Complexity Factors in Influencing the Relationship between Critical Success Factors and Performance of Building Refurbishment Projects

by

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AHP	Analytical Hierarchy Process
BI	Business Intelligence
BSC	Balanced Scorecard
BSI	British Standard
BTOS	Bartlett's Test of Sphericity
CBD	Commercial Building Disclosure
CBPP	Construction Best Practice Programme
CIBSE	The Chartered Institute of Building Services Engineer
CIDB	Construction Industry Development Board
CIRIA	Construction Industry Research and Association
CO_2	Carbon Dioxide
CFSs	Critical Success Factors
DQI	Design Quality Indicator
ECMs	Energy Conservation Measures
EFQM	European Foundation of Quality Management's Business Excellence Model
GDP	Gross Domestic Product
IPCC	Intergovernmental Panel on Climate Change
IPI	Integrated Performance Index
KMO	Kaiser-Meyer-Olkin
KPIs	Key Performance Indicators
MBNQA	Malcolm Baldridge Criteria for Performance Excellence
OECD	Organization for Economic Cooperation and Development Countries
PMBOK	Project Management Body of Knowledge
RFP	Respect for People
SEMs	Structural Equation Models
SoS KPIs	Satisfaction of Service KPIs
SPM	Stakeholder Perspective Measurement
TBL	Triple Bottom Line
TQM	Total Quality Management
WCED	World Commission on Environment and Development

Faktor Kompleksiti dalam Mempengaruhi Hubungan antara Faktor Kejayaan Kritikal dan Prestasi bagi Projek Pengubahsuaian Bangunan

ABSTRAK

Bangunan merupakan sektor yang penting dalam kehidupan manusia pada hari ini yang mana ia memenuhi keperluan asas moden manusia untuk berteduh dan sebagai tempat untuk aktiviti sosial serta perlindungan daripada ancaman alam sekitar. Kepentingan sektor ini semakin meningkat seiring dengan pertambahan populasi manusia yang memerlukan pembangunan bangunan baru. Malangnya, permintaan yang tinggi terhadap pembangunan bangunan baharu menjadi semakin sukar disebabkan oleh kekangan kekosongan tanah untuk dimajukan sebagai projek pembangunan bangunan. Oleh yang demikian, pengubahsuaian bangunan sedia ada menjadi salah satu cara untuk mengatasi masalah ini. Walaubagaimanapun, kajian-kajian lepas mendapati bahawa prestasi kejayaan projek pengubahsuaian bangunan masih di tahap kurang memuaskan. Kajian-kajian telah dijalankan bagi menentukan Faktor Kejayaan Kritikal projek pengubahsuaian bangunan, namun tidak mengambil kira aspek yang penting dalam pembangunan masa kini iaitu kemampanan, teknologi dan polisi serta Faktor Kompleksiti yang sinonim dengan projek pengubahsuaian bangunan berbanding projek bangunan baharu. Justeru itu, kajian ini dijalankan dengan matlamat menerbitkan satu model pelbagai-dimensi projek pengubahsuaian bangunan. Bagi mencapai matlamat tersebut, Faktor Kritikal Kejayaan dikenalpasti dengan mengambil kira aspek kemampanan, teknologi dan polisi serta Faktor Kompleksiti dalam mempengaruhi prestasi kejayaan projek pengubahsuaian bangunan. Sehubungan itu, kajian ini dijalankan melalui kaedah kuantitatif dengan menggunakan borang soal selidik sebagai medium kajian untuk mendapatkan maklum balas daripada organisasi pembinaan berkenaan Faktor Kejayaan Kritikal dan prestasi kejayaan projek pengubahsuaian bangunan. Borang soal selidik yang dibangunkan telah diedarkan secara kaedah kendalian-kendiri dalam kalangan pengurus bagi mewakili organisasi pembinaan yang beroperasi di Kuala Lumpur dan Selangor. Hasilnya, sebanyak 204 daripada 240 borang soal selidik telah dilengkapkan sepenuhnya. Analisa yang dijalankan mendapati bahawa kesemua Faktor Kejayaan Kritikal dikategorikan sebagai kritikal kepada prestasi kejayaan projek pengubahsuaian bangunan bahkan mempunyai perhubungan yang kuat dengan kejayaan projek pengubahsuaian bangunan. Kajian ini juga menemukan bahawa Faktor Kompleksiti bukan sahaja mempengaruhi secara terus kejayaan projek pengubahsuaian bangunan malahan turut memberikan kesan yang signifikan kepada perhubungan di antara empat Faktor Kejayaan Kritikal dengan prestasi kejayaan projek pengubahsuaian bangunan iaitu pengurusan projek, persekitaran, ekonomi, dan polisi. Secara keseluruhannya, kajian ini berjaya memenuhi matlamat dan objektif kajian. Akhirnya, kajian ini menggariskan strategi yang boleh dilaksanakan oleh organisasi pembinaan yang menjalankan projek pengubahsuaian bangunan bukan sahaja bagi mencapai prestasi kejayaan projek yang lebih baik malahan memberikan impak kepada industri pembinaan dalam menuju industri yang berdaya saing dan menghasilkan persekitaran yang baik kepada manusia.

Complexity Factors in Influencing the Relationship between Critical Success Factors and Performance of Building Refurbishment Projects

ABSTRACT

Building is an important sector of today's human life, where it meets the basic needs of modern humans for shelter and as a place for social activity and also to protect from the environmental threat. The importance of this sector is growing in line with the increasing number of population in need of new building development. Unfortunately, the high demand for new building development has become increasingly difficult due to the limited of vacant land available for development as a building development project. Consequently, refurbishment of existing buildings is one way to overcome this issue. However, recent studies have found that the success of the building refurbishment project is still not satisfactory. Previous studies have been conducted to determine the Critical Success Factors of building refurbishment projects, but they do not take into account important aspects of current development namely sustainability, technology and policy as well as Complexity Factors that are synonymous with building refurbishment projects compared to new building projects. Therefore, this study was conducted with the aim of establishing a multi-dimensional model of a building refurbishment project. To achieve this, Critical Success Factors are identified taking into account the sustainability, technology and policy aspects as well as Complexity Factors in influencing the building refurbishment project performance success. In this regard, the study was conducted through a quantitative method using the questionnaire form as a research medium to obtain feedback from the construction organization on the Critical Success Factors and the successful performance of the building refurbishment project. The questionnaire developed was distributed by employing self-administered method among managers to represent construction organizations operating in Kuala Lumpur and Selangor. As a result, 204 of the 240 questionnaires were fully completed. The analysis showed that all of the Critical Success Factors were categorized as critical to the success of the building refurbishment project and even had a strong relationship with the success of the building refurbishment project. The study also found that Complex Factors not only directly influence the success of the building refurbishment project but also have a significant impact on the relationship between the four Critical Success Factors and the success of the building refurbishment project namely project management, environment, economic and policy. Overall, this study met the goals and objectives of the study. Finally, this study outlines strategies that can be implemented by construction organizations that carry out building refurbishment projects not only to achieve better project success but also to impact the construction industry on leading a competitive industry and creating a better human environment.

CHAPTER 1 : INTRODUCTION

1.1 Research Background

Recently, the imbalance ratio between existing buildings and new buildings has become a main issue in building construction industry (Jagarajan, Abdullah, Lee, & Jaafar, 2015; Konstantinou & Knaack, 2013). According to the Chartered Institute of Building (CIOB) (2013), reported that it requires approximately 50 to 100 years replacing the current stock of existing buildings because 1.5 to 2.0 per cent number of buildings is being constructed annually in developed and developing countries because there are constant demands for new building construction. This issue drive make up the bulk of the building construction industry market which is not sustainably built. Due to this effect, building construction industry cannot offer to pursuit the quality of life especially for future generation.

At this point, by considering building refurbishment works from various perspectives in building construction industry, it will form a balance environment and natural resources for current and future generations in a holistic long-term benefit. It is because building refurbishment works have the potential to keep growing based on the demands to refurbish the vast stock of existing buildings which can be a logical resolution to reduce the imbalance ratio and environmental impact preferably (Jagarajan et al., 2015; Friege & Chappin, 2014; Cronhjort & Le Roux, 2012).

Building refurbishment work refers to the process of upgrading on major repair works, alteration, conversion, and extensions of an existing building (Ali, 2014). In fact, it can

be illustrated in terms of modernization, renovation, and rehabilitation. Therefore, for years, building refurbishment works have taken place to upgrade existing structures to provide modern conveniences to improve building lifespan for the existing buildings. Despite the well-known economic viability of much energy efficient refurbishment works which offer great potential for reducing greenhouse gas emissions and meeting climate protection targets, there is a relatively low level of implementation (Friege & Chappin, 2014). Other than that, Shipley, Utz, and Parsons (2006) discovered that by upgrading an existing building for reuse it can represent a 10 to 12 per cent cost saving as opposed to the construction of a new building.

In fact, the ability to upgrade an existing building does not only extend its useful life, but also clearly it is a more sustainable option than the process of demolition or rebuilding (Gohardani & Bjork, 2012). As studied by Corus (2013), and also Ardente, Beccali, Cellura, and Mistretta (2011) refurbishment can reflect the key pillar of sustainability concept which is environmental, economic and social aspects which can bring these three overlapping aspects of sustainability together in positive impact and harmoniously. As evidence, nowadays, building refurbishment works can be highlighted as vital economic drivers in the building construction industry.

In conjunction with all the positive benefits of refurbishment works in building construction industry, the pressure drive to concentrate particularly more on to discover the most influential factors which have influenced successful of building refurbishment project performances. However, it is important to have a comprehensive review in consideration on the influence of complexity factors on the success of building refurbishment project performances because the refurbishment projects are more

complex and multi-dimensional which encompass of many factors reflecting to the nature of works (Ali, 2014; 2013; Rahmat, 2008).

It is purposely to drive for improvement building refurbishment project performance and an inclusive shift towards better quality environment of life. Despite, the vast numbers of research initiatives that have been designed on refurbishment works management context has not been addressed properly. Therefore, the impact of the research is to assist the refurbishment's practitioner prioritize its focus factors with useful information on measuring performance of the projects. Furthermore, serves as eye-opener to the body of knowledge in this area of refurbishment contexts.

1.2 Problem Statements

Building sector has become one of the important parts of today's modern human life that provides a space for shelter and to do their daily activities. The human populations that keep growing over the years have increased the significant of building sector in meeting the demand for new building development. However, limited vacant land for new development has shifted the strategy of building construction sector towards refurbish the existing building (Angie Ng, 2014; Zawawi & Abdullah, 2013; Ali, Kamaruzzaman, & Salleh, 2009).

Correspondingly, the Malaysia building construction sector experienced a similar situation where the building refurbishment sector in Malaysia has shown an increment in terms of total construction output up to more than 8 per cent from 2002 to 2010 (Ali, 2014; CIDB, 2010). Despite, the output increment in the building refurbishment sector,

studies conducted by Syed Yahya, Ariffin and Ismail (2014), Ali (2014, 2013) and Ali, Kamaruzzaman, Zulkiflee and Pitt (2010) revealed that the success performance of building refurbishment project in Malaysia are still at unsatisfactory level.

In general, the success performance of building projects is influenced by various critical success factors (CSFs) (Babu & Sudhakar, 2015; Alias, Zawawi, Yusof, & Aris, 2014; Dezdar & Sulaiman, 2009). Table 1.1 outlines the developed research related on building refurbishment work studies. The studies conducted clearly demonstrated that the CSFs have a significant effect on the performance of building refurbishment projects. However, previous studies are focusing more on the general success factor of new building projects rather than comprehensive studies focusing on building refurbishment project (Jagarajan et al., 2015; Olanrewaju, Khamidi, & Idrus, 2011; Rahmat, 2008).

Other than that, the developed research did not comprehensive address the key pillars of sustainability which famously addressed in three terms that are environmental, economic and social in addressing the CSFs of building refurbishment projects. These three elements are becoming more common in the building construction industry as it to ensure the balance between satisfying the need of physical development without compromising the sustainability elements. In addition, the policy and technology factors also vital to be address as encouragement to fulfil current demands on building construction industry to give a balance between progress and awareness of its built environmental impact.

Table 1.1: The Analysis of Developed Research Related on Building Refurbishment Studies

Author	Developed Research	Country	Findings	Research Limitation
Egbu (1994)	Concerning the management of refurbishment works within the UK construction industry.	United Kingdom	Identifies 6 most important skills or knowledge in managing refurbishment work such as leadership, communication (oral/written), motivation of others, health and safety, decision making, and forecasting and planning.	Limited to only skills and knowledge needed for refurbishment work.
Rahmat (1997)	Study on the planning and control process of refurbishment projects.	United Kingdom	Demonstrates the planning and control process of refurbishment projects requires differentiation and integration of tasks, formal and informal interactions, rigid and yet flexible procedures.	Confirms that refurbishment projects suffered from the complexity. Only focusing on planning and control stage of projects
McKim, Tarek, and Attalla (2000)	Investigation on the poor performance of reconstruction projects.	United States	Confirms that the information about building services is normally very limited and is one of the major elements of unforeseen building conditions.	The use of inefficient project management systems are pointed out as the only main reasons for the problems encountered in renovation projects.
Naaranoja and Uden (2007)	Investigation on the major problems in renovation projects in Finland.	Finland	Reveals that problems such as time and cost overrun, defective work, and failure in fulfilling customers' requirements.	Only focusing in terms of cost, schedule, and quality in performance measurement.
Chan (2014)	Study the costs and benefits of sustainably upgrading the existing buildings stock.	Australia	Formulates the building maintenance strategy which is an important business decision such as reusing building elements, application of sustainable techniques and using new materials and adopting new technologies.	Limited to only cost performance in sustainability.

(Table 1.1 continued)

Author	Developed Research	Country	Findings	Research Limitation
Singh, Abdelhamid, Mrozowski, and El-gafy (2014)	Investigation of contemporary performance measurement systems for production management of renovation projects.	United States	The lack of a formal production management process in renovation projects, with a limited use of performance measurement systems.	Limited application in managing the performance at the activity level and assessing the performance in cost, time, and quality only.
Jagarajan, Abdullah, Lee, Misnan, Jaafar, and Mohammed (2015)	Review on critical success factors of sustainable retrofitting implementation.	Malaysia	The lack of research on CSFs for retrofitting or refurbishment projects.	Revealed that CSFs should be developed focusing on stakeholders' perspectives only.
Masrom, Abd Rahim, Siow, Mohamed, Kai, and Md Yassin (2017)	Determining barriers in sustainable refurbishment projects: commercial building owner perspectives.	Malaysia	The lack of sustainable awareness among Malaysian was the main barriers of sustainable refurbishment.	Limited in enhance economic, social and environmental benefits

Besides the significant role of building refurbishment in today's building construction industry, the building refurbishment project is well-known as a project that comprehends more complex, uncertain and risky compared to new building project (Ali, 2014, 2013; Ali et al, 2010; Rahmat, 2008). Therefore, by considering the influence of complexity factors in assisting the decision makers in prioritizing buildings to be refurbished. Although, these elements are recognized as a factor that significantly affects the overall performance of the building refurbishment project (Wilkinson, 2012).

However, the studies to ascertain this kind of element in influencing the success performance of the building refurbishment project are still small (Syed Yahya et al., 2014; Ali, 2014; 2013; Ali et al., 2010; Rahmat, 2008). Subsequently, the consideration of complexity factors as moderator variables in order to recognize the complexity factors having an effect on the relationship between CSFs and refurbishment project performance also have been influencing the overall successful building refurbishment project performance (Syed Yahya et al., 2014; Ali, 2014; 2013; Wilkinson, 2012; Ali et al., 2010; Rahmat, 2008; Miller & Buys, 2008; Hashim, 2004).

This study is aimed to establish a multidimensional model of building refurbishment project performance success in Malaysia. Therefore, this study endeavours to overcome the limitation of CSFs in the context of building refurbishment project which integrates the sustainability elements and intends to add the policy and technology as a factor that contributes to success performance of building refurbishment project. Furthermore, the complexity factor were be incorporated as moderator that could influence the overall performance of building refurbishment project and probably affect the relationship between the CSFs and building refurbishment performance.

Therefore, the impact of the outcomes was assisting the refurbishment's practitioner to manage future building refurbishment projects effectively. Besides, contribute to the new knowledge on professional practice and further research especially to the refurbish existing buildings.

1.3 Research Questions

Motivated by the concern in previous discussion in problem statements, it is necessary to establish the most influential factors which to contribute on successful building refurbishment projects performance. Therefore, the two main research questions in the study are formulated as follows:

i. What are the most influential factors of CSFs and complexity factors towards the building refurbishment project performance success?
ii. How complexity factors do moderates the relationship between CSFs and building refurbishment project performance dimensions?

1.4 Research Objectives

Based on the research questions that have been outlined, the following research objectives are developed in order to achieve the main concern of the study:

i. To measure the level of CSFs, complexity factors and building refurbishment project performance dimensions;
ii. To discover the relationship between CSFs and complexity factors towards building refurbishment project performance dimensions; and
iii. To establish the most influence factors for building refurbishment project performances success.

The first objective is to measure the level of CSFs, complexity factors and building refurbishment project performance dimensions. By measuring the levels, it is assisted to focus on the important factors that have huge influence in achieving building refurbishment project performance success. The second objective is to discover the relationship between CSFs and complexity factors towards building refurbishment project performance dimensions. The understandings of the relationship between all the variables need to be proven. This information is useful and it is important to understand the relationship between variables to establish a comprehensive research framework.

The last objective is to determine the strengths and weaknesses of all these factors. Besides, the ways to improve the classification of CSFs dimensions and complexity factors can be suggested in the establishment of the most influential factors of building refurbishment projects performance success which is limited being covered in the previous literature. With this input, refurbishment's practitioner has better insight to strategize their future building refurbishment project performances. The research objectives were discussed further in Chapter 4 and 5.

1.5 Research Scopes

This study concentrates in the central region areas of Peninsular Malaysia namely federal territory of Kuala Lumpur and Selangor. Both areas are selected as the scope of the study due to the fact that these areas are facing massive demands for spaces and limitation towards providing new buildings (Angie Ng, 2014; Zawawi & Abdullah, 2013; Tan, Hussin, & Ernest Khoo, 2010). In addition, based on the study conducted by Said, Aksah and Ismail (2013), the selected areas also faced intensified urban issues as a result of rapid population growth, economic development and urbanization. Therefore, there are several buildings that need to be upgraded, renovated and refurbished to overcome these issues.

The construction organizations that are registered as contractor from grade 4 (G4) to grade 7 (G7) with Construction Industry Development Board (CIDB) Malaysia are selected as the appropriate target respondents in this study. The reasons for selecting contractors grade 4 (G4) to 7 (G7) are because normally large projects tend to be carried out by established medium and large grade construction organizations (Ali, Cheong Peng, & Ling, 2014; Rahmat, Elforgani, & Adnan, 2012; Rahmat, 2008). Correspondingly, based on the size of organization, medium and large organizations normally employ a large number and experienced employees who can give more cooperation towards the conducted survey (Naoum & Egbu, 2015).

Therefore, the selection of contractors from grade 4 (G4) to 7 (G7) as targeted respondents is the starting point that assist in measuring the level of success and complexity of building refurbishment projects in this study. The list of the construction

organizations are filtered from the CIDB directory. Only the construction organizations that have been awarded with any building refurbishment projects are selected.

1.6 Significance of the Research

It is anticipated that the establishment framework of the most influential factors of building refurbishment project performance success has a significant contribution to the importance and its rationale due to the theory, practice and future on building refurbishment industry. Theoretically, the significance of this study can be seen in helping to bring a rich insight for refurbishment's practitioner in achieving successful building refurbishment project performance. The establishment of the framework which is based on relevant and reliable CSFs and consideration of the influence of complexity factors in the refurbishment contexts allows the practitioners to be more focused on the key areas while managing their building refurbishment projects.

It is well-known that building refurbishment project differs significantly in complexity from other types of project which can affect the overall project performance. To exacerbate the matter, it is important to discover the complexity factors which can influence the success of building refurbishment project performance. Not many projects performance measurement studies are focusing on refurbishment projects due to the difficulty in obtaining accurate data due to the complex work environment.

Moreover, by accurately establishing the most influential factors into the strategies for the future refurbishment project performance; the probability for projects to be successful can be enhanced. Furthermore, the outcomes of the study can be used as

strategic planning tool to assist both refurbishments' practitioner and the policy makers in Malaysia generally for the future refurbishment industry.

1.7 Thesis Structure

This thesis has been organized in a logical manner in order to achieve the research objectives of the study. The thesis consists of five distinct chapters. Chapter 1 provides an overview of the study which begins with background of the research and insight into problem statements, research questions, research objectives, research scopes and significance of research.

Chapter 2 presents a comprehensive review of the literature in the study area. In particular, this chapter contains discussion of refurbishment principles studies, describes the barrier and challenges, growth and opportunities which include the integration between refurbishment and sustainability approach, performance of building refurbishment project in developed and developing countries. The subsequent contents are concentrated to extend the understanding on project performance measurement in order to identify the suitable approach or models to clarify the focus of current study.

Chapter 3 explains the details on overall research methodology which has been used in the study. In which a quantitative methodology is employed in order to accomplish the research questions and objectives. The chapter elucidates the quantitative research process and design with details on the population and sampling, survey instrument development, empirical quantitative data collection and data analysis procedure that has been selected in the study.

Chapter 4 presents the main body of the thesis which are the quantitative findings and discussions from the questionnaire. The research findings are explained by using both statistical technique of analysis: descriptive and inferential statistics to interpret the findings and in order for the unification of results of the research study. Lastly, the summary of the research findings and hypotheses of this study are verified in this chapter.

Chapter 5 contains the summaries of the overall thesis based on research findings and discussions as presented in the previous Chapter 4. This chapter highlights the conclusions, fundamental contributions of the study, and limitations to the field of research and lastly, providing some recommendations for future studies.

CHAPTER 2 : LITERATURE REVIEW

2.1 Introduction

Nowadays, improving projects performance seems to be a challenging task in building construction industry. It is becoming progressively difficult to ignore the implication of challenges faced by construction practitioners given the rapid changes in the project in terms of development in technology, financial instruments and complex project execution. Therefore, they have never stopped hunting for relevant and reliable project performance measurement that can pilot their project in a holistic performance towards the intended objectives (Singh et al., 2014; Ali, Al-Sulaihi, & Al-Gahtani, 2013). As studied by Davis (2014) and Costa, Formoso, Kaiogglou, Alarcón, and Caldas (2006) have discovered that poor project performance measurement can be due to several reasons but mainly because lack of information, inadequate training, incomprehensive framework, and also lack of expertise on how to practice it.

Based on previous studies, not many project performance measurement studies have focused specifically on building refurbishment projects performance (Ali et al., 2014; 2010). Even though, numerous previous studies (Bhuiyan, Jones, & Wanigarathna, 2015; Friege & Chappin, 2014; Corus, 2013) have promoted the benefits of refurbishment works on the existing buildings which offer enormous potential advantages to improve the performance of the existing buildings in a sustainable way. Nevertheless, the majority of building refurbishment projects are still being developed in an unsustainable manner and lacking in the implementation of project performance

measurement (Bhuiyan et al., 2015; Ali et al., 2014; Singh et al., 2014; Carter & Fortune, 2008).

In Malaysia, the success performance of building refurbishment projects is still at infancy level and underperformed due to limited empirical research advocates in this area (Syed Yahya et al., 2014; Ali, 2014; 2013; 2010; Rahmat, 2008). This is also attributed to the nature of the project itself especially when refurbishment works are well-known with considerable risks and complex in the existing condition that adversely give impact to the overall project performance (Ali, 2014; 2013; Wilkinson, 2012; Rahmat, 2008; Attalla, Hegazy, & Haas, 2003). Therefore, this issue has become the main motivation for this study.

This chapter are developed to discuss, to compare, and to synthesize the literature related to the research study. Gaps and problems are addressed and ways to overcome the issues are discussed. The chapter begins with a discussion on the basic fundamental of refurbishment works and integrates to the main motivation of the study that leads to the establishment of the most influential factors of building refurbishment projects performances success in attaining the research questions and objectives. Notwithstanding, it is also important to recognize the approach and model adopted and the reasons on consideration and application into this study.

2.2 Building Refurbishment Projects

A reasonable definition of the nature of a project is proposed by Kerzner (2001) in defining an undertaking of a temporary nature with a clear start and end point and

crucially, with a specific objective. This is echoed within the Project Management Institutes (PMI) (2008) defined a project is a temporary endeavour undertaken to create a unique product or service. Temporary means that every project has a definite end. Meanwhile, a unique means that the product or service is different in a distinguishable way from other similar products or services.

Refocusing on refurbishment works, there is no exact definition of it. According to Collins English Dictionary (1989), the definition of refurbishment is to make neat, clean or complete by renovating, re-equipping or restoring. Paralleled to British Standards Institute (BSI) (1994) defined refurbishment is a combination of any actions required to retain an item or to restore it to an acceptable condition. However, it is different when comparing with new building. Riley and Cotgrave (2011) clearly obviated that new build is not a difficult concept which any work that is starting from scratch, no part of the structure is left on site.

Egbu and Lee (2006) stressed that refurbishment as to cover a wider scope not limited to alteration but also including renovation, rehabilitation, extension, improvement, conversion, modernization, fitting out and repair which undertaken on an existing building to allow it to be recycled for another purpose. Meanwhile, Mansfield (2011) defined refurbishment as a synonym of rehabilitation which has supported the terms retrofit, conversion, and modernization implying an approach that embraces wider localized environment as well as individual structures.

Therefore, the aforementioned definitions of refurbishment were too indistinct and not setting limits to the different procedures involved in refurbishment works or being too

narrow and limiting the reader's perspectives. In this study, it can be concluded that building refurbishment works include any action in upgrading the existing structure to improve a building lifespan. However, a building functional performance is different from its physical state, which can be improved to be better than its original state. It is supported by Corus (2013) who has reported that refurbishment presents a means of improving the performance of existing buildings without the economic and environmental cost associated with new build schemes. By referring to Bullen and Love (2011), the general goals when refurbishing a building are listed as follows:

i. To maximize the income or assets value of the existing buildings and this is usually the main intention of the building owner;
ii. To comply with new desires or demand which is often the main goal of the end user;
iii. To improve the indoor environment and this may be the objective of the user; and
iv. To minimize the energy consumption this is a long-term policy of the government and enforced by law and building regulations.

Rahmat (2008) revealed that there are several differences in building refurbishment work categories. The first category is for repair, rehabilitation and restoration categories. Repairs can be explained as the refurbishment of a building performance to its original or an acceptable new condition by renewing, replacing all deteriorated parts. Meanwhile, rehabilitation is a construction work which extends the life of a building in order to make it habitable and normally related with housing. On the other hand,

restoration can be defined as a work that reinstates the structural and architectural part of an old building to its original design and construction.

However, the second category are divided into four types of refurbishment categories namely modernization, retrofitting, extension and renovation categories. These types of refurbishment works can improve the quality and standard that are required in the building demand that need to be refurbished. Modernization is a process of bringing a building up to a standard that is required by the client and also to meet the statutory requirements.

Meanwhile, retrofitting is the work of redesigning and reconstructing the existing building in order to incorporate with new medium technology which the details and specifics are not foreseen in the original design. Furthermore, extension is normally demanded in order to increase the floor area of an existing building. Renovation involves the process of upgrading an old building to improve the performance of the building. Therefore, the term refurbishment is preferred throughout the thesis.

2.3 The Barrier and Challenges of Building Refurbishment Projects

Undoubtedly, the management of building refurbishment projects is complex. Egbu (1996) pointed out that this type of works will need appropriate managerial methods, tools and techniques. Egbu and Lee (2006) argued that refurbishment works demand an ability to deal with non-continuous and complex processes. The risk with major projects is much bigger but it can be met with the ability of an appropriate compatibility design, good planning and monitoring by the manager to manage the risks

occurred. The specific amount of information on existing building condition and any other risks need to be identified in advance.

A detailed review and understanding of building refurbishment projects are critical as every different project exhibits different nature and characteristics. In fact, the subject of project complexity has been focused by several studies (Syed Yahya et al., 2014; Ali, 2014; 2013; Wilkinson, 2012; Juan, Gao, & Wang, 2010; Rahmat, 2008; Bertelsen. Henrich, Koskela, & Rooke, 2007) on refurbishment work as opposed to the belief that new building is the inherent barrier and challenges of the works themselves.

The complexity or uncertainty is extends against the process as a whole. However, it must be noted that the challenges faced in this aspect also have singular significance, respectively to the project team that has carried out the works. As for building refurbishment projects, its nature and characteristics are again different due to the complexity or uncertainty of the level of works as it is usually risky and complicated, possibly involving existing and unsecured site conditions. Basically, refurbishment involves many uncertain works before and during the refurbishment process. Thus, the importance of complexity or uncertainty has been emphasized because of their major impacts on the project performance.

Complexity is a characteristic of systems whereby the interactions among the parts of the system between the system and its environment cannot be isolated, analysed, and understood separately from the system as a whole. However, these interactions tend to change over time as the system adapts to the changes in the internal and external environment and exerts influence on its environment and other systems, in turn causing

them to change (Ali, 2014; Rahmat et al., 2012; Hass, 2009; Miller & Page, 2007). Thorkildsen and Ekman (2013) discovered that complexity as the number of different actions needed to produce the end production.

Meanwhile, Qian, Chan, and Khalid (2015) agreed that uncertainty as the inconsistency between the amount of information available to perform a task and the amount of information possesses during planning stage. Planning and implementing refurbishment work involve many dependent decisions on interrelated aspects of the works and for decisions to be fully and effectively accommodated. Therefore, the manager needs to address these two issues, complexity and uncertainty systematically and explicitly.

Homthong and Moungnoi (2016) discovered that measuring the complexity of building construction project is subjectively and objectively. In building refurbishment projects, the complexity involved technical, social, ecological, technological, comfort and esthetical. A detail appropriate planning and implementation are desired to complete the project in time, to fulfil the client's expectation and to deliver quality performance. The level of complexity contributes to the uncertainties especially during planning and implementation stages. Normally, these two crucial stages are cited by many project management researchers to be the main reasons for unsatisfactory performance (Carvalho & Rabechini Jr, 2015; Mir & Pinnington, 2014).

Despite, the purpose of upgrading to modern standards is to "matching up" on the "standard" new build project anticipates becoming one of the main causes for the barriers and challenges of building refurbishment project. Indeed, Lam, Chan, and Chan (2010) further discovered that managing building refurbishment projects is facing with

some exclusive problems in dealing with people, environment and the project itself. The identification of several variables that can contribute as complexity factors in building refurbishment project is paramount because it can affect the overall performance of the project. Therefore, in this study, the complexity and uncertainty factors in building refurbishment project were combined and assumed to be interrelated and should complement each other and become one variable that needs to be measured in this study.

2.4 The Growth and Opportunities of Building Refurbishment Projects

In many countries, building construction industry is the largest single employer and probably the world's largest industrial employer. Driven by population growth and urbanisation, building construction industry itself is a significant supplier to economic growth, both globally and at the national level. Globally, it is estimated to be worth US$ 7.5 trillion per year or approximately 10 per cent of global GDP and employs more than 111 million people (ILO, 2012). At national level, the sector generates 5 to 10 per cent of employment (UNEP, 2011).

Developed country populations are approximately more urbanised and more economically reliant on the service sector than on industry or agriculture. They also have higher household incomes compared to the developing country populations. Projected economic growth is modest and projected population growth is flat or even negative in Western Europe, Russia and Japan. There are some exceptions among rich countries such as the United States of America, where higher fertility and immigration rates are expected.

In contrast, developing countries are swiftly growing, rapidly urbanising and are projected to add 2.3 billion to the global population over the coming four decades (UN DESA, 2008). More than 9 billion people are predicted to live on Earth in year 2050, 70 per cent is expected to live in urban areas (UN HABITAT, 2011). For example, India is short of 24.7 million homes and this country will need millions of homes to be built over several decades to accommodate projected income growth and urbanisation. New building construction growth for commercial and residential buildings currently averages 7 per cent per year in China and 5 per cent per year in India and South-east Asia, compared with only 2 per cent in developed countries.

Other than that, building construction industry is also responsible for more than one third of global resource consumption annually. Approximately, one third of global energy usage takes place within buildings (IEA, 2010a). Projections for year 2030 based on The Intergovernmental Panel on Climate Change (IPCC) reported that carbon dioxide (CO_2) emissions from buildings will continue to account for around one third of the total CO_2 emissions.

Apart from energy usage, nearly 60 per cent of the world's electricity is consumed in residential and commercial buildings, although this usage varies widely according to geographical location, climate and consumption patterns (IEA, 2010b). The manufacturing of building materials consumes about 10 per cent of the global energy supply.

Table 2.1: Projected CO_2 Emissions from Buildings to Year 2030

	High-growth scenario	**Low-growth scenario**
CO_2 emissions (in $GtCO_2$)	8.6 → 15.6 (2004) (2030)	8.6 → 11.4 (2004) (2030)
Largest share from	Developing Asia, Middle East/North Africa, Latin America, sub-Saharan Africa	North America and developing Asia
Average annual CO_2 emissions growth rate (2004 - 2030)	2.4%	1.5%

IPCC (2017)

Table 2.1 summarizes the projections of CO_2 emissions under two scenarios (IPCC, 2017). Table 2.1 indicates that in the high growth scenario, the largest contribution is from developing countries. Meanwhile as for the low growth scenario the largest share is from North America and developing Asian countries, which include China and India. If per-capita CO_2 emissions are considered, both scenarios suggested that by year 2030 a greater share of emissions will still come from the Organisation for Economic Cooperation and Development (OECD) countries.

Malaysia, as a part of Asian countries is also experiencing rapid economic and population growth, and expected to achieve the status of developed nation by 2020 as envisaged under the Vision 2020. Due to rapid economic growth and industrialization, Malaysia is ranks 30^{th} in the world for countries that have the largest amount of CO_2 which 24 per cent of total CO_2 comes from the building construction sector in the country (Nation Master Statistic, 2013). Additionally, Fong, Matsumoto, Ho, and Lun (2016) discovered that the main source of CO_2 emissions is from the urban sector especially for the major cities such as Kuala Lumpur or Klang Valley.

Therefore, many countries including Malaysia are playing an active role in the awareness on environmental problems such as global warming, acid rain, ozone depletion and exhaustion of the natural resources has increased substantially over the years. Consequently, the environmental, economic and social forces have added impetus to new demand. Due to that, the government has emphasized their commitment more into sustainable approach and in turn, starting to seek buildings and spaces that reflects the value.

Basically, sustainable approach offers a new method of thinking which reconciles the ubiquitous human drive to enhance our quality of life with the limitations imposed on us by global context. Sustainability is an association or balancing act between many factors which are constantly changing. It requires decision makers to be flexible and willing to modify their approaches according to changes in the environment, human needs and desires, also technological advance.

Pirages (1994) explained by ensuring sustainability over time means maintaining a dynamic balance among a growing human population and its demands, the changing capabilities of the physical environment to absorb the wastes of human activities, the changing possibilities opened up by new knowledge and technological changes and the values, aspirations and institutions that channelled human behaviour. Thus, visions of a sustainable world must naturally change in response to the shifts in any part of this dynamic relationship.

Subsequently, the concept of 'sustainable development' was introduced in year 1987 and became important antecedents in 'Our Common Future' based on The Brundtland