) remove unnecessary systems and components, (5) construct and install the new systems and components, and (6) deliver the project to the client. Inputs, controls, mechanisms and outputs of these functions were identified and presented (See **Figure 6.4**).

The fourth process “operate and maintain the adaptive reuse project” consists of five functions, namely: (1) procure the service of a facilities manager, (2) conduct commissioning process for the systems and components, (3) develop an O&M plan for the project, (4) monitor and record space utilization, and (5) assess building performance and user satisfaction. Inputs, controls, mechanisms and outputs of these functions were identified and presented (See **Figure 6.5**).

In summary, the developed framework provided the following advantages:

1. Demonstration of the processes followed across the life-cycle of the adaptive reuse project, comprising their inputs, controls, mechanisms and outputs.
2. Elaboration of the functions broken-down within these processes, comprising their inputs, controls, mechanisms and outputs.
3. The framework was developed in generic context, so it can be followed in any type of adaptive reuse project.

CHAPTER 7:

VALIDATION OF THE DEVELOPED FRAMEWORK FOR THE EFFECTIVE IMPLEMENTATION OF BUILDING ADAPTIVE REUSE THROUGHOUT THE PROJECT LIFE-CYCLE

7.1 Overview

This chapter covers a discussion of the findings of the performed validation on the developed life-cycle framework for effective implementation of adaptive reuse projects. The validation was performed through conducting a 5-point Likert scale questionnaire survey on 30 AEC/FM practitioners of these projects in the Eastern Province of Saudi Arabia. Respondents of the questionnaire survey included 10 A/Es, 10 contractors and 10 facilities managers. The questionnaire survey aimed to assess the importance rates of all framework functions, beside their implementation frequencies in the industry (see **Appendix F**). Accordingly, respondents were asked to rate the importance of each function, and the frequency of implementing it, according to their professional practice. First, the chapter covers a section for the demographic information pertaining to respondents' profile. Second, the chapter discusses findings of the performed assessment on importance rates and implementation frequencies of the framework functions. Finally, the chapter concludes with a summary and discussion of the key findings.

7.2 Respondents' Demographic Information

This section covers the demographic information pertaining to the respondents involved in the validation questionnaire survey. In the validation questionnaire survey, respondents were asked to indicate their name, address, organization address, scope of work, years of experience, number of adaptive reuse projects in which they were involved in, and types of projects where they were familiar with. Refer to **Appendix G** for more information about name, address and organization address of the respondents.

7.2.1 Spatial Distribution of Respondents

Respondents of the validation questionnaire surveys ($n = 30$) were spatially distributed across the scoped region for the study, Eastern Province of Saudi Arabia. Most of respondents were from the largest coastal cities of DMA, namely: Dammam and Khobar (**Figure 7.1**). This distribution contributed to capture the knowledge and point of views of different practitioners within the study region.

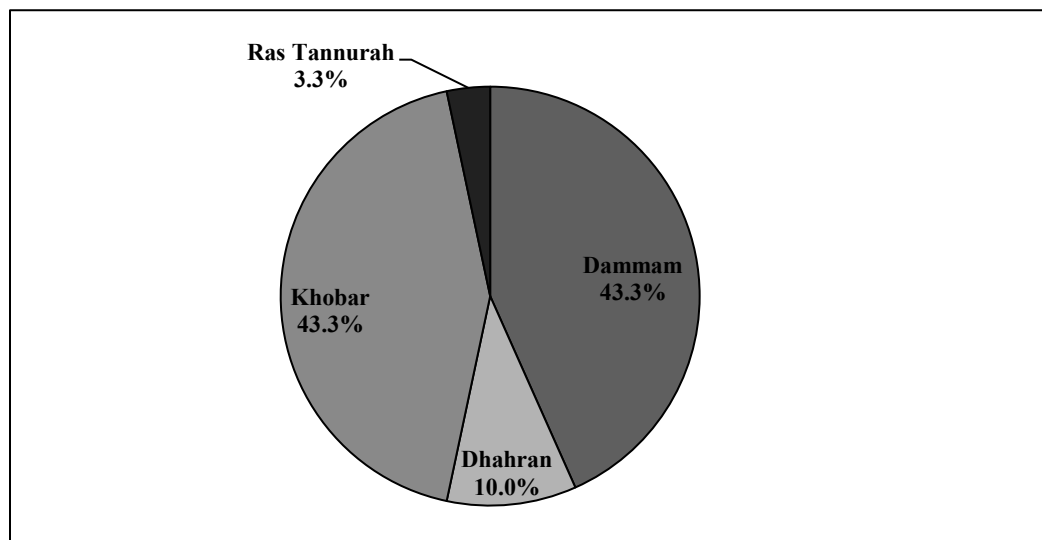


Figure 7.1: Spatial distribution of the respondents involved in the validation questionnaire survey

As shown in **Figure 7.1**, the spatial distribution of the was as follows: Dammam, 43.3% (*frequency* = 13); Khobar, 43.3% (*frequency* = 13); Dhahran, 10% (*frequency* = 3), and Ras Tanura, 3.3% (*frequency* = 1).

7.2.2 Respondents' Scope of Work

Respondents of the validation questionnaire surveys were varying in term of their scope of work, within the context of AEC/FM professions. **Figure 7.2** illustrates the scope of work of the involved practitioners ($n = 30$) in the validation questionnaire survey.

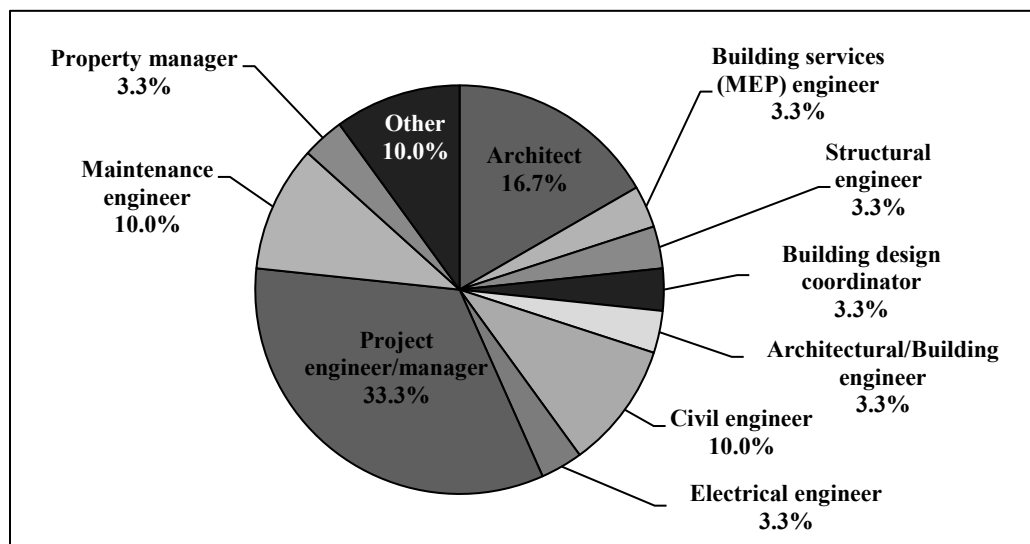


Figure 7.2: Scope of work of the involved practitioners in the validation questionnaire survey

As shown in **Figure 7.2**, most of respondents were project engineers/managers, accounting for 33.3% (*frequency* = 10) of the total number of respondents. The scope of work of other respondents was as follows: architects, 16.7% (*frequency* = 5); civil engineers, 10% (*frequency* = 3); maintenance engineers, 10% (*frequency* = 3); building services (MEP) engineer, 3.3% (*frequency* = 1); structural engineer, 3.3% (*frequency* = 1); building design coordinator, 3.3% (*frequency* = 1);

architectural/building engineer, 3.3% (*frequency* = 1); electrical engineer, 3.3% (*frequency* = 1); property manager, 3.3% (*frequency* = 1) and other fields of work, 10% (*frequency* = 3). The scope of work of the respondents who selected “other” was as follows: CEO of construction company, 3.3% (*frequency* = 1); FM director, 3.3% (*frequency* = 1); and planning engineer 3.3% (*frequency* = 1).

7.2.3 Respondents’ Years of Experience

Respondents of the validation questionnaire survey were varying in term of their years’ experience. **Figure 7.3** illustrates the ranges of years of experience of the practitioners (*n* = 30) involved in the validation questionnaire survey. As shown in **Figure 7.3**, ranges of years of experience of the practitioners involved in the validation questionnaire survey were as follows: less than 5 years, 16.67% (*frequency* = 5); 5 to 10 years, 30% (*frequency* = 9); 10 to 20 years, 26.67% (*frequency* = 8); and over 20 years, 26.67% (*frequency* = 8).

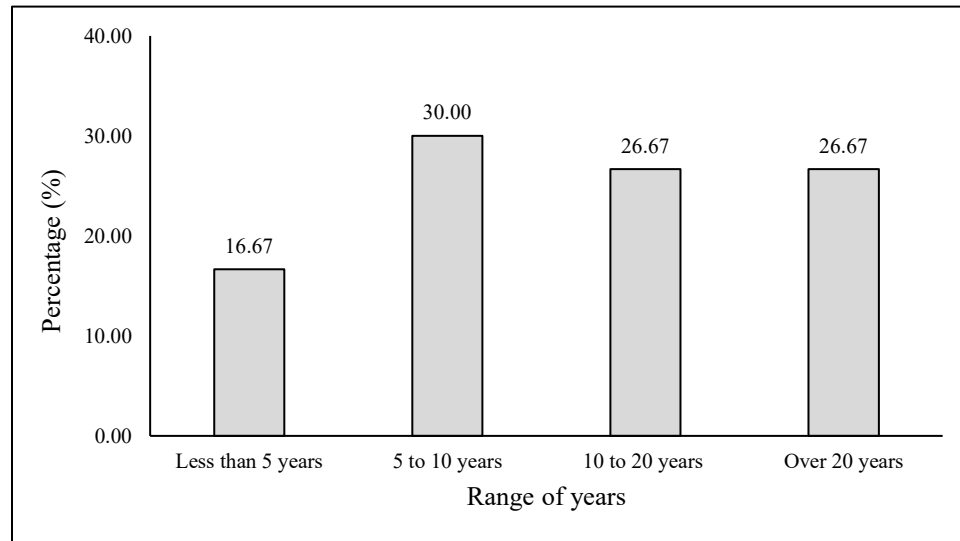


Figure 7.3: Ranges of years of experience of the practitioners involved in the validation questionnaire survey

7.2.4 Number of Adaptive Reuse Projects in which Respondents were Involved in

Respondents of the validation questionnaire survey were varying in term of their experience in adaptive reuse projects. Thus, this subsection presents data regarding number of adaptive reuse projects in which respondents of the validation questionnaire survey were involved in. **Figure 7.4** illustrates the ranges of number of adaptive reuse projects in which respondents ($n = 30$) of the validation questionnaire survey were involved in. As shown in **Figure 7.4**, the follows are the ranges of number of adaptive reuse projects where respondents of the validation questionnaire survey were involved: 1 to 5 projects, 66.67% (*frequency* = 20); 5 to 10 projects, 20% (*frequency* = 6); and more than 10 projects, 13.33% (*frequency* = 4).

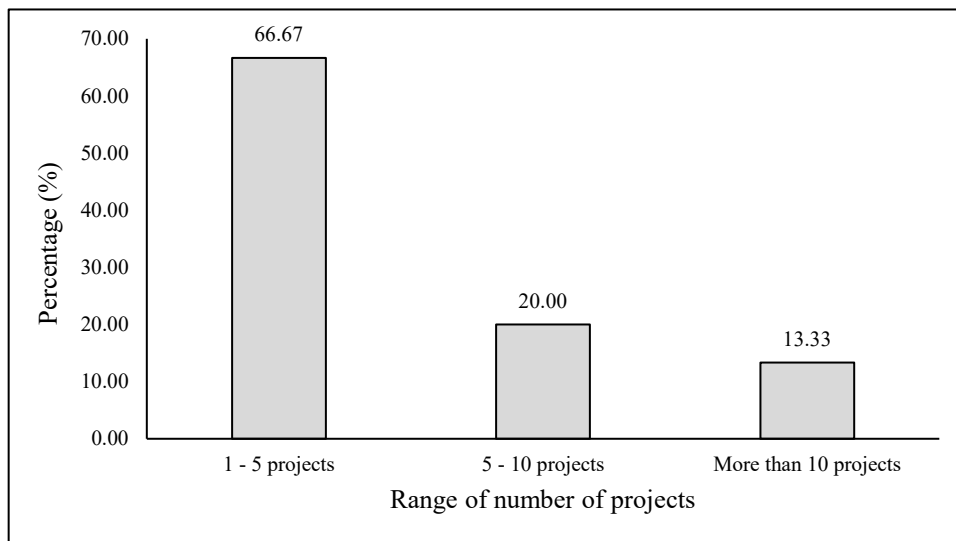


Figure 7.4: Range of number of adaptive reuse projects in which respondents of the validation questionnaire survey were involved in

7.2.5 Types of Projects in Which Respondents were Involved in

Respondents of the validation questionnaire survey were varying in term of the types of projects in which they were involved in. **Figure 7.5** illustrates the types of projects in which respondents ($n = 30$) of the validation questionnaire survey were involved in. As shown in **Figure 7.5**, the follows are percent frequencies of the types of projects in which respondents of the validation questionnaire surveys were involved in: apartment buildings, 83.33% (*frequency* = 25); shops, 83.33% (*frequency* = 25); single houses, 73.33% (*frequency* = 22); office buildings, 63.33% (*frequency* = 19); recreational buildings, 50% (*frequency* = 15); commercial centers/shopping malls, 50% (*frequency* = 15); educational buildings, 43.33% (*frequency* = 13); and others, 46.67% (*frequency* = 14). The mentioned other projects included the follows: industrial/ warehouse facilities, 23.33% (*frequency* = 7); medical facilities, 16.67% (*frequency* = 5); and mosques, 6.67% (*frequency* = 2).

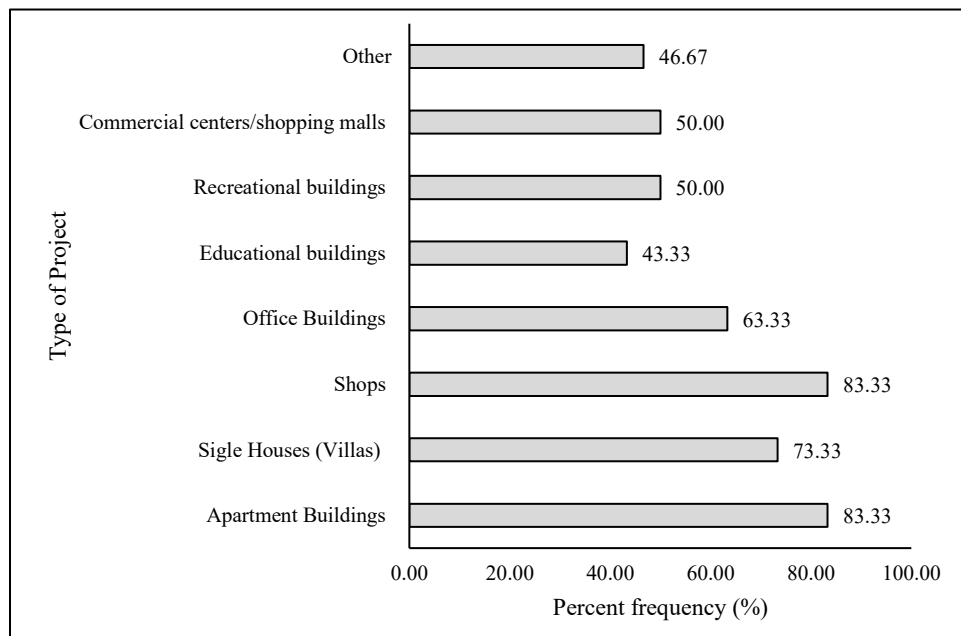


Figure 7.5: Types of projects in which respondents of the validation questionnaire survey were involved in

7.3 Assessment of the Functions involved the Life-Cycle of Adaptive Reuse Projects

This section presents and discusses the findings of the performed validation questionnaire survey on the developed framework. **Table 7.7** illustrates the overall findings of the received assessment of the importance and frequency of implementing the functions involved in the processes of the developed framework. It presents the importance mean, RII, importance rate, frequency mean, FI and rate of implementing each of the functions included in the framework. In overview, findings revealed that the rate of importance of the functions ranged between “Very Important” and “Extremely Important”. Moreover, it indicated that the frequency of implementing these functions ranged between “Sometimes” and “Always”. The obtained subjective feedbacks from the interviewed respondents indicated that the adoption of the developed framework has the potential to enhance the AEC/FM practices of adaptive reuse projects in Saudi Arabia.

7.3.1 Feasibility Studies Phase of the Adaptive Reuse Project

The results revealed that the importance rates of the functions involved in the feasibility studies phase ranged between “Very Important” and “Extremely Important”. Further, their implementation frequencies ranged between “Frequently” and “Always”.

Based on the determined RII and FI values for the functions involved in this process, it was noted that the first two functions, namely: “assess the structural integrity of the building” and “investigate the requirements for adaptive reuse”, received an importance rate of “Extremely Important”, with a frequency of “Always” in their implementation. This is due to the fact that both functions have a direct bearing on the implementation possibility of

building conversion. Findings indicated that the importance and frequency rates of the other four functions were “Very Important” and “Frequently”, respectively.

7.3.2 Design Phase of the Adaptive Reuse Project

The results revealed that the importance rates of the functions involved in the design phase ranged between “Very Important” and “Extremely Important”. Further, their implementation frequencies ranged between “Frequently” and “Always”.

Based on the determined RII and FI values of the functions involved in this process, it was noted that the first function “assess the capacity and layout of existing systems and components” received an importance rate of “Extremely Important”, with an implementation frequency of “Always”. This is due to the fact that this function provides an indication to the A/E team about the reusability and capacity of the building elements, during the design process. Similarly, the last two functions in this process, namely: “develop detailed design and specifications” and “follow-up to obtain the municipal permits”, received the equal importance and frequency rates, since both of them play a vital role in the constructability of the new project. The other two functions, namely: “propose design alternatives” and “evaluate proposed alternatives”, received an importance rate of “Very Important”, with a frequency of “Frequently” in their implementation.

Table 7.1: Overall findings of the assessment of the importance and frequency of implementing the functions involved in the processes of the developed framework

Function Code	Function	Importance									Frequency								
		Responses					n	Results & Interpretation			Responses					n	Results & Interpretation		
		Extremely Important	Very Important	Important	Somewhat Important	Not Important		Mean	RII (%)	Rate	Always	Frequently	Sometimes	Seldom	Never		Mean	FI (%)	Rate
Feasibility Studies Phase of the Adaptive Reuse Project (Process P1: Assess the Feasibility of the Adaptive Reuse Project)																			
P1.1	Assess the Structural Integrity of the Building	24	4	2	0	0	30	3.73	93.33	EI	25	4	1	0	0	30	3.80	95.00	A
P1.2	Investigate the Requirements for Adaptive Reuse	22	6	2	0	0	30	3.67	91.67	EI	25	2	3	0	0	30	3.73	93.33	A
P1.3	Assess the Building Condition	10	12	8	0	0	30	3.07	76.67	VI	14	9	7	0	0	30	3.23	80.83	F
P1.4	Develop the Architectural Program for the New Use	17	8	4	1	0	30	3.37	84.17	VI	18	5	7	0	0	30	3.37	84.17	F
P1.5	Assess the Spaces' Potential for Adaptive Reuse	17	5	6	2	0	30	3.23	80.83	VI	19	1	8	2	0	30	3.23	80.83	F
P1.6	Assess the Economic Feasibility for the Project	19	5	4	1	1	30	3.33	83.33	VI	20	3	5	1	1	30	3.33	83.33	F

Notes: EI, extremely important; VI, very important; I, important; SI, somewhat important; NI, not important; A, always; F, frequently; ST, sometimes; S, seldom; N, never

Table 7.1: Overall findings of the assessment of the importance and frequency of implementing the functions involved in the processes of the developed framework (Cont.)

Function Code	Function	Importance									Frequency								
		Responses					n	Results & Interpretation			Responses					n	Results & Interpretation		
		Extremely Important	Very Important	Important	Somewhat Important	Not Important		Mean	RII (%)	Rate	Always	Frequently	Sometimes	Seldom	Never		Mean	FI (%)	Rate
Design Phase of the Adaptive Reuse Project (Process P2: Design the Adaptive Reuse Project)																			
P2.1	Assess the Capacity and Layout of Existing Systems & Components	20	7	1	2	0	30	3.50	87.50	EI	21	8	0	1	0	30	3.63	90.83	A
P2.2	Propose Design Alternatives	10	13	7	0	0	30	3.10	77.50	VI	11	11	5	2	1	30	2.97	74.17	F
P2.3	Evaluate Proposed Alternatives	17	8	4	1	0	30	3.37	84.17	VI	16	7	5	1	1	30	3.20	80.00	F
P2.4	Develop Detailed Design and Specifications	20	8	1	1	0	30	3.57	89.17	EI	22	3	5	0	0	30	3.57	89.17	A
P2.5	Follow-up to Obtain the Municipal Permits	23	5	2	0	0	30	3.70	92.50	EI	23	4	2	0	1	30	3.60	90.00	A

Notes: EI, extremely important; VI, very important; I, important; SI, somewhat important; NI, not important; A, always; F, frequently; ST, sometimes; S, seldom; N, never

Table 7.1: Overall findings of the assessment of the importance and frequency of implementing the functions involved in the processes of the developed framework (Cont.)

Function Code	Function	Importance									Frequency								
		Responses					n	Results & Interpretation			Responses					n	Results & Interpretation		
		Extremely Important	Very Important	Important	Somewhat Important	Not Important		Mean	RII (%)	Rate	Always	Frequently	Sometimes	Seldom	Never		Mean	FI (%)	Rate
Construction Phase of the Adaptive Reuse Project (Process P3: Construct the Adaptive Reuse Project)																			
P3.1	Procure the Services of a Contractor	24	4	2	0	0	30	3.73	93.33	EI	25	1	2	1	1	30	3.60	90.00	A
P3.2	Prepare the Site for the Project	20	7	2	1	0	30	3.53	88.33	EI	19	8	1	2	0	30	3.47	86.67	F
P3.3	Plan and Schedule the Project Activities	16	7	4	3	0	30	3.20	80.00	VI	14	5	7	3	1	30	2.93	73.33	F
P3.4	Remove Unnecessary Systems and Components	19	9	1	1	0	30	3.53	88.33	EI	19	8	2	1	0	30	3.50	87.50	A
P3.5	Construct and Install the New Systems and Components	23	7	0	0	0	30	3.77	94.17	EI	24	6	0	0	0	30	3.80	95.00	A
P3.6	Deliver the Project to the Client	21	8	1	0	0	30	3.67	91.67	EI	25	3	1	1	0	30	3.73	93.33	A

Notes: EI, extremely important; VI, very important; I, important; SI, somewhat important; NI, not important; A, always; F, frequently; ST, sometimes; S, seldom; N, never

Table 7.1: Overall findings of the assessment of the importance and frequency of implementing the functions involved in the processes of the developed framework (Cont.)

Function Code	Function	Importance									Frequency								
		Responses					n	Results & Interpretation			Responses					n	Results & Interpretation		
		Extremely Important	Very Important	Important	Somewhat Important	Not Important		Mean	RII (%)	Rate	Always	Frequently	Sometimes	Seldom	Never		Mean	FI (%)	Rate
Operation and Maintenance Phase of the Adaptive Reuse Project (Process P4: Operate & Maintain the Adaptive Reuse Project)																			
P4.1	Procure the Services of a Facilities Manager	19	4	6	0	1	30	3.33	83.33	VI	14	5	7	1	3	30	2.87	71.67	F
P4.2	Conduct Commissioning Process for the Systems and Components	17	11	1	1	0	30	3.47	86.67	VI	14	7	6	1	2	30	3.00	75.00	F
P4.3	Develop an O&M Plan for the Project	18	10	0	1	1	30	3.43	85.83	VI	13	6	8	1	2	30	2.90	72.50	F
P4.4	Monitor and Record Space Utilization	10	12	4	3	1	30	2.90	72.50	VI	7	10	6	3	4	30	2.43	60.83	ST
P4.5	Assess Building Performance and User Satisfaction	17	8	3	1	1	30	3.30	82.50	VI	10	5	6	2	7	30	2.30	57.50	ST

Notes: EI, extremely important; VI, very important; I, important; SI, somewhat important; NI, not important; A, always; F, frequently; ST, sometimes; S, seldom; N, never

7.3.3 Construction Phase of the Adaptive Reuse Project

Results revealed that most of the functions involved in the construction phase received an importance rate of “Extremely Important” and an implementation frequency of “Always”. On the other hand, some functions received an importance rate of “Very Important” and an implementation frequency of “Frequently”.

Based on the determined RII and FI values of the functions involved in this process, it was noted that the first function “procure the services of a contractor” received an importance rate of “Extremely Important” with a frequency of “Always” in its implementation. Similarly, the last three functions in this process, namely: “remove unnecessary systems and components”, “construct and install the new systems and components” and “deliver the project to the client”, received the equal importance and frequency rates, since both functions play a vital role in the constructability of the change of use. In fact, these four functions are also major milestones that need to be accomplished effectively for a successful adaptive reuse project. The second function “prepare the site for the project” received an importance rate of “Extremely Important” with an implementation frequency of “Frequently”. Yet, the third function “plan and schedule the project activities” received an importance rate of “Very Important” with the equal frequency of implementation “Frequently”. The frequency of implementing both functions, second and third, is lower than the others, since they may be not necessary when the adaptation is carried out on small buildings.

7.3.4 Operation and Maintenance Phase of the Adaptive Reuse Project

The results revealed that all functions involved in the O&M phase received an importance rate of “Very Important”. Yet, results indicated that the implementation frequencies of these functions ranged between “Sometimes” and “Frequently”.

Based on the determined RII and FI values of the functions involved in this process, the first three functions, namely “procure the services of a facilities manager”, “conduct commissioning process for the systems and components” and “develop an O&M plan for the project” received a frequency of implementation of “Frequently”. The rest two functions, namely: “monitor and record space utilization” and “assess building performance and user satisfaction”, received a frequency of implementation of “Sometimes”. It was noted that the frequency of implementing the functions involved in the O&M phase is lower than the other functions included the first three phases. This implies that there is a necessity to guide AEC/FM professionals and organizations to consider and carry out these functions during their professional practice of building adaptive reuse.

7.4 Summary and Discussion

This chapter covered a discussion of the findings of the conducted validation on the developed framework for effective implementation of building adaptive reuse, throughout the project life-cycle. The framework was validated through administering a 5-point Likert scale questionnaire survey on 30 AEC/FM practitioners of building adaptive reuse. The questionnaire survey aimed to assess the importance rate as well as implementation frequency of each function involved in the developed framework.

Firstly, the chapter presented demographic information pertaining to the involved practitioners in the validation questionnaire survey, comprising: spatial distribution of respondents, scope of work of respondents, respondents' years of experience, number of adaptive reuse projects in which respondents were involved in, and types of projects in which respondents were involved in. Thereafter, the chapter presented the results and discussion of the received assessment on the functions involved in the developed framework. Results comprised the following determinants: responses, importance mean, RII, rate of importance, frequency mean, FI and the frequency of implementing each function.

In overall, findings indicated that the functions included in the feasibility studies, design and construction phases received importance rates ranged between "Very Important" and "Extremely Important", with frequencies ranged between "Frequently" and "Always" in their implementation. Yet, all functions included in the O&M phase received an importance rate of "Very Important", with frequencies ranged between "Sometimes" and "Frequently" in their implementation. The obtained individual feedbacks from the interviewees indicated that the adoption of the developed framework has the potential to enhance the AEC/FM practices of building adaptive reuse in Saudi Arabia.

CHAPTER 8:

CONCLUSIONS, RECOMMENDATIONS AND AREAS FOR FUTURE RESEARCH

8.1 Overview

This chapter covers the conclusions, recommendations and areas for future research. They were formulated according to the knowledge obtained from the reviewed literature, as well as findings and limitations of this research.

The goal of this research was to develop a life-cycle framework for effective implementation of adaptive reuse projects in Saudi Arabia. The achievement of this research goal was accomplished through meeting the following three objectives:

- To identify and evaluate the factors affecting the process of implementing building adaptive reuse throughout the project life-cycle.
- To develop a life-cycle framework for the effective implementation of adaptive reuse projects in Saudi Arabi.
- To validate the developed framework through conducting face-to-face questionnaire surveys on a selected sample of design professionals, contractors and facilities managers in the eastern province of Saudi Arabia.

To achieve the objectives, a research methodology of five-sequential phases was developed and followed in this thesis. The follows are the five-sequential phases included in the research methodology:

- Identification of the factors affecting the implementation of building adaptive reuse throughout the project life-cycle.
- Assessment of the identified factors affecting the implementation of building adaptive reuse throughout the project.
- Identification of adaptive reuse functions and their and their interactions across the project life-cycle, using IDEF₀ methodology.
- Validation of the developed framework for the effective implementation of building adaptive reuse.
- Formulation of conclusions, recommendations and areas for future research.

Each phase intended to fulfill a milestone of the research. In this regard, *Phase 1* and *Phase 2* served to achieve the first objective of this research. *Phase 3* served to achieve the second objective of this research. Finally, *Phase 4* and *Phase 5* served to achieve the third objective of this research.

Phase 1: Identification of the Factors Affecting the Implementation of Building Adaptive Reuse throughout the Project Life-Cycle

This phase focused on investigating the fundamentals and practice of building adaptive reuse, through the review of the relevant literature. Four main topics were covered in this context, namely: the traditional building life-cycle, concepts of modifications conducted on existing buildings, the practice of adaptive reuse of building, and the concept of building

performance and building performance assessment process. A review of related studies to the domain of building adaptive reuse was performed as well.

Based on an inductive and analytical approach in the review of these topics and studies, a preliminary identification of the factors affecting building adaptive reuse throughout the project life-cycle was performed. In this regard, thirty-eight factors were defined and formulated, according to a semantic analysis. These factors were classified, in a life-cycle-oriented context, under four groups, namely: “phase of conceptual planning and feasibility studies”, “design and engineering phase”, “construction phase”, and “operation and maintenance phase”.

Thereafter, three questionnaire surveys were developed in this phase, to reveal the local practice of building adaptive reuse, as well as assess the identified factors, from the point of views of AEC/FM practitioners. These questionnaire surveys were developed to be directed to A/Es, contractors and facilities managers. Multiple-answers questions as well as open-ended questions were included in each questionnaire survey, for the investigation of the local practices. For the assessment of the factors, a 5-point Likert scale rating technique was employed in the three questionnaire surveys.

A pilot study of the three questionnaire surveys was conducted on fifteen respondents, including five A/Es, five contractors and five facilities managers. The purpose of the pilot study was to test the readability, adequacy and clarity of the questionnaire surveys, as well as determine the time needed for filling each questionnaire survey. The conducted pilot study indicated the clarity, adequacy and comprehensiveness of the three questionnaire surveys.

Phase 2: Assessment of the Identified Factors Affecting the Implementation of Building Adaptive Reuse throughout the Project Life-Cycle

This phase focused on collecting and analyzing the data from respondents of the three questionnaire surveys. First, the required sample size of each questionnaire survey was calculated, based on records of the registered AEC/FM organizations in Asharqia Chamber of Commerce. Kish (1995) formulas (**Equations 1.1 and 1.2**) were used in this process. Accordingly, it was determined that the required sample to respond to each questionnaire survey was 30 responses.

Regarding the data collection, the three questionnaire surveys were mostly conducted through holding face-to-face-based interview sessions with the respondents. Some questionnaire surveys were conducted by phone with respondents who were out of DMA.

The received responses were tabulated in spreadsheets, using Microsoft Excel 365 (Version 2016), for the data processing and statistical analysis. The percent frequency (**Equation 1.3**) was calculated for each variable included in the local practice questions. Further, the Relative Importance Index (RII) for each factor was calculated, using **Equation 1.4**. The calculated RIIs were subjectively interpreted, according to an adopted scale of interpretation (**Table 1.1**). Based on the received RIIs, descending ordering of the factors, in the three groups of responses, was performed as a ranking technique. Finally, Spearman's Coefficient of Rank Correlation (p) was calculated per each paired comparison, among the three group of respondents, to determine the level of agreement among them. **Equation 1.5** was used to accomplish this analysis. The calculated p values were subjectively interpreted, according to an adopted scale of interpretation (**Table 1.2**).

Phase 3: Identification of Adaptive Reuse Functions and their and their Interactions across the Project Life-Cycle, Using IDEF₀ Methodology

This phase focused on developing a life-cycle-wise framework for the effective implementation of adaptive reuse projects in Saudi Arabia. The main processes of the framework and their functions were identified, relying on the knowledge obtained from the reviewed literature, investigated local practice and findings of the factors' assessment. Interactions among these functions and processes with their determinants (inputs, controls, mechanisms and outputs) were identified in the same context. IDEF₀ (Integration Definition for Function Modeling) methodology was used for the schematic representation of the developed framework.

Phase 4: Validation of the Developed Framework for the Effective Implementation of Building Adaptive Reuse

This phase focused on validating the developed framework, thorough obtaining the feedback of the local AEC/FM practitioners of building adaptive reuse about the framework. This validation aimed to the assess the functions of the developed framework in terms of two dimensions, namely their importance and implementation. Thus, a 5-point Likert scale questionnaire survey was developed as a validation tool, to assess the importance rate and the implementation frequency of each function included in the framework. In this regard, all functions were tabulated for the assessment of their importance rates and frequencies of implementation. Further, the developed IDEF₀ diagrams were attached in the questionnaire survey, for receiving subjective feedback on the validity of the identified relations and determinants of all process and functions.

Regarding the data collection, all validation questionnaire surveys were conducted through holding face-to-face-based interview sessions with the respondents. In this regard, 30 AEC/FM practitioners of building adaptive reuse were interviewed, to obtain the feedback of one-third of the respondents' sample of the three questionnaire surveys. Thus, the interviewed 30 practitioners included 10 A/Es, 10 contractors and 10 facilities managers. During the interview sessions, respondents were asked to rate the level of importance of each function included in the framework, as well as the frequency in which they implement it in the professional practice of building adaptive reuse. Further, their subjective feedback and comments on the attached diagrams were recorded.

The received responses were tabulated in a spreadsheet, using Microsoft Excel 365 (Version 2016), for the data processing and statistical analysis. For each function, RII was calculated and interpreted as performed in the factors' assessment. For the implementation dimension, the Frequency Index (FI) was calculated for each function, using **Equation 1.6**. The calculated FIs were subjectively interpreted, according to an adopted scale of interpretation (**Table 1.3**).

Phase 5: Formulation of Conclusions, Recommendations and Areas for Future Research

This phase focused on developing the conclusions and recommendations of the present research, as well as highlighting areas for future studies. The research conclusions were summarized in a form of sequential concluding remarks that answer the research objectives. The formulated recommendations were directed to the literature, professional practitioners and entities that are included in the context of building adaptive reuse.

Opportunities for future research, to fill other gaps, were indicated according to limitations and findings of this study, as well as knowledge obtained in the review of literature.

8.2 Conclusions

Conclusions of this research were drawn in a manner that answers the research objectives (see section 1.5), as illustrated below:

8.2.1 Achievement of Objective 1

“To identify and evaluate the factors affecting the implementation of adaptive reuse of buildings throughout the project life-cycle”

Conclusions of this objective were drawn and summarized as below:

- Adaptive reuse is the practice of converting the use of a built-facility, or part of it, into a new use that has a totally different purpose from original one.
- Building adaptive reuse is viewed as a sustainable practice, due to its potential to provide economic, environmental and social benefits, simultaneously, for the communities and their built-environments.
- On the other hand, the practice of building adaptive reuse may encounter numerous challenges, including: financial, legal, technical, functional and cultural.
- There are different stakeholders may be involved in this kind of practices, namely: owner, regulators, consultants, contractors and facilities managers.
- Based on a mixed-approach of literature review and pilot study, 38 factors were identified and categorized, under four groups, in a life-cycle-oriented context, as follows: “phase of conceptual planning and feasibility studies”; “design and engineering phase”; “construction phase”; and “O&M phase”.

- Responses of the local practice questions, included in the three questionnaire surveys, indicated that there are a set of documents and information that should be provided across each phase of the life-cycle of adaptive reuse project. Further, effective communication among the project parties should be adequately fulfilled for the effective implementation of building adaptive reuse. There are a set of legal, technical, environmental, economic and managerial challenges that could face the stakeholders involved in adaptive reuse projects. Accordingly, adoption of innovative techniques should be carried out in each phase of the adaptive reuse life-cycle.
- Findings of the assessment of the factors, received through the three questionnaire survey, indicated that the importance rates of the identified factors ranged between “Important” and “Extremely Important”.
- A/Es perceived ‘structural integrity of the building’, ‘municipal approval for the land use change’, ‘enforcement and management of safety procedures at the project site’, ‘accuracy and completeness of the contract documents’, ‘compliance with health and safety measures’, and ‘number and layout of the structural columns’ as the most important factors that affect the implementation of adaptive reuse projects, throughout their life-cycle. Based on their RII values, the first five factors received an importance rate of “Extremely Important”, while ‘number and layout of the structural columns’ received an importance rate of “Very Important”.

- Contractors perceived ‘structural integrity of the building’, ‘allocated budget for the adaptation process’, ‘municipal approval for the land use change’, ‘enforcement and management of safety procedures at the project site’, ‘availability and adequacy of the commissioning process for the MEP systems’, ‘code requirements for the new occupancy’ and ‘quality assurance/control requirements’ as the most influential factors on adaptive reuse projects, throughout their life-cycle. Based on their RII values, the first five factors received an importance rate of “Extremely Important”, while ‘code requirements for the new occupancy’ and ‘quality assurance/control requirements’ received an importance rate of “Very Important”.
- Facilities managers perceived ‘structural integrity of the building’, ‘compliance with health and safety measures’, ‘quality assurance/control requirements’, ‘enforcement and management of safety procedures at the project site’, ‘accuracy and completeness of the contract documents’, ‘availability of skilled workforce’, ‘availability and accuracy of the drawings and specifications of the existing project’ and ‘planning and control of the financial resources’ as the most important factors that affect building adaptive reuse, throughout the project life-cycle. Based on their RII values, these factors received an importance rate of “Extremely Important”.
- Overall, respondents perceived ‘structural integrity of the building’, ‘municipal approval for the land use change’, ‘enforcement and management of safety procedures at the project site’, ‘compliance with health and safety measures’ and ‘accuracy and completeness of the contract documents’ as the most important factors that affect building adaptive reuse, throughout the project life-cycle. Based on their RIIs, these factors received an importance rate of “Extremely Important”.

- Regarding the assessment of the groups of factors, A/Es and facilities managers ranked “factors related to the operation and maintenance phase” first among the other groups of factors. On the other hand, contractors ranked “factors related to the phase of conceptual planning and feasibility studies” first among the other groups of factors.
- The calculated Spearman’s Coefficient of Rank Correlation (p) on the three paired comparisons indicated that there was a strong agreement among the three group of respondents, in term of their evaluation of the importance of the factors. The highest correlation was observed in the paired comparison between responses of the participated contractors and facilities managers ($p = 0.927$). The second highest correlation was observed in the paired comparison between the responses of the A/Es and contractors ($p = 0.909$). Finally, the paired comparison between the responses of the A/Es and facilities managers indicated a high level of agreement between both groups of respondents ($p = 0.887$), but lower than the other groups.

8.2.2 Achievement of Objective 2

“To develop a framework of the process of adaptive reuse of buildings throughout the project life-cycle”

Conclusions of this objective were drawn and summarized as below:

- Based on the obtained knowledge from the reviewed literature, local practice investigation and assessment of the influential factors, the developed framework consisted of four main-sequential processes, entitled: “assess the feasibility of the adaptive reuse project”, “design the adaptive reuse project”, “construct the adaptive reuse projects” and “operate and maintain the adaptive reuse project”. The four processes were breakdown into twenty-two functions in total, while each process included five to six sequential functions.
- The first process “assess the feasibility of the adaptive reuse project” consisted of six sequential functions, namely: (1) assess the structural integrity of the building, (2) investigate the requirements for adaptive reuse, (3) assess the building condition, (4) develop the architectural program for the new use, (5) assess the spaces’ potential for adaptive reuse, and (6) assess the economic feasibility for the project.
- The second process “design the adaptive reuse project” consisted of five sequential functions, namely: (1) assess capacity and layout of existing systems and components, (2) propose design alternatives, (3) evaluate proposed alternatives, (4) develop detailed design and specifications, and (5) follow-up to obtain the municipal permits.

- The third process “construct the adaptive reuse project” consisted of six sequential functions, namely: (1) procure the service of a contractor, (2) prepare the site for the project, (3) plan and schedule the project activities, (4) remove unnecessary systems and components, (5) construct and install the new systems and components, and (6) deliver the project to the client.
- The fourth process “operate and maintain the adaptive reuse project” consisted of five sequential functions, namely: (1) procure the service of a facilities manager, (2) conduct commissioning process for the systems and components, (3) develop an O&M plan for the project, (4) monitor and record space utilization, and (5) assess the building performance and user satisfaction.
- The developed IDEF⁰-model of the framework facilitated the illustration of the interaction among the included processes, functions, inputs, controls, mechanisms and outputs, in a schematic context.

8.2.3 Achievement of Objective 3

“To validate the developed framework through conducting interviews with a selected sample of design professionals, contractors and facilities managers in the Eastern Province of Saudi Arabia”

Conclusions of this objective were drawn and summarized as below:

- The conducted validation questionnaire survey indicated that the importance rates of the functions involved in the first process “assess the feasibility of the adaptive reuse project” ranged between “Very Important” and “Extremely Important”. Frequencies of implementing these functions ranged between “Frequently” and “Always”.
- The conducted validation questionnaire survey indicated that the importance rates of the functions included in the second process “design the adaptive reuse project” ranged between “Very Important” and “Extremely Important”. Frequencies of implementing these functions ranged between “Frequently” and “Always”.
- The conducted validation questionnaire survey indicated that the importance rate of most of the functions involved in the third process “construct the adaptive reuse project” was “Extremely Important”, except one function which received an importance rate of “Very Important”. Frequencies of implementing these functions ranged between “Frequently” and “Always”.
- The conducted validation questionnaire survey indicated that the importance rate of all functions included in the fourth process “operate and maintain the adaptive reuse project” was “Very Important. Frequencies of implementing these functions ranged between “Sometimes” and “Frequently”.

- Feedbacks obtained from the 30 practitioners who were participated in the validation questionnaire survey revealed that adopting the developed framework has the potential to improve the AEC/FM practices of building adaptive reuse in Saudi Arabia.

8.3 Recommendations

Based on the research findings and conclusions, the following recommendations were proposed:

- Researchers and practitioners concerned in the practice of building adaptive reuse need to consider the importance and priority of the factors affecting adaptive reuse projects throughout their life-cycle.
- The developed framework needs to be followed in future adaptive reuse projects in Saudi Arabia, to enhance the AEC/FM performance during their professional practice of these projects.
- AEC/FM practitioners need to understand the interactions among the inputs, controls, mechanisms and outputs of all processes and functions involved in the life-cycle of the adaptive reuse projects, as demonstrated in the developed framework.
- Planners, A/Es and investors of building adaptive reuse need to assess the feasibility of these projects from the different dimensions, namely: technical, legal, functional and economic.

- Contractors of adaptive reuse projects need to implement all the executional activities in an acceptable level of quality, as such as performed in the construction new buildings.
- Facilities managers of adaptively reused buildings need to effectively carry out the functions related to the total quality management, including the space management and building performance activities. This is due to the fact that implementing this kind of functions has the potential to sustain the ongoing improvements in the functionally altered facilities, throughout their new life-span.

8.4 Areas for Future Research

Based on the limitations and findings of the research, as well as knowledge obtained from the literature, the followings are potential and suggested areas for future research:

- Development of integrated decision support systems (DDS) for the assessment of the adaptive reuse feasibility, which take into consideration all physical, economic, spatial, legal, social and environmental factors, simultaneously.
- Incorporating the enabling technologies in the processes involved in the life-cycle of building adaptive reuse, to fulfill an automated and smooth flow and operation of this kind of projects.
- Capturing and incorporating the knowledge of property and facilities managers in the early design phase of adaptive reuse projects, to improve the determination of the effective solutions and alterations for the new use.

REFERENCES

1. ADA. (2010). *2010 ADA Standards for Accessible Design*. Washington, D.C.: Department of Justice. Retrieved from <https://www.ada.gov/regs2010/2010ADAStandards/2010ADAStandards.pdf>
2. Adhikary, P. (2014). Renovation modernization uprating & Llife extension : optimal solution for small hydropower development. *International Journal of Engineering Science & Advanced Technology*, 4(3), 300–306.
3. Agha, R. H. M., and Kamara, J. M. (2017). Adaptations in traditional courtyard houses in Baghdad , Iraq. *International Journal of Building Pathology and Adaptation*, 35(4), 348–363.
4. Aigwi, I. E., Egbelakin, T., and Ingham, J. (2018). Efficacy of adaptive reuse for the redevelopment of underutilised historical buildings: Towards the regeneration of New Zealand’s provincial town centres. *International Journal of Building Pathology and Adaptation*, 36(4), 385–407.
5. Aigwi, I. E., Egbelakin, T., Ingham, J., Phipps, R., Rotimi, J., and Filippova, O. (2019). A performance-based framework to prioritise underutilised historical buildings for adaptive reuse interventions in New Zealand. *Sustainable Cities and Society*, 48, 101547.
6. Al-ghamdi, S. (2011). *Building to Subsist: Adaptive Reuse of Buildings in Saudi Arabia*. University of Dammam.
7. Al-obaidi, K. M., Wei, S. K., Ismail, M. A., and Kam, K. J. (2017). Sustainable building assessment of colonial shophouses after adaptive reuse in Kuala Lumpur. *Buildings*, 7(4), 87.
8. Alauddin, K. (2014). *The development of an intellectual capital framework for successful adaptive re-use*. RMIT University.
9. Alexander, K. (2013). *Facilities Management: Theory and Practice* (1st ed.). London: Routledge/Taylor & Francis Group.
10. Ali, A., Azmi, N., and Baaki, T. (2018). Cost performance of building refurbishment works: the case of Malaysia. *International Journal of Building Pathology and Adaptation*, 36(1), 41–62.
11. Ali, Z., Zawawi, R., Myeda, N. E., and Mohamad, N. (2018). Adaptive reuse of historical buildings: Service quality measurement of Kuala Lumpur museums. *International Journal of Building Pathology and Adaptation*, 37(1), 54–68.
12. Ancarani, A., and Capaldo, G. (2005). Supporting decision-making process in facilities management services procurement: A methodological approach. *Journal of Purchasing and Supply Management*, 11(5–6), 232–241.
13. Anderson, D. R., Sweeney, D. J., and Williams, T. A. (2015). *Modern Business Statistics with Microsoft® Office Excel®* (5th ed.). Stamford: Cengage Learning.

14. Anumba, C., Marino, B., Gottfried, A., and Egbu, C. (2004). *Health and safety in refurbishment involving demolition and structural instability*. Sudbury, Suffolk: Health & Safety Executive (HSE).
15. Arata, M. J. (2006). *Construction Site Security*. New York: McGraw - Hill Companies.
16. Arge, K. (2005). Adaptable office buildings: theory and practice. *Facilities*, 23(3), 119–127.
17. Artés, J., Wadel, G., and Martí, N. (2017). Vertical Extension and Improving of Existing Buildings. *The Open Construction and Building Technology Journal*, 11(1), 83–94. <https://doi.org/10.2174/1874836801711010083>
18. Augenbroe, G. (1992). Integrated building performance evaluation in the early design stages. *Buddmg and Enmronment*, 27(2), 149–161.
19. Azhar, S. (2011). Building Information Modeling (BIM): Trends, Benefits, Risks, and Challenges for the AEC Industry. *Leadership and Management in Engineering*, 11(3), 241–252.
20. Baker, N. V. (2009). *The Handbook of Sustainable Refurbishment: Non-Domestic Buildings* (1st ed.). London: Routledge/Taylor & Francis Group.
21. Ball, R. M. (2002). Re use potential and vacant industrial premises : revisiting the regeneration issue in Stoke-on-Trent. *Journal of Property Research*, 19(2), 93–110.
22. Beck, L. A. (2014). *New as Renewal : A Framework for Adaptive Reuse in the Sustainable Paradigm*. University of Massachusetts Amherst.
23. Behdad, H. (2006). *City of Los Angeles Adaptive Reuse Program* (2nd ed.). Los Angeles: Downtown Center Business Improvement District.
24. Best, R., and Valence, G. De. (2013). *Building in Value: Pre-Design Issues*. London: Routledge/Taylor & Francis Group.
25. Bottero, M., Alpaos, C. D., and Oppio, A. (2019). Ranking of adaptive reuse strategies for abandoned industrial heritage in vulnerable contexts : A multiple criteria decision aiding approach. *Sustainability*, 11(3), 785.
26. Bowen, P. A., and Edwards, P. J. (1996). Interpersonal communication in cost planning during the building design phase. *Construction Management & Economics ISSN:*, 14(5), 395–404.
27. Brown, L. A., and Cresciani, M. (2017). Adaptable design in Olympic construction. *International Journal of Building Pathology and Adaptation*, 35(4), 397–416.
28. Bullen, P. (2007). Adaptive reuse and sustainability of commercial buildings. *Facilities*, 25(1), 20–31.
29. Bullen, P., and Love, P. (2009). Residential regeneration and adaptive reuse: Learning from the experiences of Los Angeles. *Structural Survey*, 27(5), 351–360.
30. Bullen, P., and Love, P. (2010). The rhetoric of adaptive reuse or reality of demolition: Views from the field. *Cities*, 27(4), 215–224.
31. Bullen, P., and Love, P. (2011a). A new future for the past: A model for adaptive reuse decision-making. *Built Environment Project and Asset Management*, 1(1), 32–44.

32. Bullen, P., and Love, P. (2011b). Adaptive reuse of heritage buildings. *Structural Survey*, 29(5), 411–421.
33. Bullen, P., and Love, P. (2011c). Factors influencing the adaptive re-use of buildings. *Journal of Engineering, Design and Technology*, 9(1), 32–46.
34. Cambridge Dictionary. (2019). Meaning of energy-saving in English. Retrieved 10 April 2019, from <https://dictionary.cambridge.org/dictionary/english/energy-saving>
35. Cantell, S. F. (2005). *The Adaptive Reuse of Historic Industrial Buildings: Regulation Barriers, Best Practices and Case Studies*. Virginia Polytechnic Institute and State University.
36. Carvalho, C. G. de, Flores-Colen, I., and Faria, P. (2015). Rehabilitation of renders of old buildings in Portugal: Survey, supporting methodology proposal and case study. *Structural Survey*, 33(4), 337–353.
37. Chanter, B., and Swallow, P. (2007). *Building Maintenance Management* (2nd ed.). Oxford: Blackwell Publishing.
38. Chen, J., Judd, B., and Hawken, S. (2016). Adaptive reuse of industrial heritage for cultural purposes in Beijing, Shanghai and Chongqing. *Structural Survey*, 34(4), 331–350.
39. Chen, Z., Maiti, S., and Agapiou, A. (2017). Evidence-based safety management in building refurbishment. In *ARCOM and BEAM Centre Early Career Researcher and Doctoral Workshop on Building Asset Management*, (pp. 41–50). Glasgow: Glasgow Caledonian University.
40. Chua, R. S., and Deguchi, A. (2010). Local Communities' perceptions towards building reuse in old residential quarter of Melaka City. In *Sustainable Architecture and Urban Development (SAUD 2010) Conference* (pp. 253–271). The Center for the Study of Architecture in the Arab Region (CSAAR).
41. City of Vancouver. (2019). Section 2: Definitions. In *Parking Bylaw 6059* (pp. 2–1). Vancouver: Council of the City of Vancouver. Retrieved from <https://bylaws.vancouver.ca/parking/sec02.pdf>
42. Clarke, N. J., Kuipers, M. C., and Roos, J. (2019). Cultural resilience and the Smart and Sustainable City: Exploring changing concepts on built heritage and urban redevelopment. *Smart and Sustainable Built Environment*. <https://doi.org/10.1108/SASBE-09-2017-0041>
43. Clough, R. H., Sears, G. A., and Sears, S. K. (2005). *Construction Contracting: A Practical Guide to Company Management* (7th ed.). Hoboken, New Jersey: John Wiley & Sons, Inc.
44. Conejos, S. (2013a). *Designing for Future Building Adaptive Reuse*. Bond University.
45. Conejos, S. (2013b). Optimisation of future building adaptive reuse design criteria for urban sustainability. *Journal of Design Research*, 11(3), 225–242.
46. Conejos, S., Langston, C., Chan, E. H. W., and Chew, M. Y. L. (2016). Governance of heritage buildings: Australian regulatory barriers to adaptive reuse. *Building Research and Information*, 44(5–6), 507–519.

47. Conejos, S., Langston, C., and Smith, J. (2011). Improving the implementation of adaptive reuse strategies for historic buildings. In *Le Vie dei Mercanti S.A.V.E. HERITAGE: Safeguard of Architectural, Visual, Environmental Heritage*. Naples, Italy.
48. Conejos, S., Langston, C., and Smith, J. (2013). AdaptSTAR model: A climate-friendly strategy to promote built environment sustainability. *Habitat International*, 37, 95–103.
49. Conejos, S., Langston, C., and Smith, J. (2015). Enhancing sustainability through designing for adaptive reuse from the outset: A comparison of adaptSTAR and Adaptive Reuse Potential (ARP) models. *Facilities*, 33(9), 531–552.
50. Cooper, R., Kagioglou, M., Aouad, G., Hinks, J., Sexton, M., and Sheath, D. (1998). The development of a generic design and construction process. In *European Conference* (pp. 1–10). Product Data Technology (PDT) Days.
51. Dakhli, Z., Lafhaj, Z., and Bernard, M. (2017). Application of lean to the bidding phase in building construction: a French contractor's experience. *International Journal of Lean Six Sigma*, 8(2), 153–180.
52. Danso, F. O., Badu, E., Ahadzie, D. K., Nani, G., and Manu, P. (2015). Towards a framework for the management of health, safety and well-being on adaptive-retrofit projects in Ghana. In Edinburgh (Ed.), *Proceedings of ARCOM Doctoral Workshop - Health, Safety and Wellbeing, 11th February 2015, University of Edinburgh* (pp. 73–83). Association of Researchers in Construction Management.
53. De Silva, G. D. R., Perera, B. A. K. S., and Rodrigo, M. N. N. (2019). Adaptive reuse of buildings: the case of Sri Lanka. *Journal of Financial Management of Property and Construction*, 24(1), 79–96.
54. Dedobbeleer, N., and Béland, F. (1991). A Safety climate measure for construction sites. *Journal of Safety Research*, 22(2), 97–103.
55. Deerkoski, J. S. (2012). Chapter 1: Professional and Business Practices. In *Temporary Structures in Construction* (3rd ed., p. 1.4). New York: McGraw - Hill Companies.
56. Devine, B. (2011). Asset Management. In *Workplace Strategies and Facilities Management: Building in Value* (pp. 241–254). London: Spon Press.
57. Dominowski, R. L. (1980). *Research Methods*. Englewood Cliffs, N.J: Prentice Hall Inc.
58. Doran, D., Douglas, J., and Pratley, R. (2009). *Refurbishment and Repair in Construction*. Dunbeath, Caithness, Scotland: Whittles Publishing.
59. Douglas, J. (2006). *Building Adaptation* (2nd ed.). Oxford: Butterworth-Heinemann.
60. Downs Jr., J. C. (1980). *Principles of Real Estate Management* (12th ed.). Chicago: Institute of Real Estate Management.
61. Egbu, C. (1994). *Management education and training for refurbishment work within the construction industry*. University of Salford. University of Salford.
62. Egbu, C. (1997). Refurbishment management: challenges and opportunities. *Building Research & Information*, 25(6), 338–347.

63. Egbu, C., Marino, B., Anumba, C. J., Gottfried, A., and Neale, B. (2002). Managing health & safety in refurbishment projects involving demolition and structural instability. In *Proceedings of the CIB W070 2002 Global Symposium - Applying and Extending the Global Knowledge Base* (pp. 315–327). Glasgow: CIB and CABER.
64. Elbelkasy, M. I., Alsalafi, J. M., and Mahmoud, M. F. (2015). Re-use of historical buildings in the holy city of Makkah : case study selection guidelines. *Structural Studies, Repairs and Maintenance of Heritage Architecture XIV*, 153, 63–74.
65. Elsorady, D. A. (2018). Adaptive Reuse Decision Making of a Heritage Building Antoniadis Palace, Egypt. *International Journal of Architectural Heritage*. <https://doi.org/10.1080/15583058.2018.1558313>
66. Eray, E., Sanchez, B., and Haas, C. (2019). Usage of interface management in adaptive reuse of buildings. *Buildings*, 9(5).
67. Ernest, K., Ankomah, E. N., Tengan, C., and Asamoah, R. O. (2016). Challenges to retrofitting and adaptation of existing building within the major central business district in Ghana. *Journal of Construction Project Management and Innovation*, 6(2), 1460–1476.
68. Eshrati, P., Bahramjerdi, S. F. N., Mahabadi, S. E., and Azad, M. (2017). Evaluation of authenticity on the basis of the Nara grid in adaptive reuse of Manochehri Historical House Kashan, Iran. *International Journal of Architectural Research*, 11(3), 214–230.
69. Evbuomwan, N. F. O., and Anumba, C. J. (1998). An integrated framework for concurrent life-cycle design and construction. *Advances in Engineering Software*, 29(7–9), 587–597.
70. Eyüce, Ö., and Eyüce, A. (2010). Design education for adaptive reuse. *International Journal of Architectural Research*, 4(2), 419–429.
71. Fellows, R., and Liu, A. (2015). *Research Methods for Construction* (4th ed.). Chichester, West Sussex: John Wiley & Sons, Inc.
72. Fieldson, R. (2017). The afterlife clause; towards a strategy for improved adaptation in retail property. *International Journal of Building Pathology and Adaptation*, 35(4), 364–379.
73. FIPS OUP 183. (1993). *Federal Information Processing Standards Publication: Integration Definition for Function Modeling (IDEF0)*. Gaithersburg, MD: National Institute of Standards and Technology (NIST).
74. Foster, S. T. (2017). *Managing Quality: Integrating the Supply Chain* (6th ed.). Edinburgh Gate, Harlow: Pearson Education Limited.
75. Fournier, D. F., and Zimnicki, K. (2004). *Integrating Sustainable Design Principles into the Adaptive Reuse of Historical Properties*. Washington: U.S. Army Corps of Engineers.
76. Frey, H. (1979). Building Conversion: A Systematic for the Prediction of Capital Cost. In *Building Conversion and Rehabilitation: Designing for Change in Building Use* (pp. 31–48). London: Butterworths.
77. Froese, T. (1996). Models of construction process information. *Journal of Computing in Civil Engineering*, 10(3), 183–193.

78. Frontczak, M., Schiavon, S., Goins, J., Arens, E., Zhang, H., and Wargocki, P. (2012). Quantitative relationships between occupant satisfaction and satisfaction aspects of indoor environmental quality and building design. *Indoor Air*, 22(2), 119–131.
79. Gelfand, L., and Duncan, C. (2012). *Sustainable Renovation: Strategies for Commercial Building Systems and Envelope*. Hoboken, New Jersey: John Wiley & Sons, Inc.
80. Geraedts, R., Remøy, H., Hermans, M., and Rijn, E. van. (2014). Adaptive capacity of buildings: A determination method to promote flexible and sustainable construction. In *International Union of Architects World Congress UIA2014, Durban SA, August 2014*.
81. Glew, D., Smith, M. B., Miles-Shenton, D., and Gorse, C. (2017). Assessing the quality of retrofits in solid wall dwellings. *International Journal of Building Pathology and Adaptation*, 35(5), 501–518.
82. Graham, P. (2003). *Building Ecology - First Principles for a Sustainable Built Environment*. Hoboken, New Jersey: Wiley-Blackwell.
83. Grof, D. R., D'Agostino, R., Brady, V. K., Lutz, L. S., McDermott, T. M., Roschel, T. J., ... Cowhey, J. R. (2009). *Historic Preservation Guidelines for The Preservation, Promotion and Regulation Of Historic Resources*. Lancaster: Lancaster County.
84. Günçe, K., and Misirlisoy, D. (2019). Assessment of adaptive reuse practices through user experiences: Traditional houses in the walled city of Nicosia. *Sustainability*, 11(2).
85. Haasl, T., and Sharp, T. (1999). *A Practical Guide for Commissioning Existing Buildings*. Tennessee: Oak Ridge National Laboratory.
86. Halvitigala, D., and Reed, R. G. (2015). Identifying adaptive strategies employed by office building investors. *Property Management*, 33(5), 478–493.
87. Hamida, M. B., and Hassanain, M. A. (2020). Post occupancy evaluation of adaptively reused buildings: Case study of an office building in Saudi Arabia. *Architecture Civil Engineering Environment*, 13(1), 29–40.
88. Haroun, H.-A. A. F., Bakr, A. F., and Hasan, A. E.-S. (2019). Multi-criteria decision making for adaptive reuse of heritage buildings: Aziza Fahmy Palace, Alexandria, Egypt. *Alexandria Engineering Journal*, 58(2), 467–478.
89. Hasnain, H., and Mohseni, F. (2018). Creative ideation and adaptive reuse: a solution to sustainable urban heritage conservation. In *IOP Conference Series :Earth and Environmental Science 1* (Vol. 126, p. 012075).
90. Hassanain, M. A., Froese, T. M., and Vanier, D. J. (2003). Framework model for asset maintenance management. *Journal of Performance of Constructed Facilities*, 17(1), 51–64.
91. Hassanain, M. A., Froese, T. M., and Vanier, D. J. (2011). Operations and Maintenance Management. In *Workplace Strategies and Facilities Management: Building in Value* (pp. 177–205). London: Spon Press.
92. Hassanain, M. A., and Juaim, M. N. (2013). Modeling knowledge for architectural programming. *Journal of Architectural Engineering*, 19(2), 101–111.

93. Hassanien, A., and Losekoot, E. (2002). The application of facilities management expertise to the hotel renovation process. *Facilities*, 20(7/8), 230–238.
94. Heidrich, O., Kamara, J., Maltese, S., Re Cecconi, F., and Dejacco, M. C. (2017). A critical review of the developments in building adaptability. *International Journal of Building Pathology and Adaptation*, 35(4), 284–303.
95. Hein, M. F., and Houck, K. D. (2008). Construction challenges of adaptive reuse of historical buildings in Europe. *International Journal of Construction Education and Research*, 4(2), 115–131.
96. Hershberger, R. (2015). *Architectural Programming and Predesign Manager*. Abingdon, oxon: Routledge/Taylor & Francis Group.
97. Highfield, D. (1987). *Rehabilitation and re-use of old buildings*. London: E. & F.N. Spon.
98. Hinze, J. W. (2012). *Construction Planning and Scheduling* (4th ed.). New Jersey: Pearson Education.
99. Hon, C. K. H., Chan, A. P. C., and Chan, D. W. M. (2011). Strategies for improving safety performance of repair, maintenance, minor alteration and addition (RMAA) work. *Facilities*, 29(13/14), 591–610.
100. Hong, Y., and Chen, F. (2017). Evaluating the adaptive reuse potential of buildings in conservation areas. *Facilities*, 35(3), 202–219.
101. Hoxha, V. (2019). Sustainable impact of adaptive reuse of communist style shopping malls in Kosovo. *Property Management*, 37(5), 662–683.
102. Hui, E. C. M., Wong, J. T. Y., and Wan, J. K. M. (2008). The evidence of value enhancement resulting from rehabilitation. *Facilities*, 26(1), 16–32.
103. IBC. (2018). *International Building Code*. Country Club Hills: International Code Council.
104. Ihsan, B., and Alshibani, A. (2018). Factors affecting operation and maintenance cost of hotels. *Property Management*, 36(3), 296–313.
105. Ikediashi, D. I., Ogunlana, S. O., Boateng, P., and Okwuashi, O. (2012). Analysis of risks associated with facilities management outsourcing: A multivariate approach. *Journal of Facilities Management*, 10(4), 301–316.
106. Ikediashi, D. I., Ogunlana, S. O., and Udo, G. (2013). Structural equation model for analysing critical risks associated with facilities management outsourcing and its impact on firm performance. *Journal of Facilities Management*, 11(4), 323–338.
107. Ilozor, B. D. (2008). Architectural and building features disparity and preservation of structural and fabrics integrity. *Journal of Engineering, Design and Technology*, 6(1), 33–47.
108. Iselin, D. G., and Lemer, A. C. (1993). *The Fourth Dimension in Building: Strategies for Minimising Obsolescence*. Washington: Committee on Facility Design to Minimize Premature Obsolescence, Building Research Board, National Academy of Sciences.
109. Jakučionis, S., and Ustinovičius, L. (2000). Multicriteria analysis of the variants of the old town building renovation in the marketing aspect. *Statyba*, 6(6), 469–475.

110. Jensen, P. A., and Maslesa, E. (2015). Value based building renovation – A tool for decision-making and evaluation. *Building and Environment*, 92, 1–9.
111. Jin, T. K. (1996). Conservation, modernisation and the problems of fire safety in Singapore. In *CIB W89 Beijing International Conference*. Retrieved from <http://www.irbnet.de/daten/iconda/CIB9451.pdf>
112. Kalin, M., Weygant, R. S., Rosen, H. J., and Jr., J. R. R. (2010). *Construction Specifications Writing: Principles and Procedures* (6th ed.). Hoboken, New Jersey: John Wiley & Sons, Inc.
113. Kartam, N. A. (1996). Making effective use of construction lessons learned in project life cycle. *Journal of Construction Engineering and Management*, 122(1), 14–21.
114. Kincaid, D. (2000). Adaptability potentials for buildings and infrastructure in sustainable cities. *Facilities*, 18(3), 155–161.
115. Kincaid, D. (2002). *Adapting Buildings for Changing Uses: Guidelines for Change of Use Refurbishment* (1st ed.). London: Spon Press.
116. Kish, L. (1995). *Survey Sampling*. New Yourk: John Wiley and Sons Inc.
117. Kohler, N., and Yang, W. (2007). Long-term management of building stocks. *Building Research and Information*, 35(4), 351–362.
118. Kurul, E. (2007). A qualitative approach to exploring adaptive re-use processes. *Facilities*, 25(13), 554–570.
119. Ladinski, V. (2017). Designing for adaptability: The Gateshead Civic Centre. *International Journal of Building Pathology and Adaptation*, 35(4), 380–396.
120. Langston, C. (2008). The sustainability implications of building adaptive reuse. *Sustainable Developmen*. Retrieved from http://epublications.bond.edu.au/sustainable_development
121. Langston, C. (2011). Financial Management. In *Workplace Strategies and Facilities Management: Building in Value* (pp. 164–176). London: Spon Press.
122. Langston, C. (2012). Validation of the adaptive reuse potential (ARP) model using iconCUR. *Facilities*, 30(3), 105–123.
123. Langston, C., and Lauge-Kristensen. (2002). Obsolescence and Refurbishment. In *Strategic Management of Built Facilities* (pp. 128–133). London: Routledge/Taylor & Francis Group.
124. Langston, C., Wong, F. K. W., Hui, E. C. M., and Shen, L. Y. (2008). Strategic assessment of building adaptive reuse opportunities in Hong Kong. *Building and Environment*, 43(10), 1709–1718.
125. Lardner, H., Parsons, L., Sutherland, G., and Moloney, D. (2013). *Adaptive Reuse of Industrial Heritage : Opportunities & Challenges*. Melbourne: Heritage Council of Victoria.
126. LBDS. (2014). *Adaptive Reuse Technical Manual*. City of Long Beach: www.lbds.info.
127. Lee, C. C., and Egbu, C. (2005). Capturing Client Needs in Refurbishment Projects. In *21st Annual ARCOM Conference, 7-9 September 2005, SOAS, University of London* (Vol. 2, pp. 865–874). London: Association of Researchers in Construction Management.

128. Li, H.-W., and Tsai, T.-C. (2017a). Adaptive reuse strategies for historic old school building in Taiwan : A case study of PKVS. *The International Journal of Organizational Innovation*, 10(1), 101–109.
129. Li, H.-W., and Tsai, T.-C. (2017b). Revitalization strategies for abandoned sugar factory sites in Taiwan. *The International Journal of Organizational Innovation*, 10(1), 229–237.
130. Loftness, V., Aziz, A., Choi, J., Kampschroer, K., Powell, K., Atkinson, M., and Heerwagen, J. (2009). The value of post-occupancy evaluation for building occupants and facility managers. *Intelligent Buildings International*, 1(4), 249–268.
131. Manewa, A., Siriwardena, M., Ross, A., and Madanayake, U. (2016). Adaptable buildings for sustainable built environment. *Built Environment Project and Asset Management*, 6(2), 139–158.
132. Manu, P., Ankrah, N., Proverbs, D., and Suresh, S. (2010). The contribution of construction project features to accident causation and health and safety risk: A conceptual model. In *26th Annual ARCOM Conference, 6-8 September 2010* (pp. 261–269). Leeds: Association of Researchers in Construction Management.
133. Manu, P., Ankrah, N., Proverbs, D., and Suresh, S. (2012). The health and safety impact of construction project features. *Engineering, Construction and Architectural Management*, 21(1), 65–93.
134. Máte, K. (2011). Resource efficiency. In *Workplace Strategies and Facilities Management: Building in Value* (pp. 352–377). London: Spon Press.
135. Mehr, S. Y., and Wilkinson, S. (2018). Technical issues and energy efficient adaptive reuse of heritage listed city halls in Queensland Australia. *International Journal of Building Pathology and Adaptation*, 36(5), 529–542.
136. Mİsİrİlİsoy, D., and Günçe, K. (2016). Adaptive reuse strategies for heritage buildings: A holistic approach. *Sustainable Cities and Society*, 26, 91–98.
137. Mohamed, N., and Alauddin, K. (2016). The criteria for decision making in adaptive reuse towards sustainable development. In *The 4th International Building Control Conference 2016 (IBCC 2016)* (Vol. 66, pp. 1–6).
138. Mui, L. Y., Ahmad, Y., and Nabavi, F. (2016). Causes of high variance in building conservation tenders in Malaysia. *Structural Survey*, 34(2), 98–116.
139. Muir, A. (2011). Space Management. In *Workplace Strategies and Facilities Management: Building in Value* (pp. 81–103). London: Spon Press.
140. Mukaka, M. . (2012). Statistics Corner: A guide to appropriate use of Correlation coefficient in medical research. *Malawi Medical Journal*, 24(3), 69–71.
141. Muldoon-Smith, K., and Greenhalgh, P. (2016). Greasing the wheels, or a spanner in the works? Permitting the adaptive re-use of redundant office buildings into residential use in England. *Planning Theory and Practice*, 17(2), 175–191.
142. Naidu, K. G. (2008). The restoration and upgrading of the 100 year old Victoria Institution: The adaptive reuse of a school into an auditorium. In *I1DBMC International Conference on Durability of Building Materials and Components ISTANBUL*.

143. Niu, S., Lau, S. S. Y., Shen, Z., and Lau, S. S. Y. (2018). Sustainability issues in the industrial heritage adaptive reuse: rethinking culture-led urban regeneration through Chinese case studies. *Journal of Housing and the Built Environment*, 33, 501–518.
144. Nunnally, S. W. (2014). *Construction Methods and Management*. Edinburgh, Gate Harlow: Pearson Education Limited.
145. Nwachukwu, C. V., Udeaja, C., Chileshe, N., and Okere, C. E. (2017). The critical success factors for stakeholder management in the restoration of built heritage assets in the UK. *International Journal of Building Pathology and Adaptation*, 35(4), 304–331.
146. Olivadese, R., Remøy, H., Berizzi, C., and Hobma, F. (2017). Reuse into housing: Italian and Dutch regulatory effects. *Property Management*, 35(2), 165–180.
147. Oppong, R. ., and Masahudu, M. (2014). Exploration of building adaptations and retrofitting challenges in Ghana: The case of selected rural bank projects. *Structural Survey*, 32(5), 349–364.
148. Orbasli, A. (2009). The conservation of coral buildings on Saudi Arabia's northern Red Sea coast. *Journal of Architectural Conservation*, 15(1), 49–64.
149. OXFORD. (2011). *Oxford Wordpower Dictionary*. Oxford: Oxford University Press.
150. Papadakis, G. A., and Amendola, A. (1997). *Guidance on the Preparation of a Safety Report to Meet the Requirements of Council Directive 96/82/EC (Seveso II)*. Luxembourg: Joint Research Centre, European Commission.
151. Petković-Grozdanovića, N., Stoiljković, B., Keković, A., and Murgul, V. (2016). The possibilities for conversion and adaptive reuse of industrial facilities into residential dwellings. *Procedia Engineering*, 165, 1836–1844.
152. Peurifoy, R. L., Schexnayder, C. J., Shapira, A., and Schmitt, R. L. (2011). *Construction Planning, Equipment, and Methods* (8th ed.). New York: McGraw - Hill Companies.
153. Pinder, J. A., Schmidt, R., Austin, S. A., Gibb, A., and Saker, J. (2017). What is meant by adaptability in buildings? *Facilities*, 35(1/2), 2–20.
154. Pinto, J. K., and Prescott, J. E. (1988). Variations in critical success factors over the stages in the project life cycle. *Journal of Management*, 14(1), 5–18.
155. Preiser, W. F. ., Rabinowitz, H. Z., and White, E. (1988). *Post Occupancy Evaluation*. New Yourk: Van Nostrand Reinhold.
156. Preiser, W. F. E., and Schramm, U. (2005). A conceptual framework for building performance evaluation. In *Assessing Building Performance* (pp. 15–26). Oxford: ElsevierButterworth-Heinemann.
157. Pryke, W. M., Whiting, P. J., Pang, S., Kaur, R., and Wilmot, C. (1997). Systems integration throughout the early life cycle. *BT Technology Journal*, 15(3), 9–18.
158. Rayman, M., Boyle, R., Yang, A. Y., and Tangari, J. (2017). Adaptive reuse: a review and analysis of its relationship to the 3 Es of sustainability. *Facilities*, 35(3), 138–154.
159. Remøy, H. (2010). *Out of Office: A Study on the Cause of Office Vacancy and Transformation as a Means to Cope and Prevent*. Delft University of Technology.
160. Remøy, H., Jong, P. de, and Schenk, W. (2011). Adaptable office buildings buildings. *Property Management*, 29(5), 443–453.

161. Remøy, H., and Voordt, T. van der. (2007). A new life: Conversion of vacant office buildings into housing. *Facilities*, 25(3), 88–103.
162. Remøy, H., and Voordt, T. van der. (2014). Adaptive reuse of office buildings: opportunities and risks of conversion into housing. *Building Research & Information*, 42(3), 381–390.
163. Riggs, W., and Chamberlain, F. (2018). The TOD and smart growth implications of the LA adaptive reuse ordinance. *Sustainable Cities and Society*, 38, 594–606.
164. Rockow, Z. R., Ross, B., and Black, A. K. (2019). Review of methods for evaluating adaptability of buildings. *International Journal of Building Pathology and Adaptation*, 37(3), 273–287.
165. Rodrigues, C., and Freire, F. (2017). Adaptive reuse of buildings: Eco-efficiency assessment of retrofit strategies for alternative uses of an historic building. *Journal of Cleaner Production*, 157, 94–105.
166. Ruan, X., Ochieng, E. G., Price, A. D. F., and Egbu, C. (2012). Knowledge integration process in construction projects: a social network analysis approach to compare competitive and collaborative working. *Construction Management and Economics*, 30(1), 5–19 Knowledge.
167. Sanchez, B., and Ralph, C. H. (2018). A novel selective disassembly sequence planning method for adaptive reuse of buildings. *Journal of Cleaner Production*, 183, 998–1010.
168. Sanni-Anibire, M. O., Mahmoud, A. S., Hassanain, M. A., and Salami, B. A. (2020). A risk assessment approach for enhancing construction safety performance. *Safety Science*, 121, 15–29.
169. Šerifi, V., Dašić, P., Jecmenica, R., and Labovic, D. (2009). Functional and information modeling of production using IDEF methods. *Journal of Mechanical Engineering*, 55(2), 131–140.
170. Shah, U. A. (2014). A review on structural integrity assessment procedures. *International Journal of Structural Integrity*, 5(4), 328–338.
171. Shehada, Z. M. M., Ahmad, Y. Bin, Yaacob, N. M., and Keumala, N. I. M. (2015). Developing methodology for adaptive re-use: Case study of heritage buildings in Palestine. *Archnet-IJAR*, 9(2), 216–229.
172. Shehata, W. T. A., Moustafa, Y., and Sherif, L. (2015). Towards the comprehensive and systematic assessment of the adaptive reuse of Islamic architectural heritage in Cairo: A conceptual framework. *Journal of Cultural Heritage Management and Sustainable Development*, 5(1), 14–29.
173. Shen, L., and Langston, C. (2010). Adaptive reuse potential: An examination of differences between urban and non-urban projects. *Facilities*, 28(1), 6–16.
174. Sherratt, F., Farrell, P., and Noble, R. (2013). UK construction site safety: discourses of enforcement and engagement. *Construction Management and Economics*, 31(6), 623–635.
175. Shipley, R., Utz, S., and Parsons, M. (2006). Does adaptive reuse pay? A study of the business of building renovation in Ontario, Canada. *International Journal of Heritage Studies*, 12(6), 505–520.

176. Sofiana, R., Ourwantiasning, A., and Anisa. (2015). An implementation strategy of the adaptive reuse concept for historical old buildings within the Jakarta Old Town Area. In *6th Seminar of Urban Policies Environmental Land Management for Local and Regional Development*.
177. Sugden, E. (2017). *The Adaptive Reuse of Industrial Heritage Buildings: A Multiple-Case Studies Approach*. University of Waterloo.
178. Szarejko, W., and Trocka-Leszczynska, E. (2007). Aspect of functionality in modernization of office buildings. *Facilities*, 25(3), 163–170.
179. Tam, V. W. Y., Fung, I. W. H., and Sing, M. C. P. (2016). Adaptive reuse in sustainable development: An empirical study of a Lui Seng Chun building in Hong Kong. *Renewable and Sustainable Energy Reviews*, 65, 635–642.
180. Tan, A. Z. T., Zaman, A., and Sutrisna, M. (2018). Enabling an effective knowledge and information flow between the phases of building construction and facilities management. *Facilities*, 36(3), 151–170.
181. Tatum, C. B. (1988). Classification system for construction technology. *Journal of Construction Engineering and Management*, 114(3), 344–363.
182. Thuvander, L., Femenías, P., Mjörnell, K., and Meiling, P. (2012). Unveiling the process of sustainable renovation. *Sustainability*, 4(6), 1188–1213.
183. Velthuis, K., and Spennemann, D. H. R. (2007). The future of defunct religious buildings: Dutch approaches to their adaptive re-use. *Cultural Trends*, 16(1), 43–66.
184. Watson, P. (2009). The key issues when choosing adaptation of an existing building over new build. *Journal of Building Appraisal*, 4(3), 215–223.
185. Webb, R. S., Kelly, J. R., and Thomson, D. S. (2015). Building services component reuse : an FM response to the need for adaptability. *Facilities*, 15(12), 1997.
186. Wilkinson, S. (2011). *The Relationship between Building Adaptation and Property Attributes*. Deakin University.
187. Wilkinson, S. (2012a). Adaptation patterns in premium office buildings over time in the Melbourne CBD. *Journal of Corporate Real Estate*, 14(3), 157–170.
188. Wilkinson, S. (2012b). Analysing sustainable retrofit potential in premium office buildings. *Structural Survey*, 30(5), 398–410.
189. Wilkinson, S. (2014). How buildings learn: Adaptation of low grade commercial buildings for sustainability in Melbourne. *Facilities*, 32(7), 382–395.
190. Wilkinson, S., James, K., and Reed, R. (2009). Using building adaptation to deliver sustainability in Australia. *Structural Survey*, 27(1), 46–61.
191. Wilkinson, S., and Reed, R. G. (2011). Examining and quantifying the drivers behind alterations and extensions to commercial buildings in a central business district. *Construction Management and Economics*, 29(7), 725–735.
192. Wilkinson, S., and Remøy, H. (2015). Building resilience in urban settlements through conversion adaptation. In *RICS COBRA AUBEA 2015: The Construction, Building and Real Estate Research Conference of the Royal Institution of Chartered Surveyors, The Australasian Universities' Building Educators Association Conference, Sydney, Australia, 8-10 July 2015*. Sydney: Royal Institution of Chartered Surveyors (RICS).

193. Wilkinson, S., and Remøy, H. (2017). Adaptive reuse of Sydney offices and sustainability. *Sustainable Buildings*, 2(6), 10.
194. Wilkinson, S., and Remøy, H. (2018). *Building Urban Resilience through Change of Use*. Chichester, West Sussex: John Wiley & Sons, Ltd.
195. Wilkinson, S., Remøy, H., and Langston, C. (2014). *Sustainable Building Adaptation: Innovations in Decision-Making*. Chichester, West Sussex: John Wiley & Sons, Ltd.
196. Wordsworth, P. (2001). *Lee's Building Maintenance Management* (4th ed.). Malden: Wiley-Blackwell.
197. Wu, S., Clements-Croome, D., Fairey, V., Albany, B., and Neale, K. (2006). Reliability in the whole life cycle of building systems. *Engineering, Construction and Architectural Management*, 13(2), 136–153.
198. Yadollahi, M., and Zin, R. (2011). Applied multi-criteria ideal rehabilitation model for budget allocation across road infrastructure. *International Journal of Innovation Science*, 3(4), 193–202.
199. Yaldiz, E., and Asatekin, N. G. (2013). Definition of a new design process for the reuse of monumental buildings. In *Central Europe towards Sustainable Building (CESB 2013): Sustainable refurbishment of existing building stock*. Prague. Retrieved from http://www.cesb.cz/cesb13/proceedings/1_refurbishment/CESB13_1353.pdf
200. Yoon, J., and Lee, J. (2019). Adaptive reuse of apartments as heritage assets in the Seoul station urban regeneration area. *Sustainability*, 11(11), 3124.
201. Yung, E. H. K., and Chan, E. H. W. (2012). Implementation challenges to the adaptive reuse of heritage buildings: Towards the goals of sustainable, low carbon cities. *Habitat International*, 36(3), 352–361.
202. Yung, E. H. K., Langston, C., and Chan, E. H. W. (2014). Adaptive reuse of traditional Chinese shophouses in government-led urban renewal projects in Hong Kong. *Cities*, 39, 87–98.
203. Zavadskas, E., Kaklauskas, A., and Kvederyte, N. (2001). Multivariant design and multiple criteria analysis of a building life cycle. *Informatica*, 12(1), 169–188.
204. Zivkovic, M., Oliynyk, O., and Murgul, V. A. (2016). Reconstruction of urban areas: Sustainable strategy of obsolete building conversion to residential uses. *Construction of Unique Buildings and Structures*, (1), 102–111.

APPENDIX A:

LIST OF ADAPTIVELY REUSED BUILDINGS IN DAMMAM METROPOLITAN AREA

A.1 Overview

The practice of adaptive reuse of buildings started to take place in Saudi Arabia since a long time. This appendix covers examples and information of some of adaptively reused buildings in Saudi Arabia. The author performed a random documentation of adaptively reused buildings in Dammam Metropolitan Area, as shown in **Figure A.1**. Information regarding the name, location, coordinates, original and new functions, and date/period of adaptation of these buildings are presented in **Table A.1**.

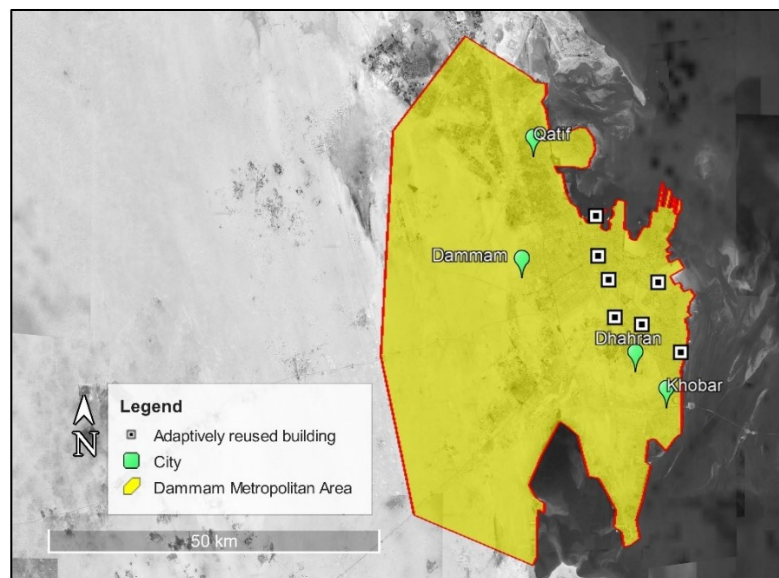


Figure A.1: Random documentation of adaptively reused buildings in Dammam Metropolitan Area

Source: The author (February 10, 2019)

Table A.1: Information about the documented adaptively reused buildings in Dammam Metropolitan Area

No.	Name/Title	Location	Coordinates	Original use	New function	Date /Period
1	Building 50	Western Campuses, Imam Abdulrahman Bin Faisal University, Dammam, Eastern Province, Saudi Arabia	Latitude = 26°23'19.64"N Longitude = 50°11'10.19"E	Student housing	Office building	1985
2	Assets Protection Training Center	South Doha Neighborhood, Dhahran, Eastern Province, Saudi Arabia	Latitude = 26°19'54.02"N Longitude = 50° 9'40.58"E	Kids' amusement center (Toy Town)	Institution	During the end of the 1990s
3	Alhokair Time Amusement Center	Al-Khobar Al Shamalia Neighborhood, Khobar, Eastern Province, Saudi Arabia	Latitude = 26°17'38.35"N Longitude = 50°13'13.45"E	Bookstore (Obiekan Bookstore)	Kid's amusement center	Between 2015 and 2017
4	Al Faraby Medical Center	Doha Neighborhood, Dhahran, Eastern Province, Saudi Arabia	Latitude = 26°19'47.30"N Longitude = 50° 9'44.02"E	Office building (NAF Company)	Polyclinic	1996
5	Petromin Express Center	Al-Adamah Neighborhood, Dammam, Eastern Province, Saudi Arabia	Latitude = 26°25'28.39"N Longitude = 50° 5'42.29"E	Supermarket (Tamim Supermarket)	Car show and workshop	Between 2001 to 2003

A.2 Discussion

From the presented sample, it was noticed that adaptive reuse of buildings started to take place in Saudi Arabi since the 20th century. It indicated also that adaptive reuse is implemented in different kind of buildings, with different patterns of alteration. This implies that this practice is carried out randomly in Saudi Arabia.

APPENDIX B:
A/Es' QUESTIONNAIRE SURVEY (ARABIC AND
ENGLISH)

*Development of A Framework for the Effective Implementation of
Building Adaptive Reuse throughout the Project Life-Cycle in Saudi
Arabia*

Section (A): Summary and Demographic Questions

Dear Sir,

Adaptive reuse of buildings is the process of converting the use of an existing building, to fulfill a change in its function according to the requirements of new/current owner, where the changes might consist of refurbishment and/or full renovation of the building. The implementation of such practice has been started to take place in many building projects in Saudi Arabia, since more than two decades. Accordingly, there is a need for understanding the adaptive reuse practices in the architecture/engineering (A/E) profession of Saudi Arabia. Further, it was noted that there are several factors influencing these projects throughout the phases of their life-cycle, namely: conceptual planning, design, construction, and operation and maintenance phases. In this regard, this questionnaire survey aims to investigate the current practice of building adaptive reuse in the A/E sector of Saudi Arabia, as well as assess the factors influencing such practice throughout its life-cycle. It consists of four sections, namely: summary and demographic questions, local practice investigation, assessment of factors, and additional remarks. Kindly fill this questionnaire as fully as possible, with all thanks and appreciation to you for your valuable contributions. Note that the study is conducted by a researcher from King Fahd University of Petroleum and Minerals, Dhahran, so all information that will be obtained from the survey will be used for a research purpose.

Regards,

Researcher. Mohammad Basel Hamida,
Architectural Engineering Department,
King Fahd University of Petroleum and Minerals,
Dhahran, Saudi Arabia
Email: g201703050@kfupm.edu.sa
Mobile phone: +966532254941

1. Respondent Information

Name	
Organization	
Organization address	
Phone	
Email address	

2. What is your scope of work at the A/E organization?

- ☐ Architect
- ☐ Building services (MEP) engineer
- ☐ Structural engineer
- ☐ Building design coordinator / Project manager
- ☐ Other (please specify) _____.

3. Please indicate your years of experience

☐ Less than 5 years	☐ 5 to 10 years
☐ 10 to 20 years	☐ Over 20 years

4. Have you been involved in the design of adaptive reuse projects before (in Saudi Arabia)?

☐ Yes	☐ No
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*Please don't fill the survey questionnaire if your answer is "No" and give the survey questionnaire to the person who is concerned with such kind of projects

5. Please indicate the number of adaptive reuse projects that you have been involved in before (in Saudi Arabia)

☐ 1 - 5 projects	☐ 5 – 10 projects	☐ More than 10 projects
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6. Types of Projects that you mostly deal with (multiple selection is allowed)

- ☐ Apartment Buildings
- ☐ Single Houses (Villas)
- ☐ Shops
- ☐ Office Buildings
- ☐ Educational buildings
- ☐ Recreational buildings
- ☐ Commercial centers/shopping malls
- ☐ Other (Please Specify) _____.

Section (B): Investigation of the Local Practice

Kindly answer all questions below as fully as possible.

1. Please identify the scenarios of adaptive reuse of buildings that are common in Saudi Arabia

- ☐ Converting a building from a commercial into residential use (e.g. from an office building to an apartment building)
- ☐ Converting a building from a commercial into another commercial use (e.g. from a restaurant to a shop, or from supermarket to an exhibition hall for car sale)
- ☐ Converting a building from a commercial into medical use (e.g from an office building to a polyclinic)
- ☐ Converting a building from a residential into commercial use (e.g. from an apartment building to an office building or commercial shops)
- ☐ Converting a building from a residential into medical use (e.g from a hotel to a hospital)
- ☐ Converting a building from an industrial into commercial use(e.g from a factory to a store)
- ☐ Other (please specify) _____.

2. Please provide a brief description of your practice in designing adaptive reuse projects, starting from the initiation phase until the completion of the project.

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3. Please identify all the drivers of adaptive reuse of buildings in Saudi Arabia

- ☐ A new tenant of a building after leasing that building.
- ☐ The building owner, in order to change the existing business/ service of the building to another use due to various forms of obsolescence (physical, economic, functional, technological and legal).
- ☐ Real estate organizations to provide more revenues from the new function use of the building.
- ☐ The legal authorities to revive heritage buildings
- ☐ Other (please specify) _____.

4. Please indicate the methods used for the communication between the parties during the design and/or preparation of the documents of adaptive reuse projects

- ☐ Workshops during the design development and review phases.
- ☐ Informal meeting with all parties of the project
- ☐ Formal meeting with all parties of the project
- ☐ Other (please specify) _____.

5. Please indicate the types of information and data needed during the design and/or preparation of documents of adaptive reuse projects

- ☐ As-built architectural blueprints
- ☐ As-built structural blueprints
- ☐ As-built services (MEP) blueprints
- ☐ As-built construction details' drawings
- ☐ Construction specifications
- ☐ Systems and equipment manuals
- ☐ Design calculations/ design calculation sheet for all systems
- ☐ Legal approvals
- ☐ Other (please specify) _____.

6. Please indicate the methods followed for collecting information and/or data needed (including stockholders' requirements) for the design and/or preparation of documents of adaptive reuse projects

- ☐ Direct contact with the owner / or owner's representative
- ☐ Direct contact with the project manager
- ☐ Direct contact with the real estate organization that leases/operates the building
- ☐ Direct request during the meetings and/or workshops with the project parties
- ☐ Other (please specify) _____.

7. Please indicate the types of utilized tool(s) for the design and/or development of documents of adaptive reuse projects

- ☐ Computer-Aided Design (CAD)
- ☐ Building Information Modeling (BIM)
- ☐ Manual drafting
- ☐ Word processing applications
- ☐ Other (please specify) _____.

8. Please identify all the applicable challenges that could face the A/E during the design and/or preparation of the documents of adaptive reuse projects

- ☐ Time allocated to complete the preparation of the documents
- ☐ Budget allocated to complete the documents
- ☐ Lack of client's experience on the adaptive reuse of projects
- ☐ Lack of data and information
- ☐ Limitation on the area to achieve the space requirements of the new function
- ☐ Inaccurate as-built drawings
- ☐ Lack of flexibility due to the layout of the structural system
- ☐ Lack of flexibility due to the layout of the original architectural configuration
- ☐ Lack of flexibility due to the layout of MEP systems
- ☐ Inadequate structural integrity to accommodate the newly imposed loads

- ☐ Inadequate capacity of the existing MEP systems to suit the requirements of the new function
- ☐ Ability to accommodate the requirements and needs of the new users
- ☐ Ability to satisfy the requirements of design codes and standards
- ☐ Other (please specify) _____.

9. Please indicate, which of the following systems would be affected by the requirements of the new function in adaptive reuse projects

- ☐ Structural system (foundations, columns, beams, slabs, shear walls)
- ☐ Construction systems (internal partitions, building facade, doors, windows, finishes, ceilings)
- ☐ MEP systems (HVAC, plumbing and fire protection systems, electrical systems)
- ☐ Other (please specify) _____.

10. Please suggest methods for improving the design process of adaptive reuse projects

- ☐ Development of adequate architectural program for the new function in the early design process.
- ☐ Identify the client budget
- ☐ Review the design with the client periodically
- ☐ Other (please specify) _____.

Section (C): Evaluation of the Factors Affecting Building Adaptive Reuse throughout the Project Life-Cycle

Kindly assess the level of importance of the factors mentioned in the table below, according to the scale shown.

Factors Influencing the Implementation of Building Adaptive Reuse		Importance Level				
		Extremely Important	Very Important	Important	Somewhat Important	Not Important
A) Factors Related to the Phase of Conceptual Planning and Feasibility Studies						
1.	Structural integrity of the building					
2.	Municipal approval for the land use change					
3.	The condition of building components and/or systems					
4.	Architectural program of the new function					
5.	Potential of the building spaces to be adaptively reused					
6.	Allocated budget for the adaptation process					
7.	Expected yield from the adaptation					
8.	The schedule of the adaptation activities					
9.	Compatibility of the building appearance with the client desired design					
	Other (Please specify)					
B) Factors Related to the Design and Engineering Phase						
10.	Previous experience of the design team with adaptive reuse projects					
11.	Code requirements for the new occupancy					
12.	Availability and accuracy of the drawings and specifications of the existing project					
13.	Net area of the adaptable space					
14.	Layout of spaces within the building					
15.	Number and layout of the structural columns					
16.	Layout of the existing MEP systems					
17.	Capacity of the existing MEP systems					
18.	Potential to install additional and/or new systems					
19.	Site configuration and requirements					
20.	Sustainability and energy saving measures					
	Other (Please specify)					

C) Factors Related to the Construction Phase						
21.	Previous experience of the contractor with adaptive reuse projects					
22.	Accuracy and completeness of the contract documents					
23.	Availability of skilled workforce					
24.	Construction equipment and methods					
25.	Planning and control of the financial resources					
26.	Quality assurance / control requirements					
27.	Complexity and difficulties within the project site					
28.	Availability and accessibility of loading space					
29.	Availability of spaces for storing the construction materials and equipment					
30.	Enforcement and management of safety procedures at the project site					
	Other (Please specify)					
D) Factors Related to Operation and Maintenance Phase						
31.	Availability and adequacy of the commissioning process for the MEP systems					
32.	Availability of accurate records of the building assets					
33.	Efficiency of the utilization of the building spaces					
34.	Compliance with health and safety measures					
35.	Development and implementation of work schedules for different maintenance types (e.g. planned, unplanned)					
36.	Potentiality of obsolescence and/or deterioration of building components and/or systems					
37.	Control over the operational characteristics of the building components and systems					
38.	User satisfaction with the layout of the building as well as the workflow of activities					
	Other (Please specify)					
Other Factors (Please Specify)						
1.						
2.						
3.						
4.						
5.						

Section (D): Additional Remarks (Optional)

Kindly if you have additional information/clarification that might enhance the research, please don't hesitate to mention them in the available below area:

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Thank you for your consideration and cooperation

تطوير إطار للتنفيذ الفعال لعملية إعادة الإستخدام المتكيف للمبنى طوال دورة حياة المشروع

القسم (أ): الخلاصة والأسئلة الديموغرافية

أخي الكريم

إن إعادة الإستخدام المتكيف للمباني هي عملية تحويل إستخدام مبنى قائم لتغييره وظيفته وفقاً لمتطلبات المستخدم الحالي أو الجديد للمبنى ، حيث تشمل عملية التحويل على إجراء أعمال تجديد للمبنى بالإضافة إلى كونها من المحتمل أيضاً قد تشمل على أعمال ترميم. وإن تنفيذ هذا النوع من الممارسات أصبح ينفذ بشكل واضح في العديد من مشاريع المباني بالمملكة العربية السعودية لمدة تزيد عن عقدين من الزمن ، ولذلك فإن هنالك حاجة إلى فهم طبيعة هذه الممارسة في قطاع الإستشارات الهندسية في المملكة العربية السعودية. لوحظ أيضاً أن هنالك مصفوفة من العوامل المؤثرة على ذات المشاريع طوال مختلف مراحل دورة حياتها مروراً بالتصميم المبدئي والتصميم الهندسي و التنفيذ ووصولاً إلى مرحلة التشغيل والصيانة. وفي هذه الصدد فإن هذا الإستبيان يهدف إلى فهم الممارسة الحالية لمشروعات إعادة الإستخدام المتكيف في قطاع الإستشارات الهندسية بالمملكة العربية السعودية ، إضافةً إلى تقييم العوامل المؤثرة على ذات المشاريع طوال دورة حياتها. يرجى منك ملء الإستبيان التالي على أكمل وجه ممكن مع كامل الشكر والتقدير على تعاونكم وإسهاماتكم القيمة . وختاماً لا بد أن ننوه بأن الدراسة يجريها باحث من قسم الهندسة المعمارية بجامعة الملك فهد للبترول والمعادن بالظهران، حيث إن جميع المعلومات التي سيتم الحصول عليها ستستخدم لغرض بحثي فقط.

وتقبل خالص تحياتي

الباحث/ محمد باسل حميده

قسم الهندسة المعمارية

جامعة الملك فهد للبترول و المعادن

الظهران – المملكة العربية السعودية

البريد الإلكتروني: g201703050@kfupm.edu.sa

الهاتف النقال: ٠٥٣٢٢٥٤٩٤١

١. بيانات المجيب

الاسم	
المؤسسة	
عنوان المؤسسة	
الهاتف	
البريد الإلكتروني	

٢. ما هو مجال عملك المهني في المكتب الهندسي أو (المكتب الاستشاري) الذي تعمل به؟

- ☐ معماري
- ☐ مهندس نظم خدمات المباني (الانظمة الميكانيكية والكهربائية والسباكة)
- ☐ مهندس إنشائي
- ☐ منسق تصاميم المباني (أو مدير المشاريع)
- ☐ غير ذلك (حددها من فضلك) _____.

٣. يرجى تبين عدد سنوات خبرتك المهنية

☐ أقل من (٥) سنوات	☐ من (٥) إلى (١٠) سنوات
☐ من (١٠) سنوات إلى (٢٠) سنة	☐ أكثر من ٢٠ سنة

٤. هل سبق لك المشاركة في تصميم مشاريع إعادة الاستخدام المتكيف للمباني في المملكة العربية السعودية؟

☐ نعم	☐ لا
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*الرجاء عدم تعبئة الاستبيان إذا كانت الإجابة "لا" وإعطاء الاستبيان بالشخص المعني بذلك

٥. يرجى تبين عدد مشاريع إعادة الاستخدام المتكيف للمباني التي قمت بالمشاركة في تصميمها بالمملكة العربية السعودية

☐ ١ - ٥ مشاريع	☐ ٥ - ١٠ مشاريع	☐ أكثر من ١٠ مشاريع
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٦. نوع المشاريع التي تتعامل معها في غالب الأحيان

- ☐ مباني شقق
- ☐ بيوت منفردة (فلل)
- ☐ محلات
- ☐ مباني مكتبية
- ☐ مباني تعليمية
- ☐ مباني ترفيهية
- ☐ مراكز تجارية – مجمعات تجارية
- ☐ غير ذلك (حددها من فضلك) _____.

القسم (ب): استقصاء الممارسة المحلية

يرجى الإجابة على الأسئلة أدناه على أكمل وجه ممكن

١. يرجى تحديد السيناريوهات الأكثر شيوعاً لمشروعات إعادة الاستخدام المتكيف للمباني في المملكة العربية السعودية

- ☐ يتم تحويل المبنى من إستخدام تجاري إلى استخدام سكني (مثال: من مبنى مكتبي إلى مبنى شقق سكنية)
- ☐ يتم تحويل المبنى من إستخدام تجاري إلى استخدام تجاري آخر (مثال: من مطعم إلى محل تجاري ، ومن مركز تسوق إلى معرض سيارات)
- ☐ يتم تحويل المبنى من إستخدام تجاري إلى إستخدام طبي (مثال: من مبنى مكتبي إلى مبنى عيادات)
- ☐ يتم تحويل المبنى من إستخدام سكني إلى استخدام تجاري (مثال: من مبنى شقق سكنية إلى مبنى مكتبي أو محل تجاري)
- ☐ يتم تحويل المبنى من إستخدام سكني إلى استخدام طبي (مثال: من فندق إلى مبنى عيادات)
- ☐ يتم تحويل المبنى من إستخدام صناعي إلى تجاري (مثال: من مصنع إلى معرض تجاري)
- ☐ غير ذلك (يرجى التوضيح) _____.

٢. يرجى تقديم وصف موجز لممارستك في تصميم مشاريع إعادة الاستخدام المتكيف للمباني بشكل متكيف بما في ذلك عملية البدء وحتى إكمال المشروع

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٣. يرجى تحديد دوافع ممارسة مشروعات إعادة الإستخدام المتكيف للمباني في المملكة العربية السعودية

- ☐ مستأجر جديد للمبنى بعد إستئجاره للمبنى
- ☐ مالك المبنى من أجل تغير الخدمة أو الوظيفة القائمة إلى وظيفة أو خدمة أخرى نتيجة لتقدم المبنى من النواحي المختلفة كالوظيفية والفزيائية والتقنية والنظامية
- ☐ المؤسسة العقارية التي تقوم بتأجير و تسويق المبنى ، من أجل تشكيل موارد إستثمار أكثر فاعلية من خلال الإستخدام الجديد
- ☐ الجهات النظامية من أجل الحفاظ على المباني التراثية
- ☐ غير ذلك (يرجى التوضيح) _____.

٤. يرجى تبين طرق الإتصال المستخدمة في التواصل بين أطراف المشروع أثناء تصميم أو إعداد وثائق التشييد الخاصة بمشروع إعادة الإستخدام المتكيف للمبنى

- ☐ حلقات (ورش) عمل أثناء مرحلتي تطوير ومراجعة التصميم
- ☐ إجتماع غير رسمي مع جميع أطراف المشروع
- ☐ إجتماع رسمي مع جميع أطراف المشروع
- ☐ غير ذلك (يرجى التوضيح) _____.

٥. يرجى الإشارة إلى المعلومات والبيانات اللازم تواجدها أثناء تصميم و إعداد وثائق التشييد الخاصة بمشروعات إعادة إستخدام المباني بشكل متكيف

- ☐ المخططات المعمارية للمبنى حسب التنفيذ
- ☐ المخططات الإنشائية للمبنى حسب التنفيذ
- ☐ مخططات النظم الخدمية للمبنى حسب التنفيذ
- ☐ تفاصيل التشييد (التفاصيل المعمارية) حسب التنفيذ
- ☐ مواصفات المبنى
- ☐ كتيبات الأنظمة والمعدات

- ☐ حسابات التصميم (وثائق الحسابات التصميمية) لجميع الأنظمة (التي تشمل كلاً من الأنظمة الإنشائية والأنظمة الخدمية بأكملها)
- ☐ الموافقات القانونية
- ☐ غير ذلك (يرجى التوضيح) _____.

٦. يرجى الإشارة إلى الأساليب المتبعة لجمع المعلومات والبيانات اللازم تواجدها أثناء تصميم وإعداد وثائق التشييد الخاصة بمشاريع إعادة الإستخدام المتكيف للمباني

- ☐ الإتصال المباشر بالمالك أو بمن يمثله
- ☐ الإتصال المباشر بمدير المشروع
- ☐ الإتصال المباشر بالمكتب العقاري الذي يقوم بتأجير أو إدارة المبنى
- ☐ طلب مباشر أثناء الاجتماعات أو ورش العمل مع أطراف المشروع
- ☐ غير ذلك (يرجى التوضيح) _____.

٧. يرجى الإشارة الأداة أو مجموعة لأدوات المستخدمة في تصميم وإعداد وثائق التشييد الخاصة بمشاريع إعادة الإستخدام المتكيف للمباني

- ☐ التصميم بمساعدة الحاسوب (CAD)
- ☐ نمذجة معلومات المباني (BIM)
- ☐ الرسم اليدوي
- ☐ تطبيقات معالجة النصوص
- ☐ غير ذلك (يرجى التوضيح) _____.

٨. يرجى تحديد التحديات التي قد تنطبق وتواجه الإستشاري أثناء تصميم وإعداد وثائق التشييد لمشاريع إعادة الإستخدام المتكيف للمباني

- ☐ الوقت المخصص لإكمال الوثائق
- ☐ الميزانية المخصصة لاستكمال الوثائق
- ☐ نقص خبرة عميل مشروع إعادة إستخدام المبنى بشكل متكيف
- ☐ نقص البيانات والمعلومات

- ☐ قيود في الفراغ المتاح لتحقيق المتطلبات المساحية للوظيفة الجديدة
- ☐ قلة دقة رسومات المبنى حسب التنفيذ
- ☐ قلة المرونة التصميمية بسبب تخطيط وتوزيع النظام الإنشائي
- ☐ قلة المرونة التصميمية بسبب التصميم المعماري الأصلي
- ☐ قلة المرونة التصميمية بسبب تخطيط الأنظمة الخدمية (النظم الكهربائية والميكانيكية والسباكة)
- ☐ ضعف السلامة الأنشائية للمبنى وقدرتها على إستيعاب الأحمال المفروضة من الوظيفة الجديدة
- ☐ عدم الكفاية في سعة النظم الخدمية الحالية لملائمة متطلبات الوظيفة الجديدة
- ☐ المقدرة على تلبية إحتياجات ومتطلبات المستخدمين الجديد للمبنى
- ☐ المقدرة على تلبية متطلبات معايير وكودات البناء والتصميم
- ☐ غير ذلك (يرجى التوضيح) _____.

٩. يرجى الإشارة إلى الأنظمة التي تتأثر عادةً بمتطلبات الوظيفة الجديدة لمشروعات إعادة إستخدام المباني بشكل متكيف

- ☐ النظام الإنشائي (القواعد والأعمدة والجسور والبلاطات والحوائط الحاملة "الحوائط الإنشائي")
- ☐ نظم التشييد (الحوائط الداخلية وواجهات المبنى ولأبواب والنوافذ والتشطيبات والأسقف المستعارة)
- ☐ نظم خدمات المبنى (أنظمة التكييف والسباكة والكهربائية)
- ☐ غير ذلك (يرجى التوضيح) _____.

١٠. يرجى إقتراح أساليب وآليات لتطوير عملية تصميم مشاريع إعادة الإستخدام المتكيف للمبنى

- ☐ تطوير برنامج معماري كافي للوظيفة الجديدة أثناء المرحلة الأولى من التصميم
- ☐ تحديد ميزانية العمل
- ☐ مراجعة التصميم مع العميل بشكل دوري
- ☐ غير ذلك (يرجى التوضيح) _____.

القسم (ج): تقييم العوامل المؤثرة على دورة حياة مشاريع إعادة الاستخدام المتكيف

يرجى تقييم مستوى الأهمية الخاص بكل عامل مذكور بالجدول أدناه وفقاً للمقياس الموضح:

درجة الأهمية					العوامل المؤثرة على تنفيذ إعادة الاستخدام المتكيف للمباني بشكل فعال
١	٢	٣	٤	٥	
١	٢	٣	٤	٥	
أ) العوامل المتعلقة بمرحلة التخطيط النظري ودراسة الجدوى					
					١. سلامة الهيكل الإنشائي للمبنى
					٢. موافقة البلدية على تغيير استخدام الأرض
					٣. حالة نظم ومكونات المبنى
					٤. البرنامج المعماري للاستخدام الجديد
					٥. قدرة فراغات المبنى على التحويل الوظيفي
					٦. الميزانية المخصصة لعملية التحويل
					٧. العائد المتوقع من التحويل
					٨. جدول أنشطة التحويل
					٩. توافق مظهر المبنى مع التصميم المرغوب من قبل العميل
					أخرى (حددها من فضلك).....
ب) العوامل المتعلقة بمرحلة التصميم الهندسي					
					١٠. الخبرة السابقة لفريق التصميم مع مشاريع إعادة الاستخدام المتكيف للمبنى
					١١. متطلبات كود البناء للاستخدام الجديد
					١٢. توافر ومدى دقة وثائق تصميم ومواصفات المبنى الحالي
					١٣. صافي مساحة الفراغ القابل للتحويل
					١٤. توزيع الفراغات بالمبنى
					١٥. عدد وتوزيع الأعمدة الإنشائية بالمبنى
					١٦. تصميم نظم الخدمات الحالية
					١٧. قدرة نظم الخدمات الحالية
					١٨. إمكانية تركيب نظم جديدة أو إضافية
					١٩. تكوين ومتطلبات الموقع
					٢٠. مقاييس الاستدامة وكفاءة الطاقة
					أخرى (حددها من فضلك).....

ج) العوامل المتعلقة بمرحلة التشييد					
					٢١. خبرة المقاول السابقة مع مشاريع إعادة استخدام المباني بشكل متكيف
					٢٢. دقة وإكمال وثائق العقد
					٢٣. توفر القوى العاملة
					٢٤. طرق ومعدات التشييد
					٢٥. مراقبة وإدارة الموارد المالية
					٢٦. متطلبات ضبط وضمان الجودة
					٢٧. تعقيد موقع المشروع
					٢٨. توافر ووصولية منطقة التحميل
					٢٩. توفر المساحة الكافية لتخزين المواد والمعدات
					٣٠. تنفيذ وإدارة إجراءات السلامة في موقع المشروع
					أخرى (حددها من فضلك).....
د) العوامل المتعلقة بمرحلة التشغيل والصيانة					
					٣١. توافر ودقة إجراءات اختبار نظم خدمات المبنى
					٣٢. وجود سجلات دقيقة لأصول المبنى
					٣٣. كفاءة استخدام فراغات المبنى
					٣٤. الإمتثال إلى مقاييس الصحة والسلامة
					٣٥. تطوير وتنفيذ جداول عمل لأنواع الصيانة المختلفة (على سبيل المثال الأعمال المخططة وغير المخططة)
					٣٦. إمكانية تقادم وتدهور مكونات ونظم المبنى
					٣٧. السيطرة على الخصائص التشغيلية لنظم ومكونات المبنى
					٣٨. رضی المستخدمين عن تصميم المبنى وكذلك سير أنشطة الأعمال
					أخرى (حددها من فضلك).....
عوامل أخرى (حددها من فضلك)					
					١.
					٢.
					٣.
					٤.
					٥.

القسم (د): ملاحظات إضافية (إختياري)

إذا كان لديك معلومات إضافية قد تعزز البحث فيرجى عدم التردد في ذكرها بالمنطقة المتاحة أدناه:

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شكراً لاهتمامك وتعاونك

APPENDIX C:

**CONTRACTORS' QUESTIONNAIRE SURVEY (ARABIC
AND ENGLISH)**

*Development of A Framework for the Effective Implementation of
Building Adaptive Reuse throughout the Project Life-Cycle in Saudi
Arabia*

Section (A): Summary and Demographic Questions

Dear Sir,

Adaptive reuse of buildings is the process of converting the use of an existing building, to fulfill a change in its function according to the requirements of new/current owner, where the changes might consist of refurbishment and/or full renovation of the building. The implementation of such practice has been started to take place in many building projects in Saudi Arabia, since more than two decades. Accordingly, there is a need for understanding the adaptive reuse practices in the construction industry of Saudi Arabia. Further, it was noted that there are several factors influencing these projects throughout the phases of their life-cycle, namely: conceptual planning, design, construction, and operation and maintenance phases. In this regard, this questionnaire survey aims to investigate the current practice of building adaptive reuse in the construction sector of Saudi Arabia, as well as assess the factors influencing such practice throughout its life-cycle. It consists of four sections, namely: summary and demographic questions, local practice investigation, assessment of factors, and additional remarks. Kindly fill this questionnaire as fully as possible, with all thanks and appreciation to you for your valuable contributions. Note that the study is conducted by a researcher from King Fahd University of Petroleum and Minerals, Dhahran, so all information that will be obtained from the survey will be used for a research purpose.

Regards,

Researcher. Mohammad Basel Hamida,
Architectural Engineering Department,
King Fahd University of Petroleum and Minerals,
Dhahran, Saudi Arabia
Email: g201703050@kfupm.edu.sa
Mobile phone: +966532254941

1. Respondent Information

Name	
Organization	
Organization address	
Phone	
Email address	

2. What is your scope of work at the contractor organization?

- ☐ Architectural / Building engineer
- ☐ Civil engineer
- ☐ Mechanical engineer
- ☐ Electrical engineer
- ☐ Project engineer / manager
- ☐ Other (please specify) _____.

3. Please indicate your years of experience

☐ Less than 5 years	☐ 5 to 10 years
☐ 10 to 20 years	☐ Over 20 years

4. Have you been involved in the execution of adaptive reuse projects before (in Saudi Arabia)?

☐ Yes	☐ No
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*Please don't fill the survey questionnaire if your answer is "No" and give the survey questionnaire to the person who is concerned with such kind of projects

5. Please indicate the number of adaptive reuse projects that you have been involved in before (in Saudi Arabia)

☐ 1 - 5 projects	☐ 5 – 10 projects	☐ More than 10 projects
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6. Types of Projects that you mostly deal with (multiple selection is allowed)

- ☐ Apartment Buildings
- ☐ Single Houses (Villas)
- ☐ Shops
- ☐ Office Buildings
- ☐ Educational buildings
- ☐ Recreational buildings
- ☐ Commercial centers/shopping malls
- ☐ Other (Please Specify) _____.

Section (B): Investigation of the Local Practice

Kindly answer all questions below as fully as possible.

1. Please identify the scenarios of adaptive reuse of buildings that are common in Saudi Arabia

- ☐ Converting a building from a commercial into residential use (e.g. from an office building to an apartment building)
- ☐ Converting a building from a commercial into another commercial use (e.g. from a restaurant to a shop, or from supermarket to an exhibition hall for car sale)
- ☐ Converting a building from a commercial into medical use (e.g from an office building to a polyclinic)
- ☐ Converting a building from a residential into commercial use (e.g. from an apartment building to an office building or commercial shops)
- ☐ Converting a building from a residential into medical use (e.g from a hotel to a hospital)
- ☐ Converting a building from an industrial into commercial use(e.g from a factory to a store)
- ☐ Other (please specify) _____.

2. Please provide a brief description of your practice in the implementation of adaptive reuse projects from mobilizing to the site until the completion of the project.

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3. Please identify the methods used in the communication between the parties during the execution of adaptive reuse projects.

- ☐ Meeting with parties in case of inspection/follow up for the progress of the construction
- ☐ Informal meeting with all parties of the project
- ☐ Formal meeting with all parties of the project
- ☐ Other (please specify) _____.

4. Please indicate the types of information and data needed during the implementation of adaptive reuse projects

- ☐ The as-built architectural blueprints for the previous function of the project
- ☐ The as-built structural blueprints for the previous function of the project
- ☐ The as-built blueprints for the MEP systems for the previous function of the project
- ☐ The as-built construction details for the previous function of the project
- ☐ Construction specifications of the previous function of the project
- ☐ Systems and equipment manuals of the previous function of the project
- ☐ Technical blueprints of the architectural layout of the new function of the project
- ☐ Construction details drawings of the new function of the project
- ☐ Updated structural drawings of the new function of the project
- ☐ Updated blueprints of the MEP systems of the new function of the project
- ☐ Construction specifications of the new function of the project
- ☐ Systems and equipment manuals of the new function of the project
- ☐ Project time schedule
- ☐ Bill of quantities (BOQ) of the project
- ☐ Other (please specify) _____.

5. Please indicate the followed method(s) for obtaining information and/or data needed during the implementation of adaptive reuse projects

- ☐ Direct contact with the owner/owner's representative
- ☐ Direct contact with the A/E
- ☐ Direct contact with the real estate organization that leases/operates the building
- ☐ Direct request during meetings/inspections on the project's progress by the owner/owner's representative
- ☐ Direct request during the meeting with the project parties
- ☐ Other (please specify) _____.

6. Please indicate the extent of work that takes place during the implementation of adaptive reuse projects.

- ☐ Demolition of construction elements (e.g. walls, partitions, ceilings)
- ☐ Demolition of structural elements (e.g. columns, beams, slabs)
- ☐ Addition to the existing structure (vertically/horizontally)
- ☐ Renewal of interior finishes (e.g. paints, tiles, skirtings, decorations)
- ☐ Renewal of exterior finishes (e.g. façade and external tiles)
- ☐ Replacement of MEP systems (e.g. HVAC, lighting, electrical circuits, plumbing fixtures and pipes, heaters, fire dictators and alarms, elevators, etc.)
- ☐ Repair of structural elements
- ☐ Construction of interior elements (e.g. walls, partitions, ceilings)
- ☐ Other (please specify) _____.

7. Please indicate all the applicable challenges that could face the contractor during the implementation of adaptive reuse projects.

- ☐ Limited access to the project site
- ☐ Inadequate loading space
- ☐ Limited space for workers to carry out their activities
- ☐ Lack of space for storing construction materials and equipment
- ☐ Lack of data and information

- ☐ Implementation of safety measures during construction
- ☐ Errors in design documents
- ☐ Lack of skilled workforce
- ☐ Other (please specify) _____.

8. Please suggest methods for improving the implementation process of adaptive reuse projects

- ☐ Ensure competent supervision of activities during construction.
- ☐ Ensure adherence to QA/QC procedures
- ☐ Other (please specify) _____.

Section (C): Evaluation of the Factors Affecting Building Adaptive Reuse throughout the Project Life-Cycle

Kindly assess the level of importance of the factors mentioned in the table below, according to the scale shown.

Factors Influencing the Implementation of Building Adaptive Reuse		Importance Level				
		Extremely Important	Very Important	Important	Somewhat Important	Not Important
A) Factors Related to the Phase of Conceptual Planning and Feasibility Studies						
1.	Structural integrity of the building					
2.	Municipal approval for the land use change					
3.	The condition of building components and/or systems					
4.	Architectural program of the new function					
5.	Potential of the building spaces to be adaptively reused					
6.	Allocated budget for the adaptation process					
7.	Expected yield from the adaptation					
8.	The schedule of the adaptation activities					
9.	Compatibility of the building appearance with the client desired design					
	Other (Please specify)					
B) Factors Related to the Design and Engineering Phase						
10.	Previous experience of the design team with adaptive reuse projects					
11.	Code requirements for the new occupancy					
12.	Availability and accuracy of the drawings and specifications of the existing project					
13.	Net area of the adaptable space					
14.	Layout of spaces within the building					
15.	Number and layout of the structural columns					
16.	Layout of the existing MEP systems					
17.	Capacity of the existing MEP systems					
18.	Potential to install additional and/or new systems					
19.	Site configuration and requirements					
20.	Sustainability and energy saving measures					
	Other (Please specify)					

C) Factors Related to the Construction Phase						
21.	Previous experience of the contractor with adaptive reuse projects					
22.	Accuracy and completeness of the contract documents					
23.	Availability of skilled workforce					
24.	Construction equipment and methods					
25.	Planning and control of the financial resources					
26.	Quality assurance / control requirements					
27.	Complexity and difficulties within the project site					
28.	Availability and accessibility of loading space					
29.	Availability of spaces for storing the construction materials and equipment					
30.	Enforcement and management of safety procedures at the project site					
	Other (Please specify)					
D) Factors Related to Operation and Maintenance Phase						
31.	Availability and adequacy of the commissioning process for the MEP systems					
32.	Availability of accurate records of the building assets					
33.	Efficiency of the utilization of the building spaces					
34.	Compliance with health and safety measures					
35.	Development and implementation of work schedules for different maintenance types (e.g. planned, unplanned)					
36.	Potentiality of obsolescence and/or deterioration of building components and/or systems					
37.	Control over the operational characteristics of the building components and systems					
38.	User satisfaction with the layout of the building as well as the workflow of activities					
	Other (Please specify)					
Other Factors (Please Specify)						
1.						
2.						
3.						
4.						
5.						

Section (D): Additional Remarks (Optional)

Kindly if you have additional information/clarification that might enhance the research, please don't hesitate to mention them in the available below area:

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Thank you for your consideration and cooperation

تطوير إطار للتنفيذ الفعال لعملية إعادة الإستخدام المتكيف للمبنى طوال دورة حياة المشروع

القسم (أ): الخلاصة والأسئلة الديموغرافية

أخي الكريم

إن إعادة الإستخدام المتكيف للمباني هي عملية تحويل إستخدام مبنى قائم لتغييره وظيفته وفقاً لمتطلبات المستخدم الحالي أو الجديد للمبنى ، حيث تشمل عملية التحويل على إجراء أعمال تجديد للمبنى بالإضافة إلى كونها من المحتمل أيضاً قد تشمل على أعمال ترميم. وإن تنفيذ هذا النوع من الممارسات أصبح ينفذ بشكل واضح في العديد من مشاريع المباني بالمملكة العربية السعودية لمدة تزيد عن عقدين من الزمن ، ولذلك فإن هنالك حاجة إلى فهم طبيعة هذه الممارسة في قطاع التشييد في المملكة العربية السعودية. لوحظ أيضاً أن هنالك مصفوفة من العوامل المؤثرة على ذات المشاريع طوال مختلف مراحل دورة حياتها مروراً بالتصميم المبدئي والتصميم الهندسي و التنفيذ ووصولاً إلى مرحلة التشغيل والصيانة. وفي هذه الصدد فإن هذا الإستبيان يهدف إلى فهم الممارسة الحالية لمشروعات إعادة الإستخدام المتكيف في قطاع التشييد بالمملكة العربية السعودية ، إضافةً إلى تقييم العوامل المؤثرة على ذات المشاريع طوال دورة حياتها. يرجى منك ملء الإستبيان التالي على أكمل وجه ممكن مع كامل الشكر والتقدير على تعاونكم وإسهاماتكم القيمة . وختاماً لا بد أن ننوه بأن الدراسة يجريها باحث من قسم الهندسة المعمارية بجامعة الملك فهد للبترول والمعادن بالظهران، حيث إن جميع المعلومات التي سيتم الحصول عليها ستستخدم لغرض بحثي فقط.

وتقبل خالص تحياتي

الباحث/ محمد باسل حميده

قسم الهندسة المعمارية

جامعة الملك فهد للبترول و المعادن

الظهران – المملكة العربية السعودية

البريد الإلكتروني: g201703050@kfupm.edu.sa

الهاتف النقال: ٠٥٣٢٢٥٤٩٤١

١. بيانات المجيب

الاسم	
المؤسسة	
عنوان المؤسسة	
الهاتف	
البريد الإلكتروني	

٢. ما هو مجال عملك المهني في مؤسسة المقاولات التي تعمل بها ؟

- ☐ مهندس معماري (أو مهندس مباني)
- ☐ مهندس مدني
- ☐ مهندس ميكانيكي
- ☐ مهندس كهربائي
- ☐ مهندس أو مدير مشروع
- ☐ غير ذلك (حددها من فضلك) _____.

٣. يرجى تبين عدد سنوات خبرتك المهنية

☐ أقل من (٥) سنوات	☐ من (٥) إلى (١٠) سنوات
☐ من (١٠) سنوات إلى (٢٠) سنة	☐ أكثر من ٢٠ سنة

٤. هل سبق لك المشاركة في تنفيذ مشاريع إعادة الاستخدام المتكيف للمباني في المملكة العربية السعودية؟

☐ نعم	☐ لا
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*الرجاء عدم تعبئة الإستبيان إذا كانت الإجابة "لا" وإعطاء الإستبيان بالشخص المعني بذلك

٥. يرجى تبين عدد مشاريع إعادة الاستخدام المتكيف للمباني التي قمت بالمشاركة في تنفيذها بالمملكة العربية السعودية

☐ ١ - ٥ مشاريع	☐ ٥ - ١٠ مشاريع	☐ أكثر من ١٠ مشاريع
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٦. نوع المشاريع التي تتعامل معها في غالب الأحيان

- ☐ مباني شقق
- ☐ بيوت منفردة (فلل)
- ☐ محلات
- ☐ مباني مكتبية
- ☐ مباني تعليمية
- ☐ مباني ترفيهية
- ☐ مراكز تجارية – مجمعات تجارية
- ☐ غير ذلك (حددها من فضلك) _____.

القسم (ب): استقصاء الممارسة المحلية

يرجى الإجابة على الأسئلة أدناه على أكمل وجه ممكن

١. يرجى تحديد السيناريوهات الأكثر شيوعاً لمشروعات إعادة الاستخدام المتكيف للمباني في المملكة العربية السعودية

- ☐ يتم تحويل المبنى من إستخدام تجاري إلى استخدام سكني (مثال: من مبنى مكتبي إلى مبنى شقق سكنية)
- ☐ يتم تحويل المبنى من إستخدام تجاري إلى استخدام تجاري آخر (مثال: من مطعم إلى محل تجاري ، ومن مركز تسوق إلى معرض سيارات)
- ☐ يتم تحويل المبنى من إستخدام تجاري إلى إستخدام طبي (مثال: من مبنى مكتبي إلى مبنى عيادات)
- ☐ يتم تحويل المبنى من إستخدام سكني إلى استخدام تجاري (مثال: من مبنى شقق سكنية إلى مبنى مكتبي أو محل تجاري)
- ☐ يتم تحويل المبنى من إستخدام سكني إلى استخدام طبي (مثال: من فندق إلى مبنى عيادات)
- ☐ يتم تحويل المبنى من إستخدام صناعي إلى تجاري (مثال: من مصنع إلى معرض تجاري)
- ☐ غير ذلك (يرجى التوضيح) _____.

٢. يرجى تقديم وصف موجز لممارستك في تنفيذ مشاريع إعادة الاستخدام المتكيف للمباني بشكل متكيف منذ عملية تعبئة الموقع البدء وحتى إكمال المشروع

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٣. يرجى تبين طرق الإتصال المستخدمة في التواصل بين أطراف المشروع أثناء تنفيذ مشاريع إعادة الإستخدام المتكيف للمباني

- ☐ الإجتماع مع أطراف المشروع أثناء عمليات التفتيش أو متابعة سير أعمال التشييد
- ☐ إجتماع غير رسمي مع جميع أطراف المشروع
- ☐ إجتماع رسمي مع جميع أطراف المشروع
- ☐ غير ذلك (يرجى التوضيح) _____.

٤. يرجى الإشارة إلى المعلومات والبيانات اللازم تواجدها أثناء تنفيذ مشاريع إعادة الإستخدام المتكيف للمباني

- ☐ المخططات المعمارية للمبنى حسب التنفيذ للوظيفة السابقة
- ☐ المخططات الإنشائية للمبنى حسب التنفيذ للوظيفة السابقة
- ☐ مخططات النظم الخدمية للمبنى حسب التنفيذ للوظيفة السابقة
- ☐ تفاصيل التشييد (التفاصيل المعمارية) للمبنى حسب التنفيذ للوظيفة السابقة
- ☐ مواصفات التشييد لوظيفة المشروع السابقة
- ☐ كتيبات الأنظمة والمعدات لوظيفة المشروع السابقة
- ☐ المخططات المعمارية الفنية للوظيفة المشروع الجديدة
- ☐ رسومات تفاصيل التشييد (التفاصيل المعمارية) لوظيفة المشروع الجديدة
- ☐ الرسومات المحدثة للمخطط الإنشائي الخاصة بوظيفة المشروع الجديدة
- ☐ الرسومات المحدثة لتخطيط الأنظمة الخدمية الخاصة بوظيفة المشروع الجديدة
- ☐ مواصفات التشييد لوظيفة المشروع الجديدة
- ☐ كتيبات الأنظمة والمعدات لوظيفة المشروع الجديدة
- ☐ الجدول الزمني للمشروع
- ☐ جداول فواتير كميات المشروع
- ☐ غير ذلك (يرجى التوضيح) _____.

٥. يرجى الإشارة إلى الأساليب المتبعة للحصول على البيانات أو المعلومات اللازم تواجدها أثناء تنفيذ مشاريع إعادة الاستخدام المتكيف للمباني

- ☐ الإتصال المباشر بالمالك أو بمن يمثله
- ☐ الإتصال المباشر بالمكتب الهندسي (الإستشاري)
- ☐ الإتصال المباشر بالمؤسسة العقاري التي تقوم بتأجير أو تشغيل المبنى
- ☐ طلب مباشر أثناء الاجتماعات أو عمليات التفتيش الخاصة بمتابعة سير المشروع من قبل المالك أو من يمثله
- ☐ طلب مباشر أثناء الاجتماع مع أطراف المشروع
- ☐ غير ذلك (يرجى التوضيح) _____.

٦. يرجى تحديد الأعمال التي يتم إجراؤها في الغالب بالموقع أثناء تنفيذ مشاريع إعادة الاستخدام المتكيف للمباني

- ☐ هدم عناصر التشييد (مثل الحوائط والحواجز والأسقف المستعرة)
- ☐ هدم العناصر الإنشائية (على سبيل المثال الأعمدة والكمرات والبلاطات)
- ☐ إضافة فراغات أو هيكل إنشائي (بشكل رأسي أو أفقي)
- ☐ تجديد التشطيبات الداخلية (مثل الدهانات والبلاط والنعلات و عناصر الزخرفة)
- ☐ تجديد التشطيبات الداخلية (مثل الواجهة والبلاط الخارجي)
- ☐ إستبدال نظم الخدمات (مثل أنظمة التبريد والإضاءة والدوائر الكهربائية وأنظمة السباكة والسخانات ، وأجهزة الإستشعار والإنذار عن الحريق والمصاعد ،،، إلخ)
- ☐ إصلاح العناصر الإنشائية
- ☐ إنشاء عناصر داخلية (مثل الجدران والحواجز والأسقف المستعرة)
- ☐ غير ذلك (يرجى التوضيح) _____.

٧. يرجى تحديد التحديات التي قد تنطبق و تواجه المقاول بالغالب أثناء تنفيذ مشروع إعادة الإستخدام المتكيف للمبنى

- ☐ قيود في إمكانية الوصول إلى الموقع
- ☐ عدم وجود مساحة تحميل كافية
- ☐ قيود في المساحة المتاحة للعمال لتنفيذ أعمالهم بسلاسة
- ☐ صعوبة توفير مساحة لتخزين مواد ومعدات التشييد
- ☐ نقص المعلومات والبيانات
- ☐ الإمتثال لمقاييس سلامة التشييد أثناء عملية التنفيذ
- ☐ أخطاء في وثائق التصميم
- ☐ نقص القوى العاملة الماهرة
- ☐ غير ذلك (يرجى التوضيح) _____.

٨. يرجى إقتراح أساليب وآليات لتطوير عملية تنفيذ مشاريع إعادة الإستخدام المتكيف للمباني

- ☐ ضمان إشراف مختص على الأنشطة أثناء التشييد
- ☐ ضمان الإلتزام بإجراءات مراقبة وضبط الجودة
- ☐ غير ذلك (يرجى التوضيح) _____.

القسم (ج): تقييم العوامل المؤثرة على دورة حياة مشاريع إعادة الإستهخدام المتكيف

يرجى تقييم مستوى الأهمية الخاص بكل عامل مذكور بالجدول أدناه وفقاً للمقياس الموضح:

درجة الأهمية					العوامل المؤثرة على تنفيذ إعادة الإستهخدام المتكيف للمباني بشكل فعال
١	٢	٣	٤	٥	
١	٢	٣	٤	٥	
(أ) العوامل المتعلقة بمرحلة التخطيط النظري ودراسة الجدوى					
					١. سلامة الهيكل الإنشائي للمبنى
					٢. موافقة البلدية على تغيير استخدام الأرض
					٣. حالة نظم ومكونات المبنى
					٤. البرنامج المعماري للإستهخدام الجديد
					٥. قدرة فراغات المبنى على التحويل الوظيفي
					٦. الميزانية المخصصة لعملية التحويل
					٧. العائد المتوقع من التحويل
					٨. جدول أنشطة التحويل
					٩. توافق مظهر المبنى مع التصميم المرغوب من قبل العميل
					أخرى (حددها من فضلك).....
(ب) العوامل المتعلقة بمرحلة التصميم الهندسي					
					١٠. الخبرة السابقة لفريق التصميم مع مشاريع إعادة الإستهخدام المتكيف للمبنى
					١١. متطلبات كود البناء للإستهخدام الجديد
					١٢. توافر ومدى دقة وثائق تصميم ومواصفات المبنى الحالي
					١٣. صافي مساحة الفراغ القابل للتحويل
					١٤. توزيع الفراغات بالمبنى
					١٥. عدد وتوزيع الأعمدة الإنشائية بالمبنى
					١٦. تصميم نظم الخدمات الحالية
					١٧. قدرة نظم الخدمات الحالية
					١٨. إمكانية تركيب نظم جديدة أو إضافية
					١٩. تكوين ومتطلبات الموقع
					٢٠. مقاييس الإستهدامة وكفاءة الطاقة
					أخرى (حددها من فضلك).....

ج) العوامل المتعلقة بمرحلة التشييد					
					٢١. خبرة المقاول السابقة مع مشاريع إعادة استخدام المباني بشكل متكيف
					٢٢. دقة وإكمال وثائق العقد
					٢٣. توفر القوى العاملة
					٢٤. طرق ومعدات التشييد
					٢٥. مراقبة وإدارة الموارد المالية
					٢٦. متطلبات ضبط وضمان الجودة
					٢٧. تعقيد موقع المشروع
					٢٨. توافر ووصولية منطقة التحميل
					٢٩. توفر المساحة الكافية لتخزين المواد والمعدات
					٣٠. تنفيذ وإدارة إجراءات السلامة في موقع المشروع
					أخرى (حددها من فضلك).....
د) العوامل المتعلقة بمرحلة التشغيل والصيانة					
					٣١. توافر ودقة إجراءات اختبار نظم خدمات المبنى
					٣٢. وجود سجلات دقيقة لأصول المبنى
					٣٣. كفاءة استخدام فراغات المبنى
					٣٤. الإمتثال إلى مقاييس الصحة والسلامة
					٣٥. تطوير وتنفيذ جداول عمل لأنواع الصيانة المختلفة (على سبيل المثال الأعمال المخططة وغير المخططة)
					٣٦. إمكانية تقادم وتدهور مكونات ونظم المبنى
					٣٧. السيطرة على الخصائص التشغيلية لنظم ومكونات المبنى
					٣٨. رضی المستخدمين عن تصميم المبنى وكذلك سير أنشطة الأعمال
					أخرى (حددها من فضلك).....
عوامل أخرى (حددها من فضلك)					
					١.
					٢.
					٣.
					٤.
					٥.

القسم (د): ملاحظات إضافية (إختياري)

إذا كان لديك معلومات إضافية قد تعزز البحث فيرجى عدم التردد في ذكرها بالمنطقة المتاحة أدناه:

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شكراً لاهتمامك وتعاونك

APPENDIX D:

FACILITIES MANAGERS' QUESTIONNAIRE SURVEY

(ARABIC AND ENGLISH)

*Development of A Framework for the Effective Implementation of
Building Adaptive Reuse throughout the Project Life-Cycle in Saudi
Arabia*

Section (A): Summary and Demographic Questions

Dear Sir,

Adaptive reuse of buildings is the process of converting the use of an existing building, to fulfill a change in its function according to the requirements of new/current owner, where the changes might consist of refurbishment and/or full renovation of the building. The implementation of such practice has been started to take place in many building projects in Saudi Arabia, since more than two decades. Accordingly, there is a need for understanding the adaptive reuse practices in the facilities management (FM) profession of Saudi Arabia. Further, it was noted that there are several factors influencing these projects throughout the phases of their life-cycle, namely: conceptual planning, design, construction, and operation and maintenance phases. In this regard, this questionnaire survey aims to investigate the current practice of building adaptive reuse in the FM sector of Saudi Arabia, as well as assess the factors influencing such practice throughout its life-cycle. It consists of four sections, namely: summary and demographic questions, local practice investigation, assessment of factors, and additional remarks. Kindly fill this questionnaire as fully as possible, with all thanks and appreciation to you for your valuable contributions. Note that the study is conducted by a researcher from King Fahd University of Petroleum and Minerals, Dhahran, so all information that will be obtained from the survey will be used for a research purpose.

Regards,

Researcher. Mohammad Basel Hamida,
Architectural Engineering Department,
King Fahd University of Petroleum and Minerals,
Dhahran, Saudi Arabia
Email: g201703050@kfupm.edu.sa
Mobile phone: +966532254941

1. Respondent Information

Name	
Organization	
Organization address	
Phone	
Email address	

2. What is your scope of work at the facilities management organization

- ☐ Architectural/ building engineer
- ☐ Mechanical engineer
- ☐ Electrical engineer
- ☐ Maintenance engineer
- ☐ Property manager
- ☐ Other (please specify) _____.

3. Please indicate your years of experience

☐ Less than 5 years	☐ 5 to 10 years
☐ 10 to 20 years	☐ Over 20 years

4. Have you been involved in the operation of adaptively reused buildings before (in Saudi Arabia)?

☐ Yes	☐ No
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*Please don't fill the survey questionnaire if your answer is "No" and give the survey questionnaire to the person who is concerned with such kind of projects

5. Please indicate the number of adaptively reused buildings that you have been involved in their operation and maintenance before (in Saudi Arabia)

☐ 1 - 5 projects	☐ 5 – 10 projects	☐ More than 10 projects
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6. Types of Projects that you mostly deal with (multiple selection is allowed)

- ☐ Apartment Buildings
- ☐ Single Houses (Villas)
- ☐ Shops
- ☐ Office Buildings
- ☐ Educational buildings
- ☐ Recreational buildings
- ☐ Commercial centers/shopping malls
- ☐ Other (Please Specify) _____.

Section (B): Investigation of the Local Practice

Kindly answer all questions below as fully as possible.

1. Please provide a brief description of your professional practice in operating and maintaining adaptively reused buildings

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2. Please indicate the types of information and data during the Operation and Maintenance phase in adaptively reused buildings

- ☐ The as-built architectural blueprints for the previous function of the project
- ☐ The as-built structural blueprints for the previous function of the project
- ☐ The as-built blueprints for the MEP systems for the previous function of the project
- ☐ The as-built construction details for the previous function of the project
- ☐ Construction specifications of the previous function of the project
- ☐ Systems and equipment manuals of the previous function of the project
- ☐ The as-built technical blueprints of the architectural layout of the new function of the project
- ☐ The as-built construction details drawings of the new function of the project
- ☐ The as-built structural drawings of the new function of the project
- ☐ The as-built blueprints of the MEP systems of the new function of the project
- ☐ Construction specifications of the new function of the project

- ☐ Systems and equipment manuals of the new function of the project
- ☐ Contact information of suppliers of building services and systems
- ☐ Inventory of all assets in the building
- ☐ Records of space utilization
- ☐ Reports of the commissioning tests of all systems and components
- ☐ Other (please specify) _____.

3. Please indicate the followed methods(s) for obtaining information and/or data needed during the operation and maintenance phase of the adaptively reused buildings

- ☐ Direct contact with the owner/owner's representative
- ☐ Direct contact with the A/E
- ☐ Other (please specify) _____.

4. Please identify all the applicable challenges that could face the facilities management team during the operation and maintenance of adaptively reused buildings

- ☐ Misfits between the function of the spaces and the design of the building
- ☐ Inefficient space utilization
- ☐ Inadequate performance of the technical systems in the building (e.g. HVAC, electric circuits and lighting, plumbing, interior finishes)
- ☐ Lack of continuous compliance with health and safety measures
- ☐ Lack of compatibility between old and new MEP systems and components
- ☐ Inefficient control over the operational characteristics of building systems and components
- ☐ Inefficient of smooth workflow of operational activities
- ☐ Lack of users' satisfaction with the design of the building
- ☐ Lack of control over the inventory of assets in the building
- ☐ Other (please specify) _____.

5. Please identify the building systems and components that frequently require maintenance and repair activities in adaptively reused building

- ☐ Construction elements (e.g. walls, partitions, ceilings)
- ☐ Structural elements (e.g. columns, beams, slabs)
- ☐ Interior finishes (e.g. paints, tiles, skirtings, decorations)
- ☐ Exterior finishes (e.g. building facade)
- ☐ MEP systems (e.g. HVAC, lighting, electric circuits, plumbing fixtures and piping, heaters, fire detectors and alarms, elevators, etc.)
- ☐ Information technology (IT) systems
- ☐ Other (please specify) _____.

6. Please suggest methods for improving the performance of adaptively reused buildings.

- ☐ Conduct commissioning process
- ☐ Assign spaces in a manner that support the workflow of activities
- ☐ Develop a maintenance program of the adaptively reused building
- ☐ Record all systems and assets of the building
- ☐ Carry out periodic building performance assessment
- ☐ Other (please specify) _____.

Section (C): Evaluation of the Factors Affecting Building Adaptive Reuse throughout the Project Life-Cycle

Kindly assess the level of importance of the factors mentioned in the table below, according to the scale shown.

Factors Influencing the Implementation of Building Adaptive Reuse		Importance Level				
		Extremely Important	Very Important	Important	Somewhat Important	Not Important
A) Factors Related to the Phase of Conceptual Planning and Feasibility Studies						
1.	Structural integrity of the building					
2.	Municipal approval for the land use change					
3.	The condition of building components and/or systems					
4.	Architectural program of the new function					
5.	Potential of the building spaces to be adaptively reused					
6.	Allocated budget for the adaptation process					
7.	Expected yield from the adaptation					
8.	The schedule of the adaptation activities					
9.	Compatibility of the building appearance with the client desired design					
	Other (Please specify)					
B) Factors Related to the Design and Engineering Phase						
10.	Previous experience of the design team with adaptive reuse projects					
11.	Code requirements for the new occupancy					
12.	Availability and accuracy of the drawings and specifications of the existing project					
13.	Net area of the adaptable space					
14.	Layout of spaces within the building					
15.	Number and layout of the structural columns					
16.	Layout of the existing MEP systems					
17.	Capacity of the existing MEP systems					
18.	Potential to install additional and/or new systems					
19.	Site configuration and requirements					
20.	Sustainability and energy saving measures					
	Other (Please specify)					

C) Factors Related to the Construction Phase						
21.	Previous experience of the contractor with adaptive reuse projects					
22.	Accuracy and completeness of the contract documents					
23.	Availability of skilled workforce					
24.	Construction equipment and methods					
25.	Planning and control of the financial resources					
26.	Quality assurance / control requirements					
27.	Complexity and difficulties within the project site					
28.	Availability and accessibility of loading space					
29.	Availability of spaces for storing the construction materials and equipment					
30.	Enforcement and management of safety procedures at the project site					
	Other (Please specify)					
D) Factors Related to Operation and Maintenance Phase						
31.	Availability and adequacy of the commissioning process for the MEP systems					
32.	Availability of accurate records of the building assets					
33.	Efficiency of the utilization of the building spaces					
34.	Compliance with health and safety measures					
35.	Development and implementation of work schedules for different maintenance types (e.g. planned, unplanned)					
36.	Potentiality of obsolescence and/or deterioration of building components and/or systems					
37.	Control over the operational characteristics of the building components and systems					
38.	User satisfaction with the layout of the building as well as the workflow of activities					
	Other (Please specify)					
Other Factors (Please Specify)						
1.						
2.						
3.						
4.						
5.						

Section (D): Additional Remarks (Optional)

Kindly if you have additional information/clarification that might enhance the research,
please don't hesitate to mention them in the available below area:

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Thank you for your consideration and cooperation

طوير إطار للتنفيذ الفعال لعملية إعادة الإستخدام المتكيف للمبنى طوال دورة حياة المشروع

القسم (أ): الخلاصة والأسئلة الديموغرافية

أخي الكريم

إن إعادة الإستخدام المتكيف للمباني هي عملية تحويل إستخدام مبنى قائم لتغيير وظيفته وفقاً لمتطلبات المستخدم الحالي أو الجديد للمبنى ، حيث تشمل عملية التحويل على إجراء أعمال تجديد للمبنى بالإضافة إلى كونها من المحتمل أيضاً قد تشمل على أعمال ترميم. وإن تنفيذ هذا النوع من الممارسات أصبح ينفذ بشكل واضح في العديد من مشاريع المباني بالمملكة العربية السعودية لمدة تزيد عن عقدين من الزمن ، ولذلك فإن هنالك حاجة إلى فهم طبيعة هذه الممارسة في قطاع إدارة المنشآت في المملكة العربية السعودية. لوحظ أيضاً أن هنالك مصفوفة من العوامل المؤثرة على ذات المشاريع طوال مختلف مراحل دورة حياتها مروراً بالتصميم المبدئي والتصميم الهندسي و التنفيذ ووصولاً إلى مرحلة التشغيل والصيانة. وفي هذه الصدد فإن هذا الإستبيان يهدف إلى فهم الممارسة الحالية لمشروعات إعادة الإستخدام المتكيف في إدارة المنشآت بالمملكة العربية السعودية ، إضافةً إلى تقييم العوامل المؤثرة على ذات المشاريع طوال دورة حياتها. يرجى منك ملء الإستبيان التالي على أكمل وجه ممكن مع كامل الشكر والتقدير على تعاونكم وإسهاماتكم القيمة . وختاماً لا بد أن ننوه بأن الدراسة يجريها باحث من قسم الهندسة المعمارية بجامعة الملك فهد للبترول والمعادن بالظهران، حيث إن جميع المعلومات التي سيتم الحصول عليها ستستخدم لغرض بحثي فقط.

وتقبل خالص تحياتي

الباحث/ محمد باسل حميده

قسم الهندسة المعمارية

جامعة الملك فهد للبترول و المعادن

الظهران – المملكة العربية السعودية

البريد الإلكتروني: g201703050@kfupm.edu.sa

الهاتف النقال: ٠٥٣٢٢٥٤٩٤١

١. بيانات المجيب

الاسم	
المؤسسة	
عنوان المؤسسة	
الهاتف	
البريد الإلكتروني	

٢. ما هو مجال عملك المهني في مؤسسة إدارة المرافق (أو التشغيل والصيانة)؟

☐ مهندس معماري (أو مهندس مباني)

☐ مهندس ميكانيكي

☐ مهندس كهربائي

☐ مهندس صيانة

☐ مدير ممتلكات

☐ غير ذلك (حددها من فضلك) _____.

٣. يرجى تبين عدد سنوات خبرتك المهنية

☐ أقل من (٥) سنوات	☐ من (٥) إلى (١٠) سنوات
☐ من (١٠) سنوات إلى (٢٠) سنة	☐ أكثر من ٢٠ سنة

٤. هل سبق لك المشاركة في تشغيل المباني المعاد إستخدامها بشكل متكيف في المملكة العربية السعودية؟

☐ نعم	☐ لا
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*الرجاء عدم تعبئة الإستبيان إذا كانت الإجابة "لا" وإعطاء الإستبيان بالشخص المعني بذلك

٥. يرجى الإشارة إلى عدد المباني المعاد استخدامها بشكل متكيف التي سبق لك وأن شاركت في تشغيلها وصيانتها من قبل بالمملكة العربية السعودية

☐ ١ - ٥ مشاريع	☐ ٥ - ١٠ مشاريع	☐ أكثر من ١٠ مشاريع
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٦. نوع المشاريع التي تتعامل معها في غالب الأحيان

- ☐ مباني شقق
- ☐ بيوت منفردة (فلل)
- ☐ محلات
- ☐ مباني مكتبية
- ☐ مباني تعليمية
- ☐ مباني ترفيهية
- ☐ مراكز تجارية – مجمعات تجارية
- ☐ غير ذلك (حددها من فضلك) _____.

القسم (ب): استقصاء الممارسة المحلية

يرجى الإجابة على الأسئلة أدناه على أكمل وجه ممكن

١. يرجى إعطاء وصف موجز لممارستك المهنية في تشغيل وصيانة المباني المعاد إستخدامها بشكل متكيف؟

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٢. يرجى الإشارة إلى المعلومات والبيانات اللازم تواجدها أثناء تشغيل وصيانة المشاريع المعاد إستخدامها بشكل متكيف ؟

- ☐ المخططات المعمارية للمبنى حسب التنفيذ للوظيفة السابقة
- ☐ المخططات الإنشائية للمبنى حسب التنفيذ للوظيفة السابقة
- ☐ مخططات النظم الخدمية للمبنى حسب التنفيذ للوظيفة السابقة
- ☐ تفاصيل التشييد (التفاصيل المعمارية) للمبنى حسب التنفيذ للوظيفة السابقة
- ☐ مواصفات التشييد لوظيفة المشروع السابقة
- ☐ كتيبات الأنظمة والمعدات لوظيفة المشروع السابقة
- ☐ المخططات المعمارية الفنية حسب التنفيذ للوظيفة المشروع الجديدة
- ☐ رسومات تفاصيل التشييد (التفاصيل المعمارية) حسب التنفيذ لوظيفة المشروع الجديدة
- ☐ المخططات الإنشائي حسب التنفيذ لوظيفة المشروع الجديدة
- ☐ مخططات الأنظمة الخدمية حسب التنفيذ لوظيفة المشروع الجديدة

- ☐ مواصفات التشييد لوظيفة المشروع الجديدة
- ☐ كتيبات الأنظمة والمعدات لوظيفة المشروع الجديدة
- ☐ معلومات الإتصال بموردي خدمات وأنظمة المبنى
- ☐ جرد لكامل أصول المبنى
- ☐ سجلات لإستخدام فراغات المبنى
- ☐ تقرير عن إختبارات التكلفة لأنظمة ومكونات المبنى
- ☐ غير ذلك (يرجى التوضيح) _____ .

٣. يرجى الإشارة إلى الأساليب المتبعة للحصول على البيانات أو المعلومات اللازم تواجدها أثناء مرحلة تشغيل وصيانة المباني المعاد إستخدامها بشكل متكيف

- ☐ الإتصال المباشر بالمالك أو بمن يمثله
- ☐ الإتصال المباشر بالمكتب الهندسي (الإستشاري)
- ☐ غير ذلك (يرجى التوضيح) _____ .

٤. يرجى تحديد التحديات التي قد تنطبق و تواجه فرق إدارة المرافق بالغالب أثناء تشغيل وصيانة المباني المعاد إستخدامها بشكل متكيف

- ☐ عدم التلائم بين وظيفة الفراغات وتصميم المبنى
- ☐ عدم كفاءة إستخدام الفراغات
- ☐ أداء الأنظمة الفنية يكون غير كاف (غير فعال)
- ☐ نقص للإمتثال المستمر لمقاييس الصحة والسلامة
- ☐ ضعف التوافق بين نظم ومكونات المبنى الجديدة والقديمة
- ☐ عدم وجود تحكم كفو على الخصائص التشغيلية لنظم ومكونات المبنى
- ☐ تسلسل غير كفو لتدفق الأنشطة التشغيلية
- ☐ نقص رضا المستخدمين حول تصميم المبنى
- ☐ نقص القدرة على مراقبة جرد أصول المبنى
- ☐ غير ذلك (يرجى التوضيح) _____ .

٥. يرجى تحديد الأنظمة والمكونات التي تتطلب أعمال صيانة وإصلاح متكررة في المباني المعاد إستخدامها بشكل متكيف

- ☐ عناصر التشييد (مثل الحوائط والأقسام والأسقف المستعارة)
- ☐ العناصر الإنشائية (مثل الأعمدة والكمرات والبلاطات)
- ☐ التشطيبات الداخلية (مثل الدهانات والبلاط والنعلات وعناصر الزخرفة)
- ☐ التشطيبات الخارجية (مثل واجهة المبنى والبلاط الخارجي)
- ☐ نظم خدمات المبنى "الأنظمة الخدمية" (مثل أنظمة التبريد والإضاءة والدوائر الكهربائية وأنظمة السباكة والسخانات ، وأجهزة الإستشعار والإنذار عن الحريق والمصاعد ،، إلخ)
- ☐ أنظمة تقنية المعلومات
- ☐ غير ذلك (يرجى التوضيح) _____.

٦. يرجى إقتراح أساليب وآليات لتطوير أداء المباني المعاد إستخدامها بشكل متكيف

- ☐ إجراء إختبارات النظم (إختبارات التكاليف)
- ☐ تعيين إستخدام الفراغ بشكل يدعم سلسلة تدفق الأعمال
- ☐ تطوير برنامج لصيانة المبنى المعاد إستخدامه بشكل متكيف
- ☐ إنشاء سجل لجميع أنظمة وأصول المبنى
- ☐ تقييم أداء المبنى بشكل دوري
- ☐ غير ذلك (يرجى التوضيح) _____.

القسم (ج): تقييم العوامل المؤثرة على دورة حياة مشاريع إعادة الاستخدام المتكيف

يرجى تقييم مستوى الأهمية الخاص بكل عامل مذكور بالجدول أدناه وفقاً للمقياس الموضح:

درجة الأهمية					العوامل المؤثرة على تنفيذ إعادة الاستخدام المتكيف للمباني بشكل فعال
١	٢	٣	٤	٥	
١	٢	٣	٤	٥	
(أ) العوامل المتعلقة بمرحلة التخطيط النظري ودراسة الجدوى					
					١. سلامة الهيكل الإنشائي للمبنى
					٢. موافقة البلدية على تغيير استخدام الأرض
					٣. حالة نظم ومكونات المبنى
					٤. البرنامج المعماري للاستخدام الجديد
					٥. قدرة فراغات المبنى على التحويل الوظيفي
					٦. الميزانية المخصصة لعملية التحويل
					٧. العائد المتوقع من التحويل
					٨. جدول أنشطة التحويل
					٩. توافق مظهر المبنى مع التصميم المرغوب من قبل العميل
					أخرى (حددها من فضلك).....
(ب) العوامل المتعلقة بمرحلة التصميم الهندسي					
					١٠. الخبرة السابقة لفريق التصميم مع مشاريع إعادة الاستخدام المتكيف للمبنى
					١١. متطلبات كود البناء للاستخدام الجديد
					١٢. توافر ومدى دقة وثائق تصميم ومواصفات المبنى الحالي
					١٣. صافي مساحة الفراغ القابل للتحويل
					١٤. توزيع الفراغات بالمبنى
					١٥. عدد وتوزيع الأعمدة الإنشائية بالمبنى
					١٦. تصميم نظم الخدمات الحالية
					١٧. قدرة نظم الخدمات الحالية
					١٨. إمكانية تركيب نظم جديدة أو إضافية
					١٩. تكوين ومتطلبات الموقع
					٢٠. مقاييس الاستدامة وكفاءة الطاقة
					أخرى (حددها من فضلك).....

ج) العوامل المتعلقة بمرحلة التشييد					
					٢١. خبرة المقاول السابقة مع مشاريع إعادة استخدام المباني بشكل متكيف
					٢٢. دقة وإكمال وثائق العقد
					٢٣. توفر القوى العاملة
					٢٤. طرق ومعدات التشييد
					٢٥. مراقبة وإدارة الموارد المالية
					٢٦. متطلبات ضبط وضمان الجودة
					٢٧. تعقيد موقع المشروع
					٢٨. توافر ووصولية منطقة التحميل
					٢٩. توفر المساحة الكافية لتخزين المواد والمعدات
					٣٠. تنفيذ وإدارة إجراءات السلامة في موقع المشروع
					أخرى (حددها من فضلك).....
د) العوامل المتعلقة بمرحلة التشغيل والصيانة					
					٣١. توافر ودقة إجراءات اختبار نظم خدمات المبنى
					٣٢. وجود سجلات دقيقة لأصول المبنى
					٣٣. كفاءة استخدام فراغات المبنى
					٣٤. الإمتثال إلى مقاييس الصحة والسلامة
					٣٥. تطوير وتنفيذ جداول عمل لأنواع الصيانة المختلفة (على سبيل المثال الأعمال المخططة وغير المخططة)
					٣٦. إمكانية تقادم وتدهور مكونات ونظم المبنى
					٣٧. السيطرة على الخصائص التشغيلية لنظم ومكونات المبنى
					٣٨. رضی المستخدمين عن تصميم المبنى وكذلك سير أنشطة الأعمال
					أخرى (حددها من فضلك).....
عوامل أخرى (حددها من فضلك)					
					١.
					٢.
					٣.
					٤.
					٥.

القسم (د): ملاحظات إضافية (إختياري)

إذا كان لديك معلومات إضافية قد تعزز البحث فيرجى عدم التردد في ذكرها بالمنطقة المتاحة أدناه:

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شكراً لاهتمامك وتعاونك

APPENDIX E:

LIST OF RESPONDENTS OF THE THREE QUESTIONNAIRE SURVEYS

E.1 Respondents of the A/E Questionnaire Surveys

Table E.1 presents further information and details pertaining to the respondents of conducted questionnaire surveys on the adaptive reuse practitioners from the A/E profession. The name, scope of work and affiliation of each respondent of the A/E questionnaire survey are demonstrated. The method of the conducted interview with each A/E respondent is mentioned as well.

Table E.1: Further information and details pertaining to the respondents of the conducted questionnaire survey on adaptive reuse practitioners from the A/E profession

#	Respondent's name and scope of work/job title	Affiliation	Interview Method
1.	Mohammad Kajjak (Architect)	Drb Atlas, Dammam, Saudi Arabia	Face-to-face
2.	Abdulaziz Al Najjar	NajjarArch, Khobar, Saudi Arabia	Face-to-face
3.	Yahya Al Najjar (Architect)	Design Plus, Khobar, Saudi Arabia	Face-to-face
4.	Aymen Alsarory (Project Manager)	RETAL , Dhahran, Saudi Arabia	Face-to-face
5.	Hossam Abdulraheem (Architect)	Naf Group Co, Dhahran, Saudi Arabia	Face-to-face
6.	Ali Al-Ahmar (Building Design Coordinator)	AlShuaibi - Architects & Engineers, Khobar, Saudi Arabia	Face-to-face
7.	Mohammed A. Althikrallah (Architect)	Hamad M. AlRugaib & Sons Trading Co. Ltd, Khobar, Saudi Arabia	Face-to-face
8.	Tarek Naguib Aziz (Architect)	National Office for Engineering Consultancy, Dammam, Saudi Arabia	Face-to-face
9.	Makkawi A. Al-Amin (Design Coordinator)	Modern Design and Engineering Consulting, Khobar, Saudi Arabia	Face-to-face

Table E.1: Further information and details pertaining to the respondents of the conducted questionnaire survey on adaptive reuse practitioners from the A/E profession (Cont.)

#	Respondent's name and scope of work/job title	Affiliation	Interview Method
10.	Roland Romero (Architect)	Design Concept Engineering, Khobar, Saudi Arabia	Face-to-face
11.	Mohamed Majdi (Structural Engineer)	Ehsan Consult, Khobar, Saudi Arabia	Face-to-face
12.	Yazeed Almotawa (Architect)	YM Studio, Dhahran, Saudi Arabia	Face-to-face
13.	Mohamed Saleh (Architect)	Fedn Consulting Engineering, Dammam, Saudi Arabia	Face-to-face
14.	Mostafa Alkhodary (Project Manager)	Eng. Yaser Alrabiah Architectural Engineering, Khobar, Saudi Arabia	Face-to-face
15.	Amneh Basel Hamida (Interior Architect and Researcher)	Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia	Face-to-face
16.	Sameh Abd-Elmordy Farag (Architect)	Construction Agencies Consultant, Dammam, Saudi Arabia	Face-to-face
17.	Abdulrahman Al-Mubarak (Project Manager)	Abdulrahman Al-Mubarak Engineering Consulting Office, Khobar, Saudi Arabia	Face-to-face
18.	Fawaz Altalib (Design coordinator and Manager)	Fahd Alireza Engineering Consultant (FAEC), Khobar, Saudi Arabia	Face-to-face
19.	Mohammed Al-Subait (Architect)	Alawami Engineering & Consulting Office (Alawami Planners and Consultants), Qatif, Saudi Arabia	By phone
20.	Mohamed Hamdi Salaheldin (Architect)	Al-Meer Engineering Consultants, Safwa, Saudi Arabia	By phone
21.	Bassem Moussa (Architect)	Alrowshen Engineering Consultants, Dammam, Saudi Arabia	Face-to-face
22.	Mostafa Tageldin Hassen (Architect)	Abdulaziz Abdullah Alsuwaidan Engineering Consultant, Dammam, Saudi Arabia	Face-to-face
23.	Mohammed Abdelzaher (Architect)	Terraze Engineering Consulting Office, Dammam, Saudi Arabia	Face-to-face
24.	Amr Shalash (Architect)	Abdulrahman Alnaim Consultant Engineers Office, Dammam, Saudi Arabia	Face-to-face
25.	Ahmed Abdelhamid (Structural Engineer)	BMA Engineering, Khobar, Saudi Arabia	Face-to-face
26.	Ahmed Mostafa (Building Services Engineer)	Alwabran Consultant Engineering Office, Khobar, Saudi Arabia	Face-to-face
27.	Hamad Almousa (Architect and Design Coordinator)	Abdullah Battour Consulting Office, Khobar, Saudi Arabia	Face-to-face
28.	Ibrahim Algosaibi (Planning Engineer)	Sharqia Development Authority, Dammam, Saudi Arabia	Face-to-face
29.	Waleed Almutahhar (Project Manager)	Waleed Almutahhar Engineering Consultant, Dammam, Saudi Arabia	Face-to-face
30.	Yousef Mosleh (Project Manager)	Rewaqa Alkhaleej Engineering Consultancy, Dammam, Saudi Arabia	Face-to-face

E.2 Respondents of the Contractors' Questionnaire Surveys

Table E.2 presents further information and details pertaining to the respondents of conducted questionnaire survey on the adaptive reuse practitioners from the construction profession. The name, scope of work and affiliation of each respondent of the contractors' questionnaire survey are demonstrated. The method of the conducted interview with each respondent is mentioned as well.

Table E.2: Further information and details pertaining to respondents of the conducted questionnaire survey on adaptive reuse practitioners from the construction profession

#	Respondent's name and scope of work/job title	Affiliation	Interview Method
1.	Abdullah Al-Moudi (Project Manager)	Walled Saeed Al-Moudi for Contracting, Khobar, Saudi Arabia	Face-to-face
2.	Hosam Oqab (Project Engineer)	Nesaj Real Estate Development, Dhahran, Saudi Arabia	Face-to-face
3.	Ahmed Ali (Project Engineer)	Integrated Services for Engineering Works Establishment, Dammam, Saudi Arabia	Face-to-face
4.	Motaz Jamman (Project Manager)	Real Estate Makers: Real Estate and Contracting, Khobar, Saudi Arabia	Face-to-face
5.	Abdulwahab A. Almousa (Manager)	Almousa, Khobar, Saudi Arabia	Face-to-face
6.	Abdullah Al-Nahdi (Project Manager)	Dar Al-Osool Contracting, Khobar, Saudi Arabia	Face-to-face
7.	Khalid Abdulaziz Al-Saeed (Project Manager)	Amlak Al-Olya Establishment, Khobar, Saudi Arabia	Face-to-face
8.	Hamad Saeed Al-Hajri (Project Manager)	Hamad Saeed Al-Hajri Construction Establishment, Khobar, Saudi Arabia	Face-to-face
9.	Ali Fahad Al-Afari (Project Manager)	Hawaet General Contracting Establishment, Dammam, Saudi Arabia	Face-to-face
10.	Tag Basheer (Project Manager)	Adeer Arabian Company, Dhahran, Saudi Arabia	Face-to-face
11.	Marwan Al-Nahdi (Project Manager)	Al-Olaya Housing	Face-to-face
12.	Mohamed Rabei (Civil Engineer)	Soroh Al-Khair Contracting Establishment, Dhahran, Saudi Arabia	Face-to-face
13.	Mohamed Mohamed Omar (Project Manager)	Yafal Contracting Establishment, Dhahran, Saudi Arabia	Face-to-face
14.	Abu-Bakr Awadh Mohammed (Civil Engineer)	Abdullah Shaiban Al-Dossary Contracting, Khobar, Saudi Arabia	Face-to-face
15.	Ahmed M. Zaki (Project Engineer)	Al-Ymama Company, Dammam, Saudi Arabia	Face-to-face
16.	Abdullah Abdullah (Project Engineer)	Dammam Development Co., Dammam, Saudi Arabia	Face-to-face

Table E.2: Further information and details pertaining to the respondents of the conducted questionnaire survey on adaptive reuse practitioners from the construction profession (Cont.)

#	Respondent's name and scope of work/job title	Affiliation	Interview Method
17.	Saleh Ba Wajih (Project Engineer)	Awan Group, Khobar, Saudi Arabia	Face-to-face
18.	Raed Abdullah Baltyor (Electrical Engineer)	Raed A. Baltyor and Sons Real Estate Company, Dammam, Saudi Arabia	Face-to-face
19.	Munjed Al-Hammouri (Civil Engineer)	Saud Rashed Contracting Establishment, Dammam, Saudi Arabia	Face-to-face
20.	Ahmed Abdulaziz (COO)	Modern Vision Contracting, Dammsm, Saudi Arabia	Face-to-face
21.	Shaheen Al-Shareef (Civil Engineer)	Rabwat Al-Dhahran General Contracting, Khobar, Saudi Arabia	Face-to-face
22.	Suliman Al-Matrudi (Building Engineer)	Amad Construction Company, Khobar, Saudi Arabia	Face-to-face
23.	Mohammed Almuhawis (Executive Manager)	Fahad Salama Almuhawis Contracting Establishment, Dhahran, Saudi Arabia	By phone
24.	Nasser Mohammed Al-Dossery (Project Manager)	Abu Bader Construction Establishment, Dammam, Saudi Arabia	Face-to-face
25.	Hamdi Abdullah (Civil Engineer)	Rawabi Specialized Contracting, Khobar, Saudi Arabia	Face-to-face
26.	Ahmed Ali Al-Balobad (Project Manager)	Ahl Alossoul Contracting Establishment, Khobar, Saudi Arabia	Face-to-face
27.	Abdulrahman Abdullah Al-Naim (Project Manager)	Abdulatif Bin Saud Al-Naim Establishment for Trading and Contracting Khobar, Saudi Arabia	Face-to-face
28.	Safwat Hakem (Project Manager)	Mfareh Al-Subie Establishment for Maintenance, Khobar, Saudi Arabia	Face-to-face
29.	Faris Al-Taleb (Surveying Engineer)	Yousef Alhamad for General Contracting Khobar, Saudi Arabia	Face-to-face
30.	Mhamoud Shiba (Decoration Engineer)	Accuracy & Implementation Contracting Establishment, Dammam Saudi Arabia	Face-to-face

E.3 Respondents of the Contractors' Questionnaire Surveys

Table E.3 presents further information and details pertaining to the respondents of conducted questionnaire survey on the adaptive reuse practitioners from the FM profession. The name, scope of work and affiliation of each respondent of the facilities managers' questionnaire survey are demonstrated. The method of the conducted interview with each respondent is mentioned as well.

Table E.3: Further information and details pertaining to the respondents of the conducted questionnaire survey on adaptive reuse practitioners from the FM profession

#	Respondent's name and scope of work/job title	Affiliation	Interview Method
1.	Dr. Sharif Salahaldin Abu-Almajed (Maintenance Engineer)	Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia	Face-to-face
2.	Saeed Alawbathani (Maintenance Engineer)	Arab Open University, Dammam, Saudi Arabia	Face-to-face
3.	Faisal Al Kheder (Electrical Engineer)	Dhahran Eye Specialist Hospital, Dhahran, Saudi Arabia	Face-to-face
4.	Mohammes Salim Patel (Facilities Management Director)	Tadbeir Integrated facilities management, Khobar, Saudi Arabia	Face-to-face
5.	Khalid Elgaili Abd-Alhadi Ali (Property Manager)	Mardi Alzahrani Maintenance Establishment, Khobar, Saudi Arabia	Face-to-face
6.	Issam Manager (Manager of Logistic and Maintenance Services)	Al-Faraby Medical Group, Dammam, Saudi Arabia	Face-to-face
7.	Shafraz Mohamed (Property Manager)	Al-Hokair Group, Khobar, Saudi Arabia	Face-to-face
8.	Abdulaziz Al-Qahtani (Manager of Technical Services and O&M)	Almajal Service Master G4S, Khobar, Saudi Arabia	Face-to-face
9.	Ali AlKhashan (CEO)	SRACO Maintenance, Dammam, Saudi Arabia	Face-to-face
10.	Bader Ali Bajahlan (Building Engineer)	Almana General Hospital, Khobar, Saudi Arabia	Face-to-face
11.	Zayed Alboggami (Maintenance Engineer)	Saudi Aramco, Ras Tanura, Saudi Arabia	By phone
12.	Mohammed Alzuraiq (Architectural Engineer)	Royal Commission for Jubail and Yanbu, Jubail, Saudi Arabia	By phone
13.	Nabeel Mohammad Abu-Rizeq (Maintenance Engineer)	Awan Group, Khobar, Saudi Arabia	Face-to-face
14.	Ammar Bin Saleh (Property Manager)	Tamimi Real Estate, Dammam, Saudi Arabia	Face-to-face
15.	Mohammed Al-Ahmed (Facilities Engineer)	Saudi Electricity Company, Dammam, Saudi Arabia	Face-to-face
16.	Mohamed Samak (Property Manager and Marketing Specialist)	Alnajem Real Estate Company, Dammam, Saudi Arabia	Face-to-face
17.	Ahmed Al-Hakeem (Manager)	Musanadah Facilities Management, Khobar, Saudi Arabia	Face-to-face
18.	Hasan Fardan (O&M Manager for three years)	Ministry of Education, Dammam, Saudi Arabia	By phone
19.	Khaled Baataa (Property Manager)	Saeed Baataa for Real Estate Services and General Maintenance, Dammam, Saudi Arabia	Face-to-face
20.	Haris Shaikh (Operation Manager)	EMCOR Saudi Arabia (EFS Facilities Services), Khobar, Saudi Arabia	Face-to-face
21.	Zamil Alzamil (Architectural Engineer and area Manager)	King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia	Face-to-face

Table E.3: Further information and details pertaining to the respondents of the conducted questionnaire survey on adaptive reuse practitioners from the FM profession (Cont.)

#	Respondent's name and scope of work/job title	Affiliation	Interview Method
22.	Abdulaziz Batarfi (Property Manager)	Zamil O&M Limited Company, Khobar, Saudi Arabia	Face-to-face
23.	Abeer Aljanahi (Park Manager)	Future Fun Trading Company, Dhahran, Saudi Arabia	Face-to-face
24.	Khalid Mubarak Al-Dossary (Property Manager)	Al-Ebdaa Sharrqi for General Contracting and Real Estate Services, Dammam, Saudi Arabia	Face-to-face
25.	Ali Al-Younas (Property Manager)	Fahad Al-Younas Establishment for Real Estate, General Services and Maintenance, Dammam, Saudi Arabia	Face-to-face
26.	Mohammad Arshad (Facilities Manager)	Facilities Management Company (FMCO), Dammam, Saudi Arabia	Face-to-face
27.	Abdulrahman Albashir (Property Manager)	Al-Dossary Establishment for Contracting and Real Estate Services, Dammam, Saudi Arabia	Face-to-face
28.	Mohsen Al-Hajri (Property Manager)	Mani Company: Contracting, Operation and Maintenance, Trading, Khobar, Saudi Arabia	Face-to-face
29.	Khalid Alshikh (Maintenance Supervisor)	Hamad Bin Abdulrahman Al-Saadi Contracting Establishment for Building Operation and Maintenance Services, Dammam, Saudi Arabia	Face-to-face
30.	Hussien Alkaf (Building Engineer)	Maintenance Contracting Company (MCC), Dammam, Saudi Arabia	Face-to-face

APPENDIX F:

VALIDATION QUESTIONNAIRE SURVEY (ARABIC AND ENGLISH)

Development of A Framework for the Effective Implementation of Building Adaptive Reuse throughout the Project Life Cycle

Section (A): Summary and Demographic Questions

Dear Sir,

A lifecycle-oriented framework was developed for effective implementation of adaptive reuse projects in Saudi Arabia. The framework consists of four main processes, namely: “Assesses the Feasibility of the Adaptive Reuse Project”, “Design the Adaptive Reuse Project”, “Construct the Adaptive Reuse Project” and “Operate and Maintain the Adaptive Reused Building”. Each process consists of a set of sequential functions (See Figure I - V in section C). IDEF₀ (Integration Definition for Function Modeling) methodology was employed to schematically represent the developed framework.

In this regard, this questionnaire survey aims to assess the importance rate and the frequency of implementing the sequential functions listed under each of the mentioned processes, as well as test the validity of the overall framework. Thus, the schematic representations of the developed framework are also provided in this questionnaire survey for further elaboration.

Kindly fill this questionnaire as fully as possible, with all thanks and appreciation to you for your valuable contributions. Your comments and suggestions on the developed framework are important and considered in this research.

Note that the study is conducted by a researcher from the Architectural Engineering Department at King Fahd University of Petroleum and Minerals in Dhahran, so all information that will be obtained from the survey is used for a research purpose.

Regards,

Researcher. Mohammad Basel Hamida,
Architectural Engineering Department,
King Fahd University of Petroleum and Minerals,
Dhahran, Saudi Arabia
Email: g201703050@kfupm.edu.sa
Mobile phone: +966532254941

1. Respondent Information

Name	
Organization	
Organization address	
Phone	
Email address	

2. Respondent Profession

- ☐ Architect
☐ Contractor
☐ Facilities Manager
☐ Other (Please Specify) _____.

3. What is your scope of work at the organization?

- | | |
|---|---|
| ☐ Architect | ☐ Civil engineer |
| ☐ Building services (MEP) engineer | ☐ Electrical engineer |
| ☐ Structural engineer | ☐ Project engineer/manager |
| ☐ Building design coordinator | ☐ Maintenance engineer |
| ☐ Architectural/Building engineer | ☐ Property manager |
| | ☐ Other |

4. Number of Years of Experience

☐ Less than 5 years	☐ 5 to 10 years
☐ 10 to 20 years	☐ Over 20 years

5. Have you dealt with adaptive reuse projects before?

☐ Yes	☐ No
------------------------------	-----------------------------

*Please don't fill the survey questionnaire if your answer is "No" and give the survey questionnaire to the person who is concerned with such kind of projects

6. Please indicate the number of adaptive reuse projects that you have been involved in before (in Saudi Arabia)

☐ 1 – 5 Projects	☐ 5 – 10 Projects	☐ More than 10 projects
---	--	--

7. Types of Projects that you mostly deal with (multiple selection is allowed)

- ☐ Apartment Buildings
☐ Single Houses (Villas)
☐ Shops
☐ Office Buildings
☐ Educational buildings
☐ Recreational buildings
☐ Commercial centers/shopping malls
☐ Other (Please Specify) _____.

Section (B): Assessment of the Importance and Practicality of the Functions of the Developed Framework

Kindly assess the level of importance of the functions of the developed framework, as well as the frequency rate in which your organization pay attention to them in actual practice of building adaptive reuse.

Function		Importance Level					Frequency Rate				
		Extremely Important	Very Important	Important	Somewhat Important	Not Important	Always	Frequently	Sometimes	Seldom	Never
P1 ‘Assess the Feasibility of the Adaptive Reuse Project’ – (See Node P1 in Figure I; and Figure II)											
1.	Assess the Structural Integrity of the Building (See Node P1.1 in Figure II)										
2.	Investigate the Requirements for Adaptive Reuse (See Node P1.2 in See Figure II)										
3.	Assess the Building Condition (See Node P1.3 in Figure II)										
4.	Develop the Architectural Program for the New Use (See Node P1.24 in Figure II)										
5.	Assess the Spaces Potential for Adaptive Reuse (See Node P1.5 in Figure II)										
6.	Assess the Economic Feasibility for the Project (See Node P1.6 in Figure II)										
P2 ‘Design the Adaptive Reuse Project’ – (See Node P2 in Figure I; and Figure III)											
7.	Assess the Capacity and Layout of Existing Systems and Components (See Node P2.1 in Figure III)										
8.	Propose Design Alternatives (See Node P2.2 in Figure III)										
9.	Evaluate Proposed Alternatives (See Node P2.3 in III)										
10.	Develop Detailed Design and Specifications (See Node P2.4 in Figure III)										
11.	Follow-up to Obtain the Municipal Permits (See Node P2.5 in Figure III)										

Function		Importance Level					Frequency Rate				
		Extremely Important	Very Important	Important	Somewhat Important	Not Important	Always	Frequently	Sometimes	Seldom	Never
P3 ‘Construct the Adaptive Reuse Project’ – (See Node P3 in Figure I; and Figure IV)											
12.	Procure the Services of a Contractor (See Node P3.1 in Figure IV)										
13.	Prepare the Site for the Project (See Node P3.2 in Figure IV)										
14.	Plan and Schedule the Project Activities (See Node P3.3 in Figure IV)										
15.	Remove Unnecessary Systems and Components (See Node P3.4 in Figure IV)										
16.	Construct & Install the New Systems and Components (See Node P3.5 in Figure IV)										
17.	Deliver the Project to the Client (See Node P3.6 in Figure IV)										
P4 ‘Operate and Maintain the Adaptive Reuse Project’ – (See Node P4 in Figure I; and Figure V)											
18.	Procure the Services of a Facilities Manager (See Node P4.1 in Figure V)										
19.	Conduct Commissioning Process for the Systems and Components (See Node P4.2 in Figure V)										
20.	Develop an O&M Plan for the Project (See Node P4.3 in Figure V)										
21.	Monitor and Record Space Utilization (See Node P4.4 in Figure V)										
22.	Assess Building Performance and User Satisfaction (See Node P4.5 in Figure V)										

Section (C): List of Figures of the Schematically Developed IDEF₀ Framework

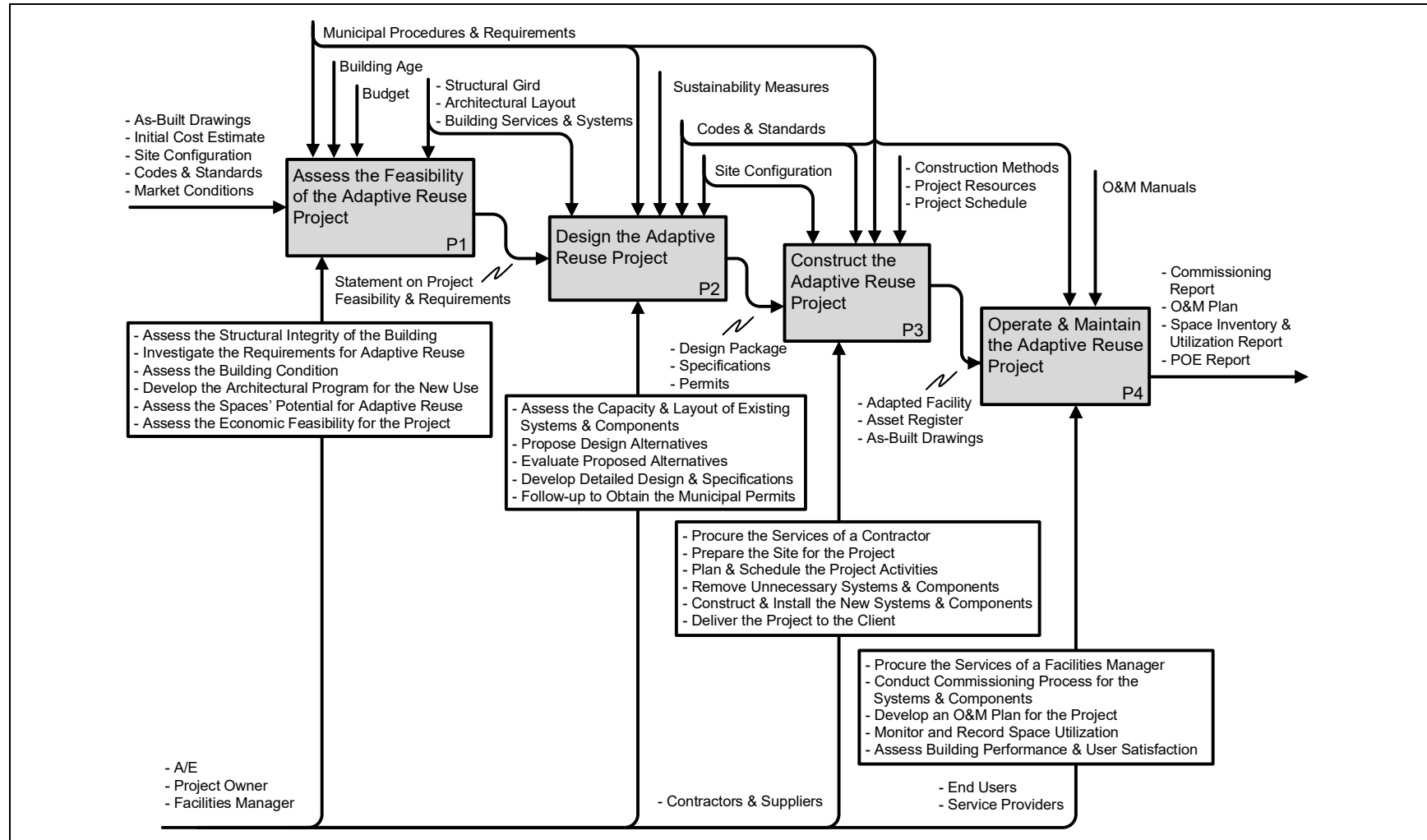


Figure I: Generic framework for the processes involved in the life-cycle of adaptive reuse projects

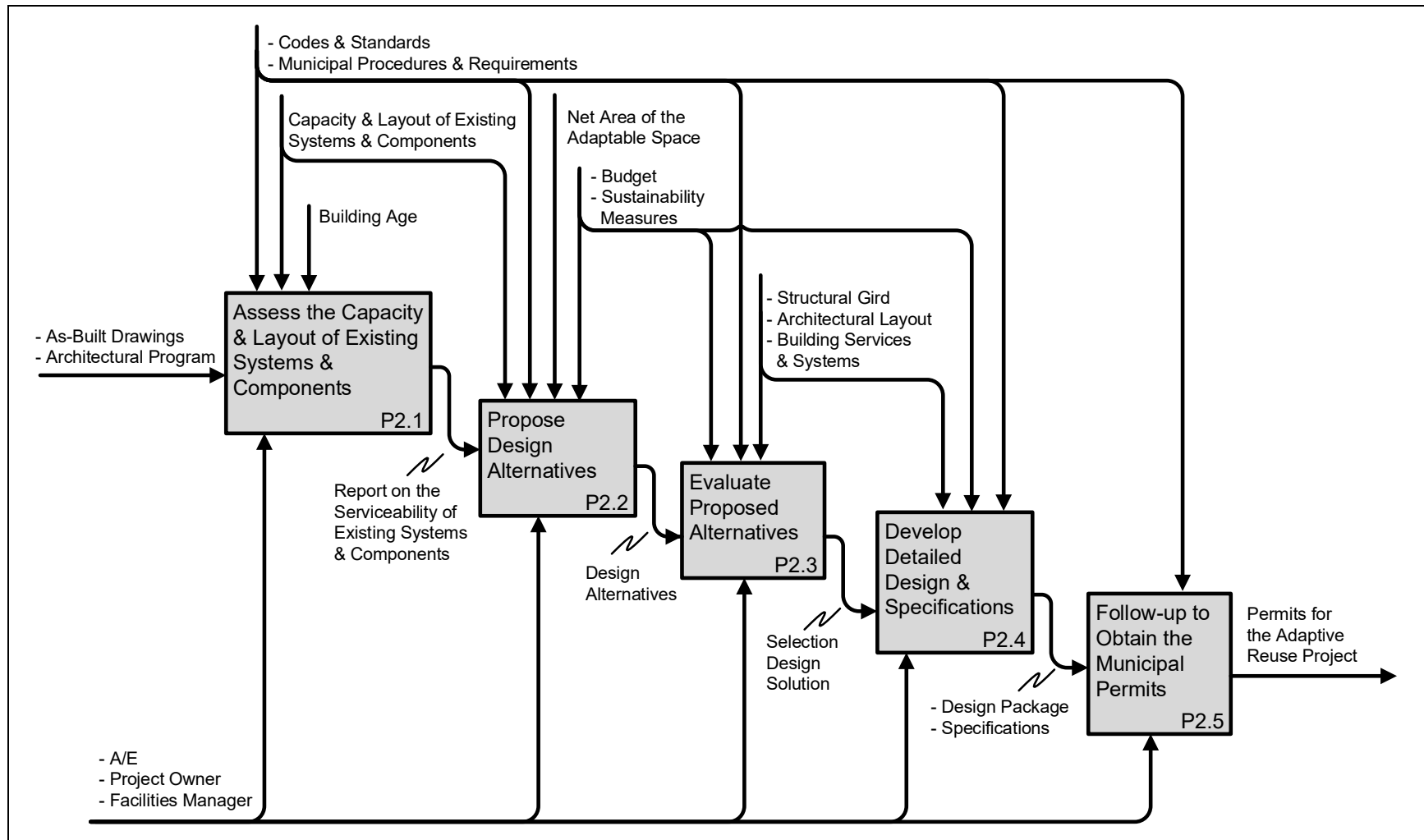


Figure III: Node P2 'design the adaptive reuse project'

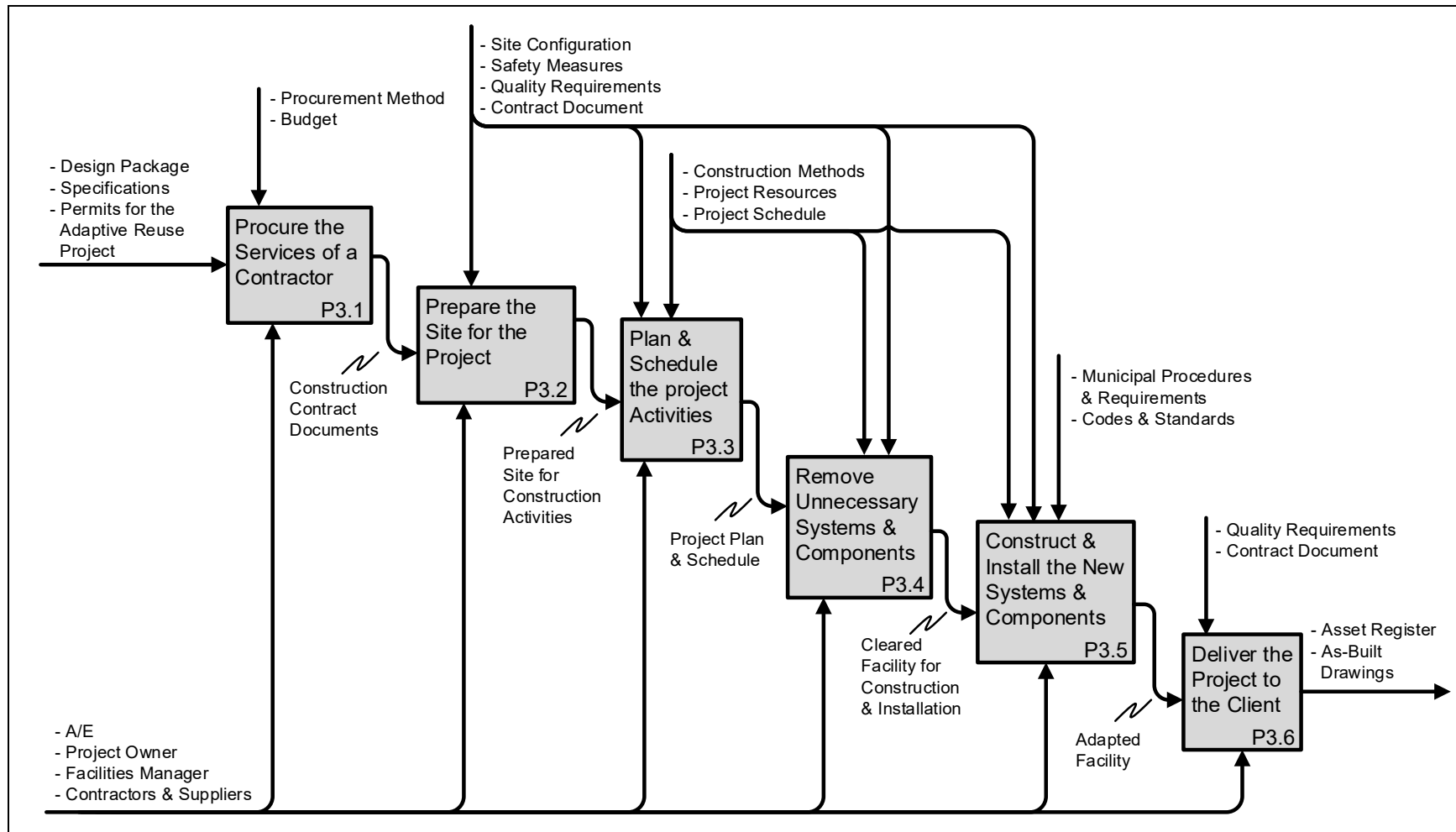


Figure IV: Node P3 ‘construct the adaptive reuse project’

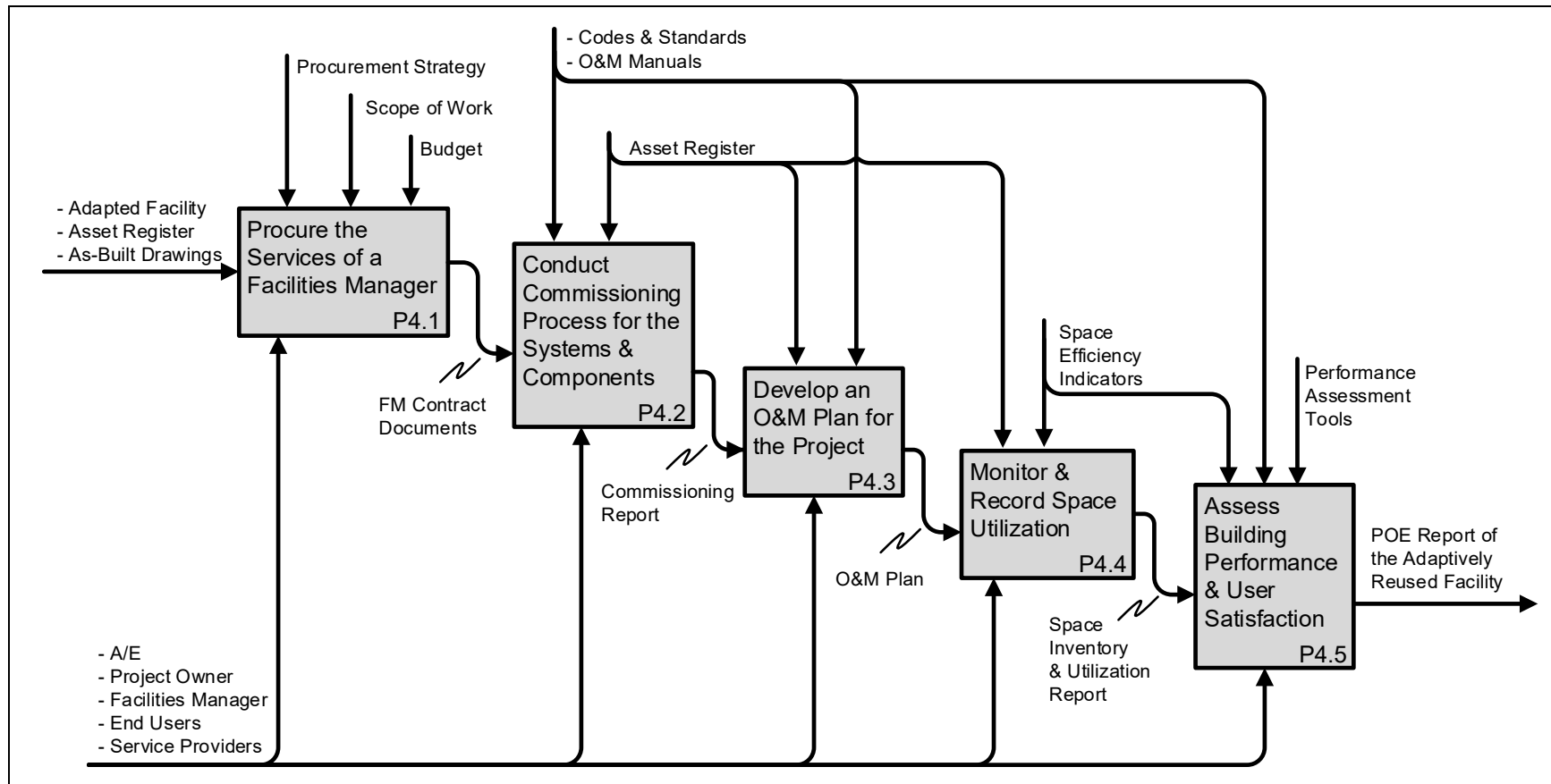


Figure V: Node P4 ‘operate & maintain the adaptive reuse project’

Section (D): Additional Remarks (Optional)

Kindly if you have additional information/clarification that might enhance the research, please don't hesitate to mention them in the available below area:

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Thank you for your consideration and cooperation

تطوير إطار للتنفيذ الفعال لعملية إعادة استخدام المتكيف للمبنى طوال دورة حياة المشروع

القسم (أ): الخلاصة والأسئلة الديموغرافية

أخي الكريم

تم تطوير إطار للتنفيذ الفعال لمشاريع إعادة استخدام المتكيف للمباني (مايعرف بمشاريع تحويل أنشطة المباني القائمة) في المملكة العربية السعودية ضمن سياق موجه نحو دورة الحياة المتكاملة، حيث إن الإطار يتكون من أربعة عمليات متتابعة والتي بعنوان "تقييم جدوى مشروع إعادة استخدام المتكيف" و "تصميم مشروع إعادة استخدام المتكيف" و "تنفيذ مشروع إعادة استخدام المتكيف" وأخيراً "تشغيل وصيانة مشروع إعادة استخدام المتكيف". شملت كلاً من هذه العمليات على مجموعة من المهام المتتابعة الموضحة في الأشكال من (أ) إلى (هـ) المرفقة في القسم (ج) حيث تم استخدام منهجية تعريف التكامل لنمذجة الوظيفة (IDEF₀) لتمثيل الإطار وعرضه تخطيطياً.

وفي هذا الصدد فقد تم إنشاء هذا الاستبيان لتقييم معدل أهمية كل مهمة مدرجة بالإطار و مدى تنفيذها العملي في الواقع ، بالإضافة إلى هدف التحقق من صحة الإطار بشكل عام ؛ ولذلك فقد تم إدراج النماذج التخطيطية للإطار في هذا الاستبيان لعرضه بشكل أكثر وضوحاً.

يرجى منك التكرم بتعبئة الاستبيان على أكمل وجه ممكن مع كامل التقدير لكم على جهودكم الطيبة حيث إن جميع تعليقاتكم وإقتراحاتكم ذات أهمية و ستؤخذ في عين الاعتبار.

وختاماً لا بد من أن ننوه بأن الدراسة يجريها باحث من قسم الهندسة المعمارية بجامعة الملك فهد للبترول والمعادن بالظهران، وبالتالي فإن جميع المعلومات التي سيتم الحصول عليها من هذا الاستبيان تستخدم لغرض بحثي فقط.

وتقبل خالص تحياتي

الباحث/ محمد باسل حميده

قسم الهندسة المعمارية

جامعة الملك فهد للبترول و المعادن

الظهران – المملكة العربية السعودية

البريد الإلكتروني: g201703050@kfupm.edu.sa

الهاتف النقال: ٠٥٣٢٢٥٤٩٤١

١. بيانات المجيب

الاسم	
المؤسسة	
عنوان المؤسسة	
الهاتف	
البريد الإلكتروني	

٢. القطاع الذي يعمل به المجيب

- ☐ معماري
☐ مقاول
☐ مدير منشآت
☐ غير ذلك (حددها من فضلك) _____

٣. ماهو مجال عملك المهني؟

☐ مهندس مدني ☐ مهندس كهربائي ☐ مهندس أو مدير مشروع ☐ مهندس صيانة ☐ مدير عقاري (ممتلكات) ☐ غير ذلك (حددها من فضلك) _____	☐ معماري ☐ مهندس نظم خدمات المباني (الأنظمة الميكانيكية والكهربائية والسباكة) ☐ مهندس إنشائي ☐ منسق تصاميم المباني ☐ مهندس مباني (مهندس معماري)
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٤. عدد سنوات الخبرة

☐ أقل من (٥) سنوات ☐ من (٥) إلى (١٠) سنوات ☐ أكثر من ٢٠ سنة	☐ من (١٠) سنوات إلى (٢٠) سنة
--	---

٥. هل سبق لك التعامل مع مشاريع إعادة الاستخدام المتكيف للمباني؟

☐ نعم ☐ لا	
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* الرجاء عدم تعبئة الاستبيان إذا كانت الإجابة "لا" وإعطاء الاستبيان بالشخص المعني بذلك

٦. يرجى تبين عدد مشاريع إعادة الاستخدام المتكيف للمباني التي قمت بالمشاركة في تصميمها بالمملكة العربية السعودية

☐ ١ - ٥ مشاريع ☐ ٥ - ١٠ مشاريع ☐ أكثر من ١٠ مشاريع	
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٧. نوع المشاريع التي تتعامل معها في غالب الأحيان

- ☐ مباني شقق
☐ بيوت منفردة (فلل)
☐ محلات
☐ مباني مكتبية
☐ مباني تعليمية
☐ مباني ترفيهية
☐ مراكز تجارية - مجمعات تجارية
☐ غير ذلك (حددها من فضلك) _____

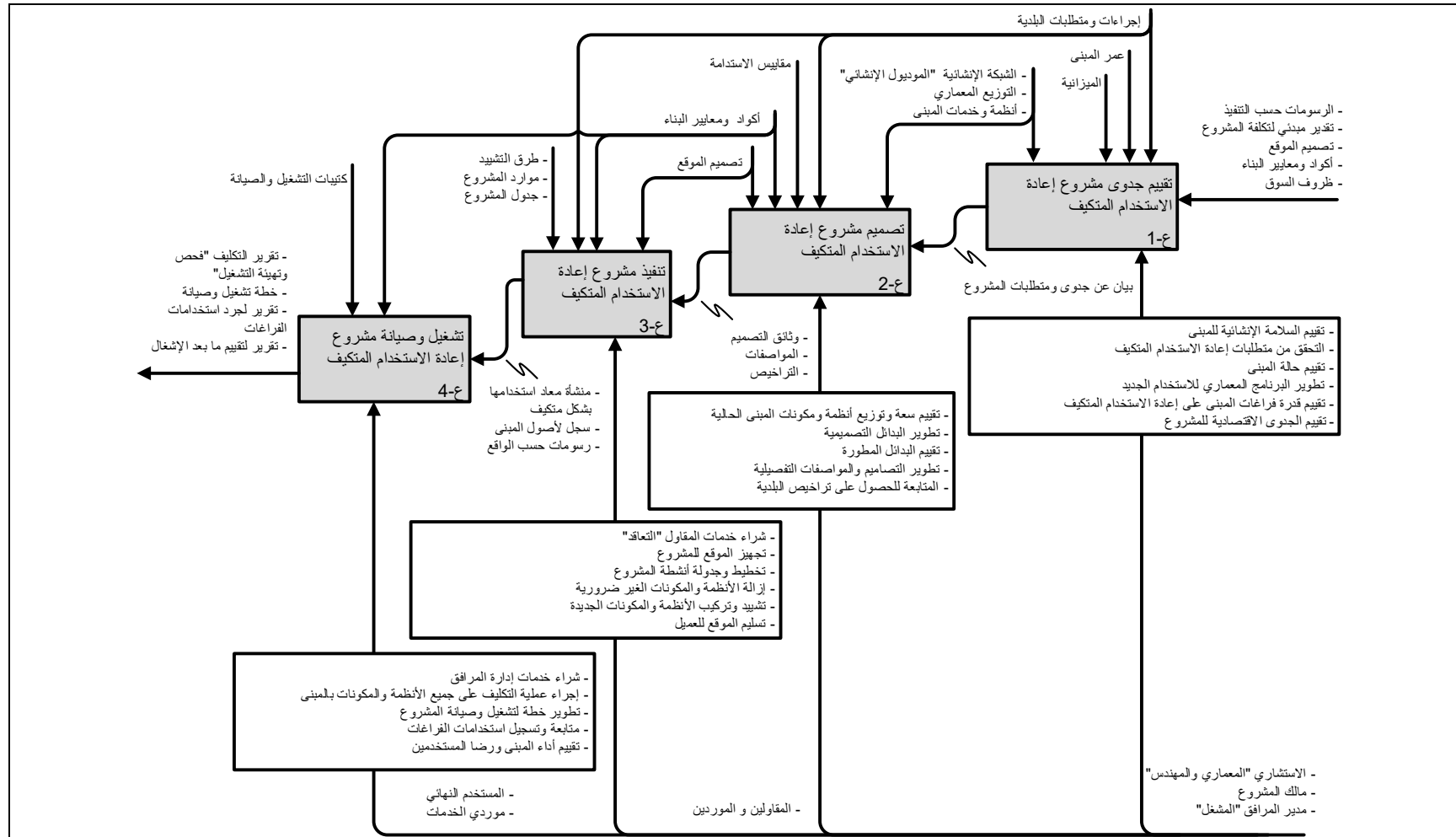
القسم (ب): تقييم مستوى أهمية ومعدل التطبيق العملي لمهام الإطار المطور

يرجى تقييم مستوى أهمية مهام الإطار المطور وكذلك معدل تكرار تنفيذها في مؤسستكم عند الإنضمام بمشاريع إعادة الاستخدام المتكيف للمباني:

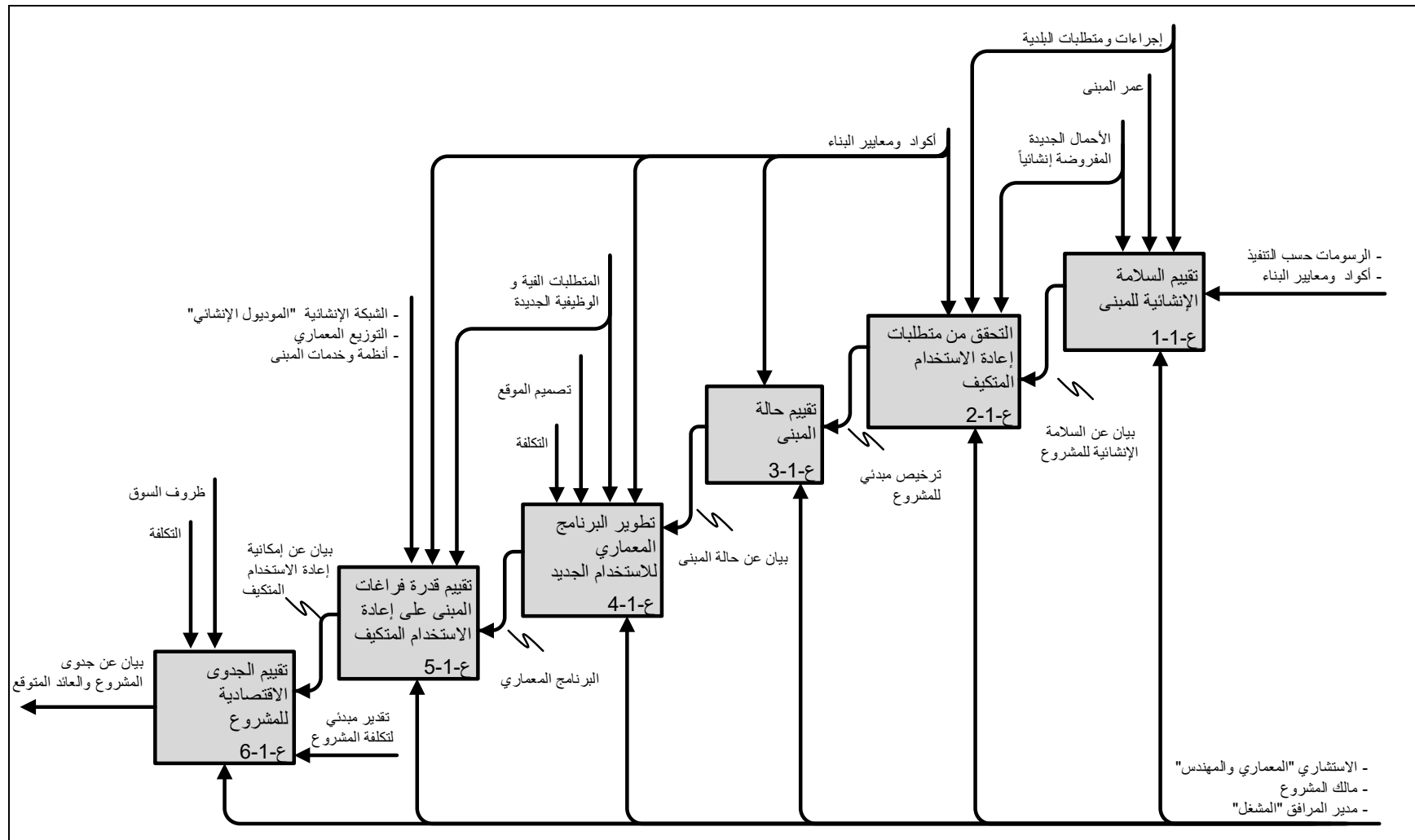
معدل التكرار					درجة الأهمية					المهمة
أبداً	نادراً	في بعض الأحيان	في كثير من الأحيان	دائماً	منخفضة جداً	منخفضة	متوسطة	مرتفعة جداً (درجة كبيرة)		
العملية ع ١: تقييم جدوى مشروع إعادة الاستخدام المتكيف انظر العملية ع-١ في الشكل (أ) ، وكذلك الشكل (ب)										
									١. تقييم السلامة الإنشائية للمبنى - انظر المربع ع-١-١ في الشكل (ب)	
									٢. التحقق من متطلبات إعادة الاستخدام المتكيف (ما يعرف بتغيير النشاط) - انظر المربع ع-١-٢ في الشكل (ب)	
									٣. تقييم حالة المبنى - انظر المربع ع-١-٣ في الشكل (ب)	
									٤. تطوير البرنامج المعماري للإستخدام الجديد - انظر المربع ع-١-٤ في الشكل (ب)	
									٥. تقييم قدرة فراغات المبنى على إعادة الاستخدام المتكيف (القدرة على التحول وظيفياً) - انظر المربع ع-١-٥ في الشكل (ب)	
									٦. تقييم الجدوى الإقتصادية للمشروع - انظر المربع ع-١-٦ في الشكل (ب)	
العملية ع ٢: تصميم مشروع إعادة الاستخدام المتكيف انظر العملية ع-٢ في الشكل (أ) ، وكذلك الشكل (ج)										
									٧. تقييم سعة وتوزيع أنظمة ومكونات المبنى الحالية - انظر المربع ع-٢-١ في الشكل (ج)	
									٨. تطوير البدائل التصميمية - انظر المربع ع-٢-٢ في الشكل (ج)	
									٩. تقييم البدائل المطورة - انظر المربع ع-٢-٣ في الشكل (ج)	
									١٠. تطوير التصاميم والمواصفات التفصيلية - انظر المربع ع-٢-٤ في الشكل (ج)	
									١١. المتابعة للحصول على تراخيص البلدية - انظر المربع ع-٢-٥ في الشكل (ج)	

المهمة			درجة الأهمية							معدل التكرار			
			مهم للغاية (جداً بدرجة كبيرة)	مهم جداً	مهم	مهم إلى حد ما	غير مهم	دائماً	في كثير من الأحيان	في بعض الأحيان	نادراً	أبداً	
العملية ع ٣: "تنفيذ مشروع إعادة استخدام المتكيف انظر العملية ع-٣ في الشكل (أ) ، وكذلك الشكل (د)													
١٢.	شراء خدمات المقاول (التعاقد)												
	- انظر المربع ع-٣-١ في الشكل (د)												
١٣.	تجهيز الموقع للمشروع												
	- انظر المربع ع-٣-٢ في الشكل (د)												
١٤.	تخطيط وجدولة أنشطة المشروع												
	- انظر المربع ع-٣-٣ في الشكل (د)												
١٥.	إزالة الأنظمة والمكونات الغير ضرورية												
	- انظر المربع ع-٣-٤ في الشكل (د)												
١٦.	تشبيد وتركيب الأنظمة والمكونات الجديدة												
	- انظر المربع ع-٣-٥ في الشكل (د)												
١٧.	تسليم الموقع للعميل												
	- انظر المربع ع-٣-٦ في الشكل (د)												
العملية ع ٤: تشغيل وصيانة مشروع إعادة استخدام المتكيف انظر العملية ع-٤ في الشكل (أ) ، وكذلك الشكل (هـ)													
١٨.	شراء خدمات إدارة المرافق												
	- انظر المربع ع-٤-١ في الشكل (هـ)												
١٩.	إجراء عملية التكليف على جميع الأنظمة و المكونات (ما يعرف بفحص نظم المبنى وتدريب المشغلين عليها)												
	- انظر المربع ع-٤-٢ في الشكل (هـ)												
٢٠.	تطوير خطة لتشغيل وصيانة المشروع												
	- انظر المربع ع-٤-٣ في الشكل (هـ)												
٢١.	متابعة وتسجيل إسخدامات الفراغات												
	- انظر المربع ع-٤-٤ في الشكل (هـ)												
٢٢.	تقييم أداء المبنى ورضا المستخدمين												
	- انظر المربع ع-٤-٥ في الشكل (هـ)												

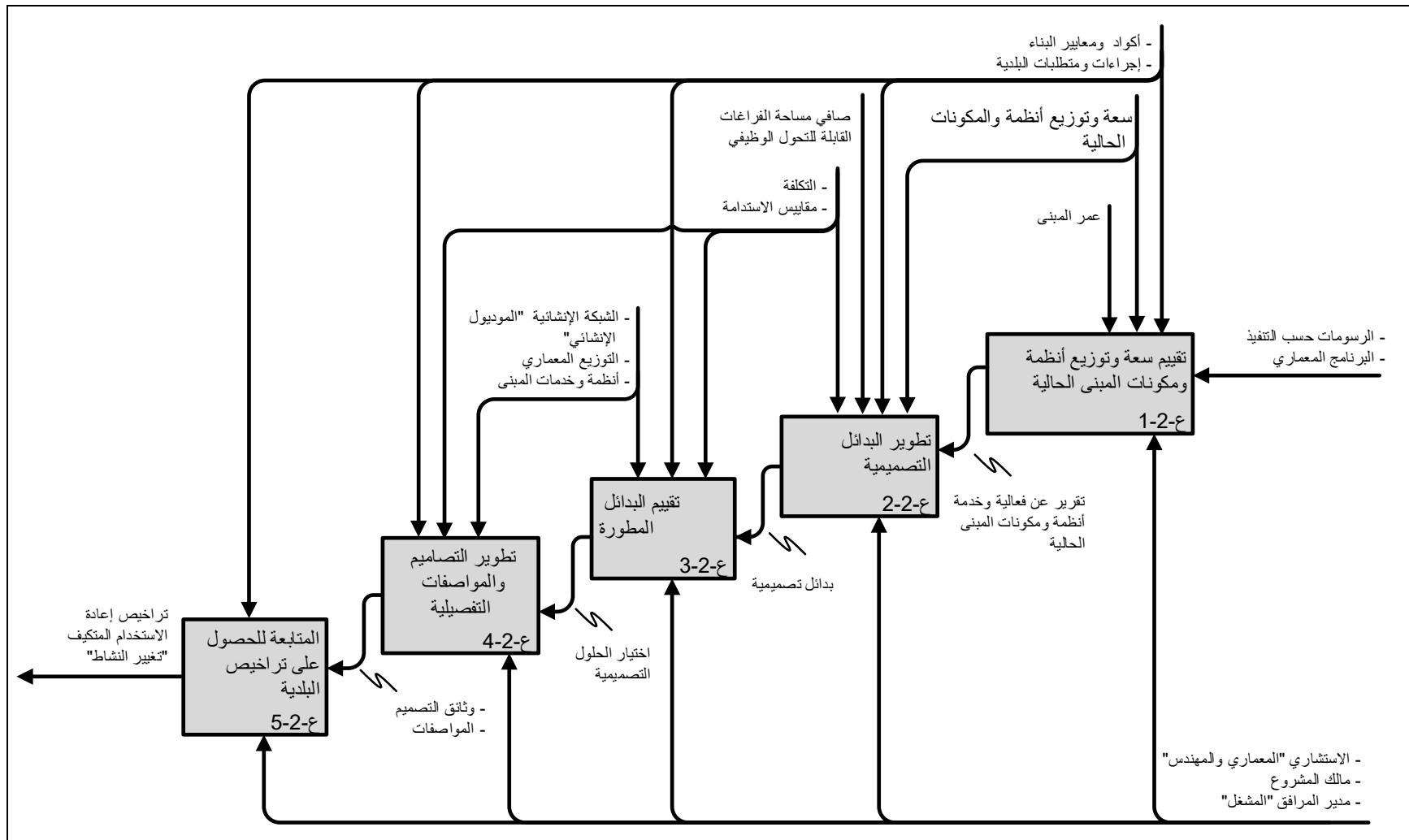
القسم (ج): قائمة الأشكال التوضيحية للتمثيل التخطيطي المعد للإطار بواسطة منهجية تعريف التكامل لنمذجة الوظيفة (IDEF₀)



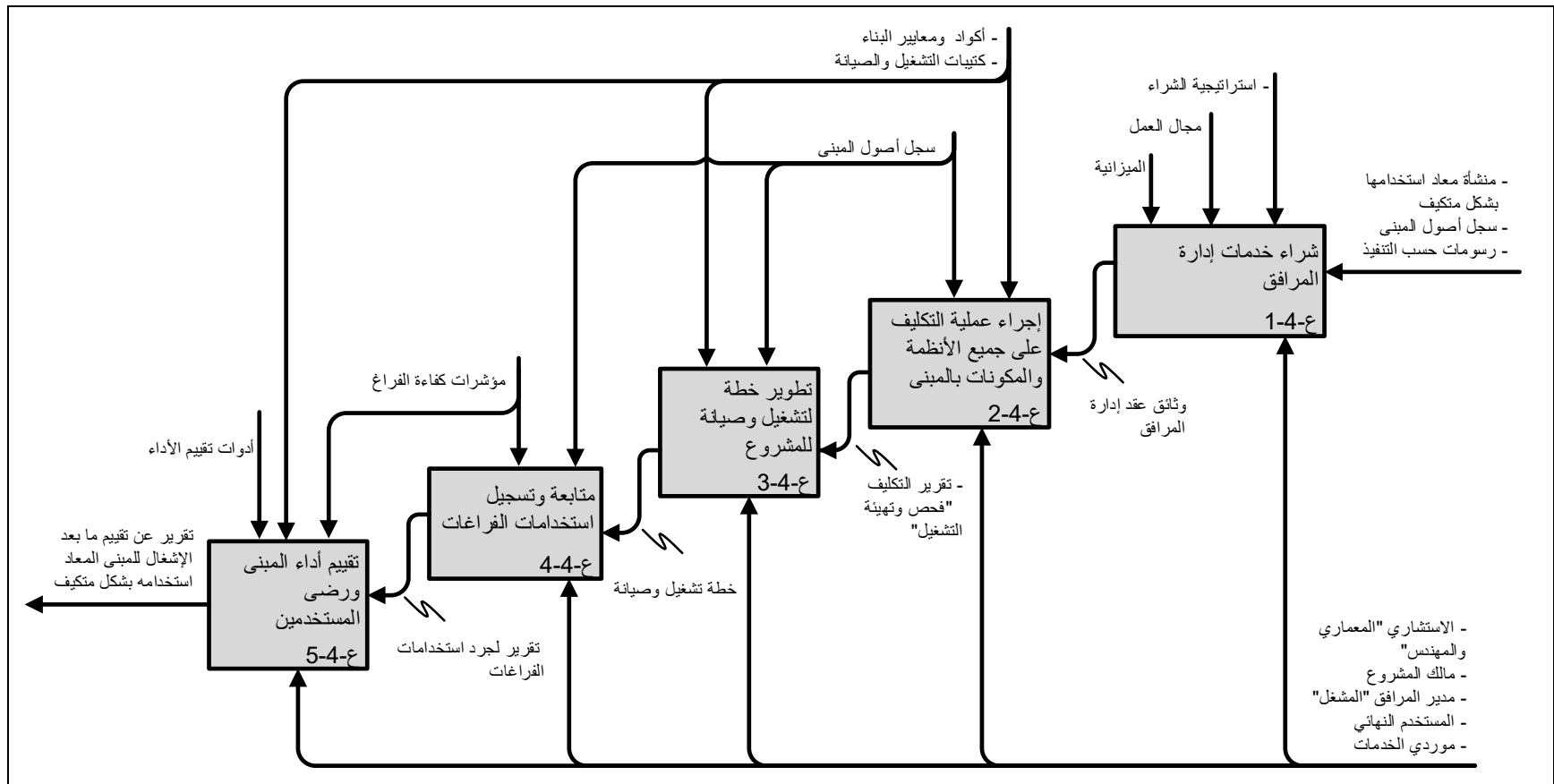
الشكل (أ): الإطار العام للعمليات التي تتم طوال دورة حياة مشاريع إعادة استخدام المتكيف



الشكل (ب): العملية ع-١ "تقييم جدوى مشروع إعادة الإستخدام المتكيف"



الشكل (ج): العملية ٢-ع: "تصميم مشروع إعادة استخدام المتكيف"



القسم (د): ملاحظات إضافية (إختياري)

إذا كان لديك معلومات إضافية قد تعزز البحث فيرجى عدم التردد في ذكرها بالمنطقة المتاحة أدناه:

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شكراً لاهتمامك وتعاونك

APPENDIX G:

LIST OF RESPONDENTS OF THE VALIDATION QUESTIONNAIRE SURVEY

G.1 Respondents of the Validation Questionnaire Survey from the A/E Profession

Table G.1 presents further information and details pertaining to the respondents of the conducted validation questionnaire survey from the A/E profession. The name, scope of work and affiliation of each respondent are demonstrated

Table G.1: Further information and details pertaining to the respondents of the validation questionnaire survey from the A/E profession

#	Respondent's name and scope of work/job title	Affiliation
1.	Mohammad Kajjak (Architect)	Drb Atlas, Dammam, Saudi Arabia
2.	Yahya Al Najjar (Architect)	Design Plus, Khobar, Saudi Arabia
3.	Mohammed A. Althikrallah (Architect)	Hamad M. AlRugaib & Sons Trading Co. Ltd, Khobar, Saudi Arabia
4.	Mahmoud Ibrahim Mohammad (Architect)	National Office for Engineering Consultancy, Dammam, Saudi Arabia
5.	Sameh Abd-Elmordy Farag (Architect)	Construction Agencies Consultant, Dammam, Saudi Arabia
6.	Abdulrahman Al-Mubarak (Project Manager)	Abdulrahman Al-Mubarak Engineering Consulting Office, Khobar, Saudi Arabia
7.	Bassem Moussa (Architect)	Alrowshen Engineering Consultants, Dammam, Saudi Arabia
8.	Ahmed Abdelhamid (Structural Engineer)	BMA Engineering, Khobar, Saudi Arabia
9.	Hamad Almousa (Architect and Design Coordinator)	Abdullah Battour Consulting Office, Khobar, Saudi Arabia
10.	Ibrahim Algosaibi (Planning Engineer)	Sharqia Development Authority, Dammam, Saudi Arabia

G.2 Respondents of the Validation Questionnaire Survey from the Construction Profession

Table G.2 presents further information and details pertaining to the respondents of the conducted validation questionnaire survey from the construction profession. The name, scope of work and affiliation of each respondent are demonstrated

Table G.2: Further information and details pertaining to the respondents of the validation questionnaire survey from the construction profession

#	Respondent's name and scope of work/job title	Affiliation
1.	Abdullah Al-Moudi (Project Manager)	Walled Saeed Al-Moudi for Contracting, Khobar, Saudi Arabia
2.	Ahmed Ali (Project Engineer)	Integrated Services for Engineering Works Establishment (ISEW EST), Dammam, Saudi Arabia
3.	Hamad Saeed Al-Hajri (Project Manager)	Hamad Saeed Al-Hajri Construction Establishment, Khobar, Saudi Arabia
4.	Ali Fahad Al-Afari (Project Manager)	Hawaet General Contracting Establishment, Dammam, Saudi Arabia
5.	Marwan Al-Nahdi (Project Manager)	Al-Olaya Housing
6.	Mohamed Rabei (Civil Engineer)	Soroh Al-Khair Contracting Establishment, Dhahran, Saudi Arabia
7.	Saleh Ba Wajih (Project Engineer)	Awan Group, Khobar, Saudi Arabia
8.	Munjed Al-Hammouri (Civil Engineer)	Saud Rashed Contracting Establishment, Dammam, Saudi Arabia
9.	Ahmed Abdulaziz (COO)	Modern Vision Contracting, Dammsm, Saudi Arabia
10.	Hamdi Abdullah (Civil Engineer)	Rawabi Specialized Contracting, Khobar, Saudi Arabia

G.3 Respondents of the Validation Questionnaire Survey from the FM Profession

Table G.3 presents further information and details pertaining to the respondents of the conducted validation questionnaire survey from the FM profession. The name, scope of work and affiliation of each respondent are demonstrated

Table G.3: Further information and details pertaining to the respondents of the validation questionnaire survey from the FM profession

#	Respondent's name and scope of work/job title	Affiliation
1.	Dr. Sharif Salahaldin Abu-Almajed (Maintenance Engineer)	Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia
2.	Faisal Al Kheder (Electrical Engineer)	Dhahran Eye Specialist Hospital, Dhahran, Saudi Arabia
3.	Mohammes Salim Patel (Facilities Management Director)	Tadbeir Integrated facilities management, Khobar, Saudi Arabia
4.	Khalid Elgaili Abd-Alhadi Ali (Property Manager)	Mardi Alzahrani Maintenance Establishment, Khobar, Saudi Arabia
5.	Bader Ali Bajahlan (Building Engineer)	Almana General Hospetal, Khobar, Saudi Arabia
6.	Zayed Alboggami (Maintenance Engineer)	Saudi Aramco, Ras Tanura, Saudi Arabia
7.	Hussain Hamdi (Property Manager)	Alnajem Real Estate Company, Dammam, Saudi Arabia
8.	Hasan Fardan (O&M Manager for three years)	Ministry of Education, Dammam, Saudi Arabia
9.	Abeer Aljanahi (Park Manager)	Future Fun Trading Company, Dhahran, Saudi Arabia
10.	Hussien Alkaf (Building Engineer)	Maintenance Contracting Company (MCC), Dammam, Saudi Arabia

VITAE

➤ Personal Information

MOHAMMAD BASEL HAMIDA

Date of Birth: November 27, 1994

Place of Birth: Dhahran, Saudi Arabia

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Temporary address: Room 235 (Graduate Students' Room), Second Floor, Building 19
(College of Environmental Design)
King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia

➤ Profile

Mohammad Basel Hamida holds a Bachelor of Building Engineering with practical knowledge and skills related to the use of state-of-the-art tools and technologies in the technical design of buildings, besides the capability of developing the technical documents of construction projects. He obtained his master's degree in Architectural Engineering with an emphasis in Facilities Engineering and Management. Through his master's study, he gained a theoretical background and research experience in the domains of built-environment management, building adaptive reuse, building life-cycle integration and building performance assessment.

➤ Education

September 2017 – March 2020

- **Master of Science in Architectural Engineering (emphasis in Facilities Engineering and Management)**

Department of Architectural Engineering, King Fahd University of Petroleum and Minerals (KFUPM), Dhahran, Saudi Arabia

Thesis title: *“Development of a Framework for the Effective Implementation of Building Adaptive Reuse throughout the Project Life Cycle in Saudi Arabia”*

Advisor: Prof. Mohammad A. Hassanain

GPA: 3.91/4.00 (Excellent)

September 2012 – June 2017

- **Bachelor of Building Engineering**

Building Engineering Department, Imam Abdulrahman Bin Faisal University (formerly University of Dammam), Dammam, Saudi Arabia

Senior project title: *“Energy Auditing of Educational Building in the Eastern Province of Saudi Arabia”*

Advisor: Dr. Faris Abdullah Almaziad

GPA: 4.04/5.00 (Very Good)

➤ Academic Experience

September 2017 – December 2019
(six academic semesters)

- **Grader,**
King Fahd University of Petroleum and Minerals (KFUPM), Dhahran, Saudi Arabia
Courses: ARE 413: Construction Management
ARE 459: Contracts and Specifications
Level: Undergraduate

May 2016 – August 2016

- **Trainee Building Engineer**
Azmeel Contracting & Construction Corporation, Dammam, Saudi Arabia
Project: Establishment of the Main Administration Building and the Multi- Purpose Hall of Imam Abdulrahman Bin Faisal University
Location: East Campus, Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia

August 2013 – September 2014

- **Questionnaire interviewer**
Saudi Aramco Chair for Traffic Safety, University of Dammam, Dammam, Saudi Arabia.
Achievements: Assisting the research team to complete two studies in the domain of traffic safety..

➤ Honors and Awards

- | | |
|-----------------------|--|
| November 2019 | <ul style="list-style-type: none">• Certificate of Appreciation from the chairman of Architectural Engineering Department, King Fahd University of Petroleum and Minerals
This was received as an acknowledgement of presenting a short course (workshop), entitled “<i>Autodesk Revit 2019</i>”, for the department students between the 29th and 30th of October 2019, at the College of Environmental Design, King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia |
| October 2019 | <ul style="list-style-type: none">• Appreciation letter from the chairman of Architectural Engineering Department, King Fahd University of Petroleum and Minerals
This was received as an acknowledgement of presenting a short course (workshop), entitled “<i>Microsoft Excel: Applications of the Software in the Architectural Engineering Domain</i>”, for the department students on the 4th of February 2019, at the College of Environmental Design, King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia |
| July 2016 | <ul style="list-style-type: none">• Punctual Behavior Certificate, University of Lincoln
This was received during attendance of the 6th Annual University of Lincoln Summer School: Sustainable Energy & Building Technology; Resilient Architecture, Lincoln, United Kingdom |
| July 2016 | <ul style="list-style-type: none">• Hardwork & Outstanding Performance Certificate, University of Lincoln
This was received during attendance of the 6th Annual University of Lincoln Summer School: Sustainable Energy & Building Technology; Resilient Architecture, Lincoln, United Kingdom |
| September 2014 | <ul style="list-style-type: none">• Appreciation letter from the head of Saudi Aramco Chair for Traffic Safety, University of Dammam
This was received as an acknowledgement of the strong sense of duty and responsibility displayed when assisting the research team to complete two transportation road safety studies in Dammam, Saudi Arabia |
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