

DEVELOPING PEOPLE CAPABILITIES FOR THE PROMOTION OF SUSTAINABILITY IN FACILITY MANAGEMENT PRACTICES

Norliana Sarpin

B.Sc Quantity Surveying (Hons), M.Sc Construction Management (UTM)



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Science and Engineering Faculty
Queensland University of Technology

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Abstract

Sustainability is becoming an integral part of the life-cycle development of built facilities. It is increasingly highlighted during the post construction phase, as facility management personnel can have major influence to the sustainability agenda through operational and strategic management functions. Sustainable practices in facility management can bring substantial benefits such as reducing energy consumption and waste, while increasing productivity, financial return and corporate standing in the community. Despite the potential, facility managers have yet to embrace sustainability ideas holistically and implement them in their operation. The lack of capabilities and skills coupled with knowledge gaps are among the barriers. In the developmental context, capabilities are vital to foster the competency of an organisation. Facility managers need to be empowered with the necessary knowledge, capabilities and skills to support sustainability.

This research investigates the potential people capabilities factors that can assist in the implementation of sustainability agenda in facility management practices. Through questionnaire survey, twenty three critical people capability factors were identified and encapsulated into a conceptual framework. The critical factors were separated into four categories of strategic capabilities, anticipatory capabilities, interpersonal capabilities and system thinking capabilities. Pair-wise comparison and Interpretive Structural Modelling techniques were then used to further explore the interrelationship and influence of each critical factor. An interpretive structural model for people capability was developed to identify the priority of critical factors and provide a hierarchical structure to guide facility managers for appropriate actions. The research concludes with three case-studies of professional facility management practices to finalise the developed people capabilities framework and interpretive structural model. Through the identification and integration of different perceptions and priority needs of the stakeholders, a set of guidelines for action and potential effects of each people capability factor were brought forward for the industry to promote sustainability endeavour in facility management practices.

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List of Abbreviations

BIFM	British Institute of Facilities Management
BREEAM	Building Research Establishment Environment Assessment Tool
CIB	Chartered Institute of Building
EIA	Environmental Impact Assessment
FMA	Facility Management Association of Australia
IFMA	International Facility Management Institution
LCCA	Life-Cycle Cost Analysis
LEED	Leadership in Energy and Environmental Design
MAFM	Malaysian Association of Facilities Management
PFI	Private Finance Initiative
TEFMA	Tertiary Education Facilities Management Association
WCED	World Commission on Environment and Development

Chapter 1 Introduction

1.1 RESEARCH BACKGROUND

With sustainability being a commonly recognised principle and practice, the construction industry is facing major challenges around the world due to its significant impact on the environment. To develop an effective built environment and achieve sustainable construction along the whole project development life-cycle, more attention should be paid to the occupancy phase (Elmualim et al. 2010). This effort can be carried out through the implementation of sustainable practices in building operations and maintenance activities. An emphasis on the issue of sustainability during this phase is crucial because it will cause a significant impact on the life-cycle cost, as well as its potentially detrimental and long-term impact on the environment (CIOB 2004; Hodges 2005; Prasad and Hall 2004).

Presently, there is an emergent interest among facilities managers and building owners to integrate sustainability measures into the management of built assets (Nielsen et al. 2009). This scenario is supported by the fact that facilities management (FM) personnel are in a unique position to view and influence the entire life-cycle of a facility (Hodges 2005). Facilities managers can also create long-lasting value for an organisation by developing, implementing and maintaining sustainable FM practices since they are armed with the proper financial and strategic planning tools (Hodges 2005). Furthermore, the extant research suggests that the implementation of sustainability measures in FM activities can deliver benefits such as reducing energy consumption and waste, while increasing productivity, financial returns and standing in the community (Hodges 2005; Lai and Yik 2006; Nielsen et al. 2009).

However, in spite of the growing awareness of sustainability in the FM sector, few managers and building owners positively embrace the ideas and implement them in their operations (Elmualim et al. 2009; Shah 2007). There is also other issues such as lack of understanding of the sustainability and the skills required to put sustainability idea into action due to the early stage of the sustainable development concept in FM practices (Elmualim et al. 2008). Previous studies have identified various factors such as capabilities, knowledge and organisational issues as the barriers that inhibit sustainability implementation. Capability issues in

achieving sustainability in FM including the lack of professional capability, capability discrepancies and skill and capability magnitude have been emphasised in several extant research studies as being crucial challenges that need to be addressed in order to promote sustainability (Hodges 2005; Shafii et al. 2006; Shah 2007). In addition, issues such as the lack of sustainability knowledge, knowledge chasm and challenges faced in the knowledge transfer process have been highlighted (Elmualim et al. 2009; Elmualim et al. 2010; Jensen 2009; Shah 2007). Moreover, the unwillingness of FM personnel and organisations to adopt new routines to implement sustainability in their business also contributes to current drawbacks (Elmualim et al. 2010).

In this context, there is a need for better understanding of the potential for enhancing the capabilities of FM personnel before the wider adoption of sustainability can be expected. Capabilities and skills are regarded as the key enablers in dealing with the sustainability endeavours of an organisation. They are also vital to the fostering of competency in an organisation so that it can innovate in a more sustainable way and vital to support the sustainability agenda in an organisation (Gloet 2006; van Kleef and Roome 2007). Currently, research that focuses on soft issues such as people's capabilities and skills is still lagging behind the efforts in developing guidelines, technical manuals and knowledge portals. Therefore, it is beneficial to explore the capabilities issues in order to support the implementation of the sustainability agenda in FM practices.

The people capability concept has been used in research to enhance sustainability implementation in different industries. In the education sector, research reveals that engineers' ability to contribute to sustainable development effectively is compromised due to a deficiency of knowledge, skills and practices for sustainable development (Crofton 2000). It is vital to discuss the key capabilities in sustainability in order to support academic programs to shape professional profiles and produce a capable human resources to support the sustainable development agenda in the industry (Crofton 2000; Sterling and Thomas 2006; Wiek et al. 2011). In addition, Barth et al. (2007) emphasised that competencies such as foresighted thinking, interdisciplinary work and participatory skills were important to enable active and reflective participation in sustainable development within higher education. In the area of business management, Hind et al. (2009) suggested that organisations should develop leaders who have the competencies and skills necessary to develop and operate sustainable organisations. They emphasised that the understanding and practice of responsible leadership can be enhanced by integrating social and

environmental considerations into business decision-making processes. Similarly, Daboub et al. (1995) emphasised the relationship between the characteristics of an organisation's top management personnel and the corporate responsibility agenda in the organisation.

In line with the potential of the FM and sustainability in construction industry, this research attempts to examine the elements of people capabilities that emphasise sustainability from the perception of professionals involved in the FM sector. Therefore, a people capabilities framework that has the potential to facilitate sustainability measures in FM practices must be established.

1.2 STATEMENT OF RESEARCH PROBLEM

The issue of limited capabilities for achieving sustainability goals in the FM sector has been highlighted as a barrier that needs to be overcome (Hodges 2005; Shafii et al. 2006; Shah 2007; Yang et al. 2005). This situation has led to more concerted efforts towards sustainable development where the involvement of FM functions is required, especially in activities with an environmental and economic focus. For this reason, facility managers need to understand how the growing importance of sustainability is affecting the way they execute their roles and responsibilities. FM personnel must become professionally competent and knowledgeable about the sustainability issues that will impact on their business environment, both operationally and strategically (Elmualim 2013).

Previous researchers in sustainability have highlighted the importance of personnel and organisational capabilities in achieving sustainability goals. According to Gloet (2006), to support a sustainability agenda in an organisation, there are four key areas of capabilities that need to be developed, namely, learning, roles, responsibilities and strategy. These capabilities are important to ensure that ideas related to ecology, sustainability and social justice form part of management's thinking and priorities. Likewise, van Kleef and Roome (2007) identified specific areas of the capabilities needed to encourage business to implement more sustainable practices. These include: systemic thinking capabilities, capabilities for learning and developing, capabilities to integrate business, capabilities to solve environmental and social problems, capabilities in developing alternative business models and methods, networking capabilities and finally, collaborative building capabilities. These capabilities are vital for strengthening the competency

of personnel in managing sustainability agenda issues and challenges and the ability of organisations to operate in a more sustainable way and to support sustainability measures.

The role of the people or human resource domain in efforts to implement a sustainability agenda in an organisation has also been considered by researchers. Jeston and Nelis (2008) claimed that the most important components in any business innovation are the management of organisational change associated with people/staff impacts and providing staff with the skills and capability to ensure they will be able to execute their job to a high standard. The people within the organisation must have the knowledge and skills to be able to continuously improve the business processes, as well as to measure and manage business in a way that leads to the betterment of the organisation.

The contribution of the human resources domain in the successful integration of environmental management in an organisation should be given more attention since it has a crucial role in stimulating the accomplishment of the organisation's sustainability goals (Boudreau and Ramstad 2005; Jabbour and Santos 2008). According to Govindarajulu and Daily (2004), human resource dimensions play an important role in ensuring the effectiveness of an environmental management system together with the required technical aspects. Similarly, del Brío and Junquera (2003) agreed that environmental management is human resource-intensive and depends much on the development of tacit skills through the employees' involvement. Therefore, environmental management and sustainability efforts in an organisation are a complex process, which requires support from the area of human resources and the development of people capabilities and skills in order to guarantee the success of its implementation.

In addition, the construction industry is known as a labour-intensive sector due to its reliance on the capabilities and skills of workers in their operations and activities (Pathirage et al. 2007; Woo et al. 2004). According to Cooke-Davies (2002), it is the people who deliver the construction projects and not processes or systems. There is a necessity for this industry to consider the personnel knowledge, capabilities, skills and behaviour inputs which contribute to superior performance at both project and organisational level.

The issue of capabilities in achieving sustainability goals in the FM sector has been highlighted by Shah (2007), Shafii et al. (2006), Hodges (2005) and Yang et al. (2005) as being a challenge that requires remedying. Several early studies have attempted to apply sustainability in FM. Shah (2007) provided a book on practical guidance and comprehensive information which can be implemented to integrate sustainability into daily FM activities. Hodges (2005) suggested the key steps in developing a sustainability strategy for a facility and highlighted the importance of the life-cycle cost (LCC) and total cost of ownership (TCO) techniques to justify any potential costs of implementing sustainable practices in FM. Additionally, Elmualim et al. (2010) conducted several case studies and developed a knowledge portal to share good sustainability practice in FM. The portal was developed to aid FM stakeholders in searching for specialist knowledge, tools and supporting case study material necessary for implementing the sustainability agenda, which the research suggested did not exist in the FM context. However, these studies were restricted and solely focused on tools and techniques rather than people capabilities and skills, training and personal motivation. In addition, the focus of these studies was on short-term benefits, rather than the long-term benefits that can be gained through changes in the human resources domain. Therefore, there is a research gap in this area that needs to be addressed.

The necessity for sustainable practice in FM and for capable facilities managers to facilitate sustainability practice is becoming increasingly challenging. The involvement of the FM function is required in all aspects, with a particular focus on environmental and economic activities. Therefore, FM personnel and organisations need to improve their capabilities and skills in order to conduct this task efficiently and further the sustainability agenda in their operations. The focus of this research is on people capabilities within the organisational or work-related context due to the promising opportunities that it brings to organisational growth and performance.

1.3 RESEARCH QUESTIONS

Based on the research background outlined above, three research questions are raised to guide the researcher to achieve the aim of the research. This research focuses on the following research questions:

1. What are the perspectives of FM personnel towards people capability issues that influence their professional practices?

The selection of appropriate solutions for capabilities issues depends largely on the opinions and perspective of industry stakeholders with regards to their professional practices. Thus, a good understanding of the capabilities issues in regards to sustainability endeavour is important to this research. Due to the limited existing research investigating people capabilities for promoting sustainability, especially with regard to FM context, identifying and investigating the various perspectives, views and potential factors constitutes a valid line of enquiry in this research.

2. What are the specific people capability factors that will assist personnel to promote sustainable FM practices?

According to previous people capabilities research, various factors have been identified which have the potential to improve sustainability in different areas. The FM sector has its own unique criteria, business patterns and barriers. These unique characteristics and issues of this sector may affect the implementation of the people capability approach and, thus, should be further explored.

3. How can FM professionals use the identified people capability factors to promote sustainability in FM practices?

The people capabilities framework proposed in this research should be able to assist FM stakeholders to promote the implementation of sustainability in their practices. The aim of the framework is to provide a basis for exploring what to do and how to do it in order to improve sustainability practice. Although, previous people capabilities studies have suggested plenty of tools, mechanisms and strategies that are effective in other disciplines, their suitability, effectiveness and priority to be applied in the FM sector are still uncertain. Thus, investigations of these strategies, tools and mechanisms are the principal concerns of this research.

1.4 RESEARCH AIM AND OBJECTIVES

The aim of this research is to formulate a people capabilities framework to promote the implementation of sustainability deliverables in FM practices. As a result, the likelihood of sustainability implementation in FM is enhanced by providing the right foundation to equip FM personnel with the tools and mechanisms to obtain the right knowledge, education, training and mind-set to achieve the implementation of the sustainability agenda in FM practices.

The following three objectives are designed to achieve the above aim and answer the research questions:

1. To determine the current implementation status of the people capabilities approach in promoting sustainability implementation in FM practices. This objective involves the following sub-objectives:
 - To understand current initiatives related to the people capabilities approach in promoting sustainable practices;
 - To identify the people capability issues for FM implementation.
2. To identify the critical people capability factors in promoting sustainability implementation in FM practices. This objective involves the following sub-objectives:
 - To explore the different perspectives of various stakeholders regarding the people capability factors in promoting sustainability in FM practices;
 - To identify the critical factors of people capabilities in supporting sustainability efforts in FM practices;

- To develop a people capabilities conceptual framework that demonstrates the critical factors.
3. To develop a people capabilities framework to enable FM personnel to promote the implementation of sustainability agenda in FM practices. This objective involves the following sub-objectives:
- To compile the verified critical people capability factors into a conceptual framework;
 - To develop a model of people capability to demonstrate the relationship and influences of each factor;
 - To develop an action guidelines to support the implementation of sustainability in FM practices.

1.5 RESEARCH SIGNIFICANCE

Sustainability has become a crucial principle to be pursued throughout the life-cycle of project development, particularly during the post-construction phase involving the FM functions. As discussed above, the implementation of the sustainability agenda in FM practices has the potential to reduce energy consumption and waste, while increasing productivity, financial returns and standing in the community. However, the current implementation of sustainability in FM practices is still in its infancy. Few FM personnel have embraced sustainability ideas holistically and implemented them in their operations. There is also a lack of common understanding of sustainability knowledge, a gap between capability and skills, and unwillingness of FM personnel and organisations to adopt new routines. Therefore, at the forefront of sustainable practice, FM professionals can apply a great deal of influence through operational and strategic management roles and demand that the relevant personnel are empowered with the necessary knowledge, capabilities and skills.

This study investigates the issues of people capabilities and skills that would promote sustainability measures in the FM sector. Through scrutinising and identifying the potential people capability factors, this study provides valuable information linked with sustainability implementation in the FM context. It identifies and integrates the understandings and main concerns of the FM stakeholders, and this leads to the identification of the critical factors that impact on the gap between people capabilities and sustainability in FM practices.

The outcomes of this study are a people capability framework and a set of guidelines for optimising the FM personnel capabilities needed to implement sustainability in FM practices. The understanding of the people capability factors contributes to the establishment of a mechanism that allows FM personnel to develop new mind-sets in order to lift their performance in delivering sustainability. This will also help them to identify knowledge deficiencies and skill gaps for continuing education and training. FM personnel will benefit from this research through a better understanding of the concept of people capabilities and skills that can motivate and enhance sustainability in their daily practices as well as at a strategic level.

This study adds to the body of knowledge pertaining to the sustainability concept in the FM sector, particularly in regard to the people capabilities approach. The findings of this research will directly assist in increasing the abilities of FM personnel and organisations to promote the implementation of sustainable practices.

This research also establishes the groundwork for future research adopting people-centred approach to enhance capabilities and skills in advancing the sustainability agenda in the project life-cycle.

1.6 OVERVIEW OF RESEARCH METHODOLOGY

Researchers must decide on the methodological approach to finding the solutions to the research problem or research questions being addressed (Fellows and Liu, 2008). A study should have a detailed research design which can be used as a framework for the data collection and observations. The research design involves a systematic plan to coordinate a research project to ensure the efficient use of resources, and to guide the researcher in the use

of suitable research methods. It presents a broad picture to the researcher and helps them to structure the research methodology in logical steps through logical stages (King et al. 1994).

Trochim and Donnelly (2008) stated that the research design is used to structure the research, display the functions of the major parts of the research project, and explain the contribution of each part in addressing the central research questions. The probability of success of a research project is greatly enhanced when the “beginning” is correctly defined as an accurate statement of goals and justifications. Having accomplished this, it is easier to identify and organise the sequential steps necessary for writing a research plan and then successfully executing a research project.

The type of research used in this research is explanatory. According to Fellow and Liu (2008), an explanatory research investigates a specific issue or phenomenon or answer certain questions. The explanatory nature of the research is demonstrated in the investigation of the significance and interrelationships of the people capability factors, in order to answer research question 1 and research question 2. In addition, these factors were investigated in depth to develop guidelines for the FM decisions maker.

The questionnaire survey was the main data collection technique used in the research. Surveys are used to gather sufficient data and information from a large number of respondents within a limited time frame (Naoum 2006). After the questionnaire was drafted and developed, a pilot test was conducted to ensure the questionnaire’s clarity, comprehensiveness, and acceptability. The purpose of a pilot test is to assess whether the questions are intelligible, easy to answer and unambiguous, and the feedback obtained is an opportunity to improve the questionnaire, fill in any gaps and calculate the time required to complete the exercise (Fellows and Liu 2008). In this study, the questionnaire survey was conducted in order to determine the critical people capability factors. Subsequently, a pair-wise comparison survey was used to explore the FM professionals’ opinions on the relationship between these critical factors, then, the interpretive structural modelling (ISM) technique was used to develop the hierarchical model. This technique was employed to analyse the relationships between the people capability factors and to understand the dependency and driving power of each factor. The developed framework was further improved by the use of an applied case study to verify and validate its applicability. The case

study employed interview and document review techniques aimed at an in-depth assessment and discussion of the proposed framework. Then, guidelines were formulated from the findings of the case studies.

The implementation of the above key research methodologies in this research assists in defining appropriate processes to answer the research questions and to achieve the research objectives.

1.7 RESEARCH SCOPE AND LIMITATIONS

The scope of this research is limited to the construction industry, which involves the FM sector. The scope is delineated by focusing on three important viewpoints, namely the FM sector as a research object, the capabilities or competencies challenges as the research content and the FM personnel or people capabilities as the research range. The promotion of sustainability measures in FM practices through the development of people capabilities framework and guidelines is the research focus. This research focuses on the people capabilities issue as it is regarded as the key enabler to implementing the sustainability agenda in an organisation. Based on an extensive literature review and information gained from the key stakeholders, this research aims to identify the critical people capability factors that can support the sustainability effort in FM practices.

This study involves the FM stakeholders in Australia and Malaysia. The focus of this study is more on the FM work routines and technical roles and actions of the professionals without specific references to cultural, religious and political differences. It was found through the pilot study (which is further discussed in Chapter 3) that the typical professional conduct of the FM professionals between the two countries are quite similar, despite the different cultural environment and economic systems in which they operate.

The objectives of the research limited the types of respondents to those who were involved in the FM sector. Most of the respondents had extensive experience and held decision-making roles in their respective organisation, and had some exposure to sustainable development concepts. The key stakeholders involved in this research played various roles in the FM sector including directors, facility managers, consultants and engineers. The

involvement of multiple stakeholders in this study provides holistic views and enriches the research findings. In addition, according to Ng et al. (2005), a mix of respondents with different backgrounds is important in order to minimise the possibility of bias.

1.8 OUTLINE OF THE THESIS

This thesis consists of eight chapters. A brief summary of each chapter is provided in this section.

Chapter 1 includes the introductory section, which contextualise the proposed research and develops the direction of the research. The research problems and objectives are formulated based on the identification of the crucial issues. It also provides a brief description of methodology and the research scope and limitations.

Chapter 2 reviews the literature on sustainable development in the FM sector by first introducing the concept of sustainable development and then discussing the importance of its application in the FM industry. This chapter also introduces the FM sector in the construction industry, the current sustainability gap and the challenges in adopting sustainability in FM practices. This chapter also discusses the capabilities challenges in dealing with the sustainability agenda in FM and the potential of the people capabilities concept as a remedy to counter these challenges. The literature review identifies the research gaps and argues the need to establish a people capabilities framework.

Chapter 3 discusses the research philosophy that underpinned the selection of the research methodology. It outlines the research design and the selection of the research methods, namely, the questionnaire surveys, pair-wise comparison study and case study which were considered appropriate for investigating the research questions. This chapter also provides an overview of the research methods and justifies their selection. The type of method is selected and designed according to the aim and objectives of the study and their ability to answer the research questions. Furthermore, the process of executing each selected method to direct the data collection and analysis is outlined.

Chapter 4 describes the analysis of data and results of the questionnaire survey. The questionnaire design, survey instrument, data sampling and administration are discussed. It then discussed the findings of the questionnaire survey and introduced a preliminary conceptual framework of the people capability factors that promote the application of the sustainability agenda in FM practices.

Chapter 5 explores the results of the pair-wise comparison study and discusses the relationship between the significant factors. It then, synthesises the findings from the questionnaire survey and pair-wise comparison study results into an interpretive structural model. The hierarchical model clarifies the relationships between the critical people capability factors.

Chapter 6 presents the analysis of the data and discusses the results of the case study. The types and purposes of the case study data collection methods are described. The validation process of the proposed people capability framework and interpretive structural model is discussed. The additional information related to different perceptions and priority needs of the stakeholders on each of the people capability factors is also reviewed.

Chapter 7 discusses the results and outcomes from the data collection, namely, questionnaire survey, pair-wise comparison study and case studies. Accordingly, the research findings are presented.

Chapter 8 summarises the research findings that are related to the research objectives. The significance and limitations of the research are outlined, and recommendations for future research are suggested.

1.9 SUMMARY

This chapter provided an overview of the research background and the problem statement regarding sustainability efforts in the FM industry. The connection between the people capabilities approach and sustainability efforts in the FM sector was highlighted in order to showcase the potential of the people capabilities approach as a solution. The objectives of this research were then articulated based on the research questions. This was followed by a

description of the research outcomes, research significance, overview of research methodology and research scope and limitations. Finally, an overview of the thesis structure was presented to show how the chapters interconnect. The next chapter presents the literature review.



Chapter 2 Literature Review

2.1 INTRODUCTION

This chapter provides an overview of the current literature on sustainable construction and facilities management (FM), focusing specifically on the challenges and opportunities in integrating the sustainability agenda in FM practices. The first part of this chapter presents a discussion on the concept of sustainable development in the construction industry. With consideration for the whole project development life-cycle, it particularly focuses on the post-construction phase, which involves the roles of FM professionals. The need for the integration of the sustainability agenda in FM is discussed with the consideration of the issues and challenges.

The second part of this chapter discusses the issue of capability challenges in dealing with the sustainability agenda in FM, since personnel capabilities are regarded as the key enablers in understanding sustainability and are important in fostering an organisation's competency in sustainability. Finally, based on an extensive review of the literature on sustainability in FM and people capabilities, the gaps in relation to the integration of these components to enhance sustainability efforts are identified. The identification of these gaps serves as a guide to further examination of the literature on research methodologies in Chapter 3 and assists the research design.

2.2 SUSTAINABILITY AND FACILITIES MANAGEMENT

2.2.1 Sustainable Development in the Construction Industry

The built environment has been criticised for its contribution to environmental issues, and increasing awareness in this context has encouraged people in the industry to reflect on previous actions and search for solutions. The concept of sustainability has been recognised as a guiding paradigm to educate built environment activities. This concept has expanded as a result of the growing awareness of the global links between mounting environmental

problems, socio-economic issues and concerns about a healthy future for humanity (Hopwood et al. 2005).

A wide range of people and organisations around the world have been promoting the concept of sustainability. A well-known definition of sustainable development is found in the Brundtland Report from the World Commission on Environment and Development (WCED) which defines sustainable development as “development that meets the needs of the present without compromising the ability of future generations to meet their own need” (World Commission on Environment and Development (WCED) 1987). This definition indicates that the environment and quality of human life are as important as economic performance and emphasises the interdependency between humans, the environment and economic systems. It also highlights the responsibility of the present generation for the welfare of future generations and implies that we are borrowing the planet, its resources and its environmental functions and quality from future generations. Kibert’s definition of sustainability also supports the idea of sustainable development for the benefit of future generations as he declares sustainability as the foundational principle underlying various efforts to ensure a decent quality of life for future generations (Kibert 2008).

As such, the idea of sustainability is gradually developing into a concept based on the pillars of “people, planet and prosperity” (White and Lee 2009). This general definition of sustainability has been translated into the triple bottom line of economic, environmental and social performance (Koo and Ariaratnam 2007; Robins 2006). Figure 2.1 illustrates the general concept of sustainable development which includes these three major sustainability pillars. These major impact areas need to be considered, incorporated and improved to achieve a desirable level of sustainable development. Robins (2006) proposed the following definitions of economic, environmental and social sustainability:

- Economic sustainability occurs when development (which moves toward social and environmental sustainability) is financially feasible;
- Environmental sustainability is a practice that ensures the capital of natural resources remains intact; that is, it ensures the functions of the environment are not degraded. Thus, in order to achieve environmental sustainability, it is

important to make sure that the extraction of renewable resources does not exceed the rate at which they are renewed, and the capacity of the environment to assimilate waste should not be exceeded.

- Social sustainability is a practice that ensures the cohesion of a society and maintains its ability to work towards common goals. Individual needs such as health, wellbeing, shelter, education and cultural expression should be preserved.

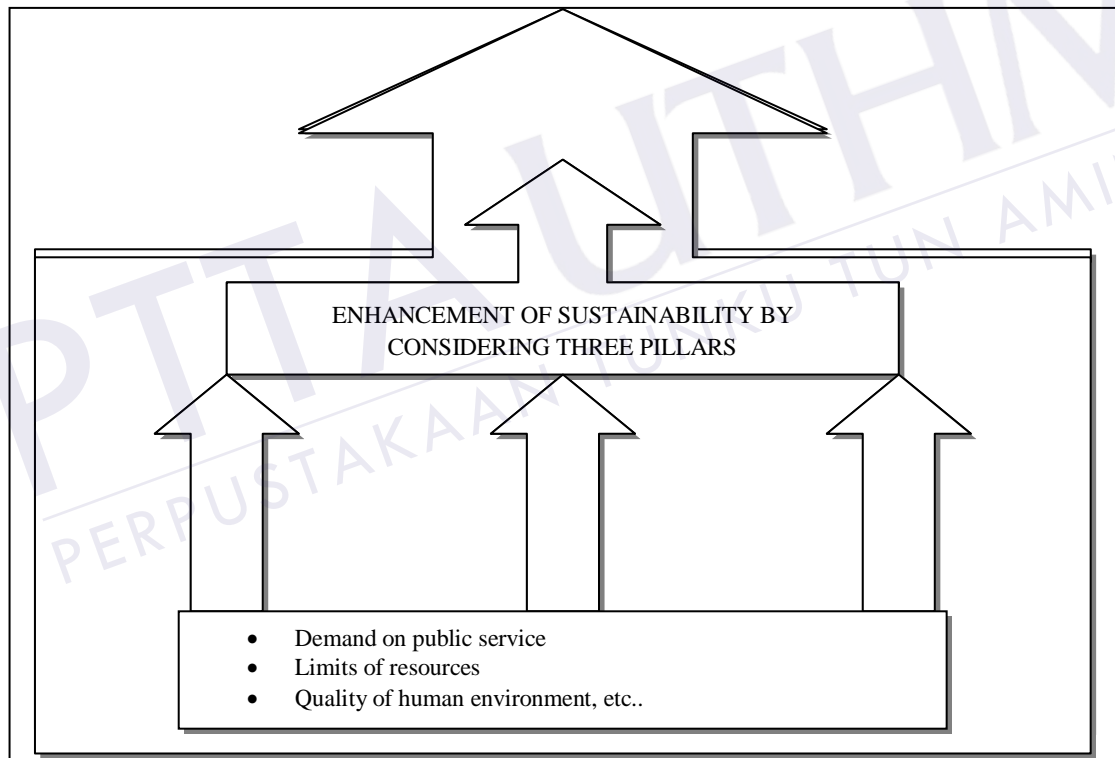


Figure 2.1: Three pillars of sustainable development (adapted from Koo and Ariaratnam, 2007)

The economic and environmental challenges faced by the architecture, engineering and construction industries are increasing due to the significant environmental impact of the construction industry, its critical role in the economy, and the urgent need to respond to global climate change (Mukherjee and Muga 2009). Sustainability issues draw considerable attention to the construction field, and sustainable construction has been regarded as an important component of the creation of sustainable development (Bourdeau 1999). A diverse range of stakeholders and organisations in the industry have explored and embodied this concept due to the rising interest and demand to achieve sustainability goals.

The significance of the sustainability agenda has been widely recognised. As highlighted above, the concept of sustainability must be extended to many aspects beyond the economic, environmental and social impacts. The concept of sustainability is now broadly well-known around the world and has been adopted in many industries including the construction sector.

To date, the construction industry has responded positively to calls to support the sustainable development agenda. Its efforts can be seen in the wide range of sustainability initiatives by industry, academia and government agencies all across the globe. The first International Conference on Sustainable Construction held in 1994 introduced the definition of sustainable construction as “the creation and responsible maintenance of a healthy built environment based on resource efficient and ecological principles” (Kibert. 1994). The term “sustainable construction” was originally proposed to describe the responsibility of the construction industry to implement the sustainability agenda. According to Spence and Mulligan (1995), in order to improve the environmental sustainability of construction activity, ways need to be found urgently to build more with less, to reduce inputs, to operate more efficiently in resource terms, to find less environmentally damaging substitutes and also to increase the life of assets. Some of the changes needed within the construction industry to achieve these aims included (1) intensifying research into the utilisation of mineral and agricultural wastes, (2) improving the fuel efficiency of the kiln process, (3) reducing material usage in design and construction by considering embodied energy in design, (4) reducing energy usage in buildings over their lifetime and (5) reducing avoidable transportation (Spence and Mulligan 1995).

The International Council for Research and Innovation in Building and Construction CIB (1998) envisioned that sustainable construction would lead to healthier built environments and ecological systems, energy conservation, better comfort, waste reduction, resource conservation, and better service life prediction and enhancement, but also recognized the need to integrate existing technical knowledge and tools with new ideas in order to achieve the sustainable construction vision. Sustainable construction aims to achieve sustainable development objectives through the use of technology and knowledge to enhance the sustainability of production processes, operations and practices, and the design of infrastructure (Wai et al. 2009).

According to Kibert (2008), the goal of sustainable construction is to create and operate in a healthy environment based on resource efficiency and ecological design. Kibert proposed the following seven principles of sustainable construction:

- Minimise resource consumption
- Maximise resource reuse
- Use renewable or recycle resources
- Protect the natural environment
- Create a healthy, non-toxic human environment
- Apply life-cycle cost analysis
- Pursue quality in creating the built environment

This very broad definition is a starting point to build a more concrete definition of the concept of sustainable construction and begin to illustrate the stakes and issues of sustainable development that relate to the construction sector. Therefore, sustainable construction could be best described as a subset of sustainable development, which relates to matters such as tendering, site planning and organisation, financial management, material selection, recycling and waste minimisation.

Recent definitions of sustainable construction are more holistic and specific but at the same time still incorporates the principal meanings, goals and aspects of sustainable construction that were introduced at the early stage of its inception. In one of these new definitions, Pietrosevoli and Rodríguez Monroy (2013) described sustainable construction as the result of the common efforts of construction stakeholders such as investors, construction leaders, service representatives, industry suppliers and communities to develop new buildings considering the environmental, energy, socio-economic and cultural conditions needed to bring integral solutions to society in order to improve quality of life and develop the potential of mankind. Miller and Doh's (2014) definition of sustainable construction also considers the importance of the roles and responsibilities played by construction industry stakeholders in order to achieve the goals of sustainable construction. They emphasised that cooperation among the stakeholders in terms of sharing knowledge, expertise, awareness and action is crucial to contribute to the economic and social benefits, and, at the same time, to minimise the related impacts on the environment (Miller and Doh 2014).

However, in this respect, the consideration and application of sustainability in the construction sector are still at the early stage and much more has to be done to make all construction phases and activities more sustainable (Myers 2005; Serpell et al. 2013; Son et al. 2011; Zainul Abidin 2010). It is widely accepted that the concept of sustainable construction is currently vague and ambiguous (Bourdeau 1999, Wai et al. 2009). Different definitions are used by different stakeholders (Pearce 2006), and different aspects are emphasised in different countries due to their own approaches, priorities and special contexts (Bourdeau 1999; Kibert 2007). Despite the efforts to define, promote and develop sustainable construction, many construction companies and professionals hesitate to implement sustainability (Wai et al. 2009). A study by Myers (2005) on construction companies' attitudes towards sustainability in the UK revealed that very few of the major companies positively embraced sustainable ideas and implemented them in their operations. In addition, Serpell et al. (2013) emphasised that the Chilean construction firms are in early stage in achieving sustainable construction due to lack of financial incentives, lack of integrated design and lack of affordability. A majority of the construction industry stakeholders also believed that the industry was taking some account of sustainability issues, but identified that more needed to be done (Pitt et al. 2009). Moreover, the development of sustainability guidelines for specific sectors in the construction industry, such as the FM sector is often

neglected, hence, a focus on sustainability in this sector requires an immediate resurgence if the sustainability agenda is to be adopted.

2.2.2 Construction Project Life-Cycle and Sustainability

Sustainability is increasingly crucial for all parties in the construction industry. Consequently, there is an urgent need to change the way people think and operate. The sustainability agenda in construction covers issues throughout the entire life-cycle of construction projects, from planning, design, construction, operations and maintenance to demolition. Many sustainability initiatives have been implemented in each of the construction phases to ensure sustainable construction, for example, the application of the principles, procedures and methods of an Environmental Impact Assessment (EIA) during the planning and design stages of a project (Hill and Bowen 1997), and the application of construction environment plans and environmental supply chain management during the construction phase (Addis and Talbot 2001). Table 2.1 presents a summary of the various opportunities available to influence sustainability throughout the life-cycle of a facility. However, there is still a lack of initiatives being applied during the operations and maintenance phase compared to various efforts being done in other phases in the construction life-cycle.

Table 2.1: Sustainability opportunities throughout the facility life-cycle (Sustainable Construction Procurement CIRIA Publication C571, adapted from Shah, 2007)

Key project stages	Opportunities for influencing sustainability issues in a project
Define needs/briefing	<ul style="list-style-type: none"> • Sustainability objectives • Funding availability – ring-fenced money • Coordination with corporate responsibility agenda
Feasibility studies	<ul style="list-style-type: none"> • Sustainability impact appraisal of alternative <ul style="list-style-type: none"> ◦ Route, sites, technologies, new build versus reuse and demolition • Life-cycle cost study • Selection of advisers and design team
Decision to construct	<ul style="list-style-type: none"> • Brief writing, including sustainability goals, target, etc • Stakeholder engagement
Outline design	<ul style="list-style-type: none"> • Project sustainability policies • Innovative design solution • Performance specifications
Planning permission	<ul style="list-style-type: none"> • Environmental impact assessment • Sustainability appraisal • Public/community engagement
Scheme design stage	<ul style="list-style-type: none"> • Performance specification for systems and products • Life-cycle and cost analysis • Value engineering
Construction tendering	<ul style="list-style-type: none"> • Material/component specification • Contractor selection based on sustainability issues
Construction	<ul style="list-style-type: none"> • Construction planning • Sustainability/environmental management plan • Waste/material management
Handover and commissioning	<ul style="list-style-type: none"> • Final sustainability performance assessment • Energy/building management system
Fit-out	<ul style="list-style-type: none"> • Procurement of furniture and materials
Occupation	<ul style="list-style-type: none"> • Performance in use • Post-occupancy evaluation • Capital projects • Operational management • Churn
Decision to refurbish	<ul style="list-style-type: none"> • Sustainability evaluation of options • Adaptation for new use • Demolition for recycling
Demolition	<ul style="list-style-type: none"> • Re-use and recycling of materials

In the life-cycle costing literature, evidence shows that the cost for the operations and maintenance of a building system is a significant element. On the basis of research in office building services systems, Evans et al. (1998) identified the life cost ratio covering initial capital costs, maintenance and building operating costs and business operating costs. They found that maintenance and operating costs can be five times the capital costs, and the business operating costs can be two hundred times the capital costs over the life of the building (Wu et al. 2006). This calculations were supported by research conducted by Fuller (2010) as published in the National Institute of Building Sciences website which found that, in the Life-Cycle Cost Analysis (LCCA) of a building over 30 years, the initial building costs accounted for approximately 2 percent of the total cost, while the operations and maintenance costs equalled 6 percent and the personnel costs equalled 92 percent as indicated in Figure 2.2.

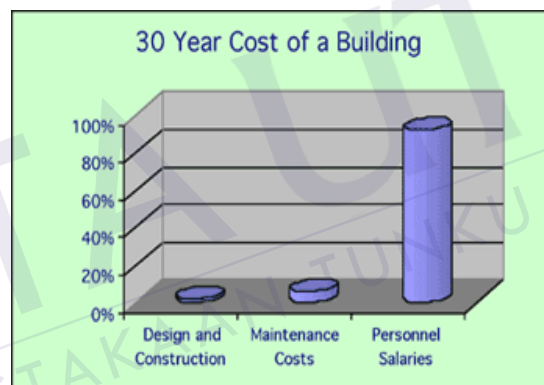


Figure 2.2: LCCA for 30 year cost of building (adapted from Fuller, 2010)

According to Flanagan and Jewell (2008), an office building will consume more than three times its initial capital costs over a 25 year period. Based on this calculation, they considered it strange that far more attention continue to be paid to the initial capital costs. This scenario can be best described as “the iceberg principle” (Lansink 2013), as illustrated in Figure 2.3.

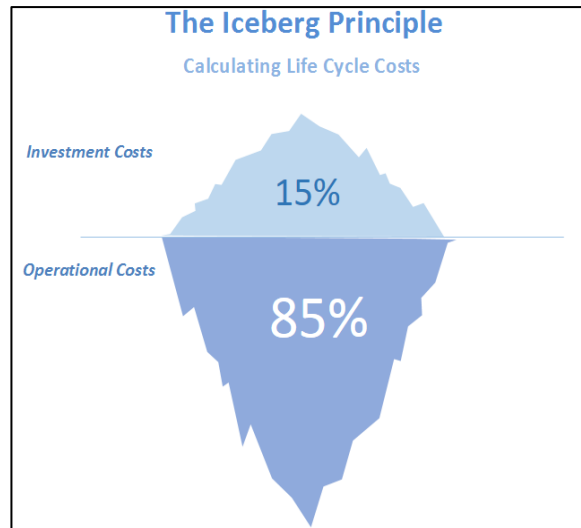


Figure 2.3: The iceberg principle (adapted from Lansik, 2013)

Buildings need energy in their life-cycle from construction to demolition. The total life-cycle energy of a building includes both embodied energy and operational energy (Dixit et al. 2010; Miller and Doh 2014). Embodied energy is the energy sequestered in building materials and processes required during construction. Operational energy is the energy required to enable the usage of the building such as for heating and cooling, lighting, maintenance and everyday appliances consumption requirements. Meanwhile, recurring embodied energy is the sum of the energy embodied in the material used in the rehabilitation, replacement and maintenance of a building. A critical review by Ramesh et al. (2010) on the life-cycle energy analyses of buildings revealed that operational energy contributed to 80%–90% of a building’s life-cycle energy demand, while embodied energy contributed about 10%–20%. Furthermore, an analysis by Treloar et al. (2000) of the life-cycle energy usage for a house over a 30 year period showed that the initial embodied energy represented 28.5%, the recurring embodied energy represented 8% and the operational energy represented 63.5% of building’s life-cycle energy demand as illustrated in Figure 2.4.

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