EXPLORING THE POTENTIAL FOR GREEN-ORIENTED PROCUREMENT FOR BUILDING PROJECTS: A CASE OF THE MALAYSIAN CONSTRUCTION INDUSTRY

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Abstract

The construction sector is essential in providing physical development for nations, to cater for education, housing, retail, and manufacturing purposes. Meanwhile, the adverse impact of the construction sector on the natural environment has triggered a growing awareness of the need for sustainability. Green construction is expected to be implemented in every construction project and Malaysia is developing a national pathway to sustainable development. One of the strategies used to tackle environmental problems in Malaysia, as emphasised by the Malaysian government, is green procurement. The construction industry is no exception. Furthermore, construction procurement has been identified as a strategic tool to manage environmental issues. Despite its importance, green procurement is an emerging research area and relatively new to the Malaysian construction industry. Given that, it is an urgent necessity for the industry to enhance the awareness of sustainable development, which motivates this research to explore further the potential of green-oriented procurement for a building project in the Malaysian construction industry.

This research has aimed to provide a procurement strategy that could potentially guide the project stakeholder to procure a building project. The research posed three research questions: i) which practices, associated with green-oriented procurement of a building project in Malaysia, are important? ii) do these practices have any significant relationship with the green performance of a building project in Malaysia? iii) how can project stakeholder use the identified key practices of green oriented procurement to improve project's green performance? To achieve these three research questions, the list of practices was initially compiled from the literature world-wide, and further confirmed through face-to-face interviews involving five experts of green construction in Malaysia. The findings from this stage produced an initial green procurement model and identified fifty-four practices of green procurement that will be further investigated in the second phase of this research. The main data collection of this research is using the questionnaire as a tool to conduct a survey. The data collection was conducted in Malaysia, and the respondents were the experienced practitioners in green building in Malaysia. Structural Equation Modelling (SEM) was also used to achieve the second and third research question.

The final green procurement model as the main outcome of this research, was produced based the findings from the literature, the preliminary interview and SEM

analysis. The model concludes that policies and guidelines, incorporation of green practices in product and process, and environmental evaluation, are the key practices for green procurement. Meanwhile, stakeholder values were identified as the enabler for green procurement delivery for a building project. Overall, this research demonstrates that green procurement will help to improve projects' green performance in term of environmental aspects and social aspects.

The implication of this final green procurement model could potentially be a guide for construction industry practitioners and policy makers. The model will help them to plan a strategy to procure a building project to improve a project's delivery, which incorporates green-oriented practices. These findings have contributed to filling the knowledge gap by not just only exploring the concept of green procurement for building projects and identifying the list of key practices for green-oriented procurement, but also by providing a model that helps to prioritise these green practices. Since research in this area is very limited, an overview of green procurement practices can potentially create awareness and enhance knowledge among practitioners.

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List of Abbreviations and Acronyms

α	*Cronbach alpha*
AMOS	*Analysis of Moments Structures*
ASEAN	*Association of Southeast Asian Nations*
AVE	*Average Variance Extracted*
CB-SEM	*Covariance-Based Structural Equation Modeling*
CFA	*Confirmatory Factor Analysis*
CFI	*Comparative Fit Index*
CIDB	*Construction Industry Development Board*
CITP	*Construction Industry Transformation Programme*
CO^2	*Carbon Dioxide*
CR	*Construct Reliability*
df	*Degrees of freedom*
EPU	*Economic Planning Unit Malaysia*
EMS	*Environmental Management System*
EMP	*Environmental Management Plan*
ERO	*Environmental responsible operations*
GFI	*Goodness-of-Fit Index*
IBS	*Industrialised Building System*
ISO	*International Organization for Standardization*
KeTTHA	*Kementerian Tenaga, Teknologi Hijau dan Air Malaysia*
GBI	*Green Building Index*
GP	*Green Performance*
GPO	*Green-oriented procurement*
GHG	*Greenhouse Gas*
LCA	*Life Cycle Analysis*
MAMPU	*Malaysian Administrative Modernisation and Management Planning Unit*
MOF	*Ministry of Finance*
NGTP	*National Green Technology Policy*
PEMANDU	*Performance Management and Delivery Unit Malaysia*
p	*p-value*
S.E.	*Standard error*
SEM	*Structure Equation Model*

SPSS	*IBM SPSS software*
TBL	*Triple Bottom Line*
RMSEA	*Root Mean Square of Error Approximation*
WCED	*World Commission on Environmental and Development*
x^2/df	*Normed Chi-square*
10MP	*Tenth Malaysian Plan (Annual Malaysia Economic Planning)*
11MP	*Eleventh Malaysian Plan (Annual Malaysia Economic Planning)*

Glossary

Client	*The natural or legal person for whom a structure is constructed, or the person or organisation that took the initiative of the construction (Berry and McCarthy, 2003).*
Construct	*The core categories of variables of initial model for this research.*
Green performance	*Another dimension of project performance that considers the sustainability application including environmental, economic and social aspects (Ofori, 2000; Rogers, Jalal and Boyd, 2006).*
Green	*"Green" understood as the recognition, integration and implementation of environmental practices, initiatives and systems in organisations to address environmental issues (Albino, Balice, and Dangelico, 2009; Winkler, 2010).*
Green building	*Healthy facilities designed and constructed in a resource-efficient manner using environmentally based principles and sustainable construction principles and methodologies (Kibert, 2012).*
Green-oriented procurement for building projects	*The act and process of obtaining goods, services, engineering and construction work or disposal from commencement to the end of the procurement process including the framework and structure of responsibilities and authorities for stakeholders within the building project that recognise, integrate and implement environmentally-friendly practices throughout the processes. Benefits associated with the implementation of green procurement are not limited to environmental benefits, and rather it includes economic aspect and social well-being of the projects' organisation and stakeholders.*

Project stakeholder	*Project consisting of external and internal stakeholder including client, designers, constructors and specialist suppliers that are involved in the development of a project., i.e., in which planning, design, construction operation and maintenance are considered as a whole (Atkin and Skitmore, 2008; El-Gohary, Osman, and El-Diraby, 2006).*
Project team	*See project stakeholder.*
Procurement	*The act and process of obtaining goods, services, engineering and construction work or disposal from commencement to the end of the procurement process including the framework and structure of responsibilities and authorities for stakeholders within the building project (Ruparathna and Hewage, 2015a).*
Sustainable development	*"Development that meets the needs of the present without compromising the ability of future generations to meet their needs" (Bruntland, 1987.*
Sustainable construction	*Sustainable construction is an approach taken by the building industry to achieve sustainable development (Bourdeau, 1999).*

Statement of Original Authorship

The work contained in this thesis has not been previously submitted to meet requirements for an award at this or any other higher education institution. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made.

Signature: QUT Verified Signature

Date: April 2017

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Dedication

I dedicate this thesis to my parents,
Mohamad Bohari Bol and Darot Kassim,
Whom I love endlessly.

For my beloved husband,
Mohamad Fairuz Kiprawi,
Thank you so much for your love and support

CHAPTER 1: INTRODUCTION

1.1 RESEARCH BACKGROUND

The building sector is essential for the physical development of nations, providing shelter for social and business purposes. It aims to cater for the demand for education, housing, retail, and manufacturing. However, despite its positive contribution, the building sector has an adverse impact on the environment. Throughout its life cycle, building makes a significant contribution to global greenhouse gas (GHG) emissions. The amount of annual GHGs caused by buildings across the world has been estimated to reach 42.4 billion tonnes by 2035, 43 percent more than the 2007 level (USEIA, 2010). The building sector is also a major consumer of energy (Robichaud and Anantatmula, 2011). Sustainable construction is an approach taken by the building industry to achieve sustainable development. In fact, sustainable construction is mentioned in Agenda 21, Chapter 7, as aiming to promote sustainable construction activities (CIB, 1999). The sustainable concept in construction seeks to provide physical development to society, simultaneously minimising the environmental impact of a building throughout its lifetime while providing comfort and safety to its occupants without discounting economic viability.

Malaysia has targeted the achievement of high-income economy by the year 2020 (Economic Planning Unit Malaysia, 2010). There will be lots of construction activity in the future to meet the demand for this forecast economic growth as the "upper-middle-income economy" (The World Bank, 2013). The focus of the development is to improve the socio-economic sector of public transport and infrastructure, rural infrastructure and essential building services such as education and health. Under the Tenth Malaysian Plan (10MP), an amount of RM20 billion was allocated for the construction sector out of the RM138 billion allocation made for building the nation's physical development (Abu Mansor, 2010; ITALIA, 2012). The Malaysian construction industry was projected to contribute 2.9 percent to the Gross Domestic Product by 2015 with 3.7 percent annual growth from 2011 to 2015. In the Construction Industry Transformation Programme 2016-2020 (CITP 2016-2020)'s report, more than 120 other industries in the Malaysian economy rely on the construction industry and that shows the strong correlation with economic development (CIDB, 2015). At the same time, Malaysia is urged to adopt environmentally friendly development methods. According to CITP 2016-2020's report,

Malaysia carbon dioxide (CO_2)- equivalent emissions are comparatively high with the ratio of GDP: CO_2 among the lowest. World Bank (2013) revealed that Malaysia growth in CO_2 surpasses the growth in most emerging economies at a rate of 5 percent in Malaysia.

In response to global awareness of environmental protection, the government of Malaysia underlines a few strategies to tackle environmental problems, which are divided into three waves. The first and second waves discuss the issue on environment and development separately and leaving the construction industry with a conflict of priorities: the response to development needs and to minimise the impact on the environment. This conflict of priorities caused a slow- progress towards green development. The third wave, from 2006 until the present, aims to tackle environment and development as a single issue. The third wave, also known as the green investment or Post NGTP 2009, was to reduce carbon growth, energy switch and technology localisation (Chua and Oh, 2011; Hezri, 2011). Malaysia aims to reduce the per capita greenhouse gas (GHG) emission by the year 2020 based on the levels published in 2005, in order to become a sustainable nation in the long term (Kahlenborn, Mansor, and Adham, 2013). For the construction industry, this third wave aims to improve on issues such as environmental sustainability (CIDB, 2009). The CITP (2016-2020) report underlined the need for Malaysia to be a model for delivering a project sustainably for the emerging world (CIDB, 2015).

Malaysia recognised a few attempts and beyond to preserve the environment, such as utilising resources, minimising waste efficiently and introducing a policy to preserve the environment. One of the strategies that was underlined by the Malaysian government to tackle environmental problems in Malaysia is called green procurement. The construction industry is no exception. Procurement is important for any construction project, because it will influence the overall project performance. The United Nations (2008) and Zhu, Geng, and Sarkis (2013) further recognised procurement as a vital tool to manage environmental issues. In this research, the focus is given to integrating green concepts to procure a building project. Green procurement for a building project is understood as the act of obtaining goods, services, engineering and construction work or disposal from commencement to the end of the procurement process. It defines the framework and structure of responsibilities and authorities for stakeholders within the building project, to recognise, integrate and implement environmentally friendly practices throughout the processes.

Despite its importance, green procurement for building projects is an emerging research area (Zhang, Wu and Shen, 2015) and relatively new to the Malaysian construction industry (Kahlenborn et al., 2013). Furthermore, the green procurement concept practices are still not clearly visible (GPNM, 2003) and as highlighted by Ellegaard et al. (2010), current green practices in construction are still fragmented in terms of focusing on individual firms rather than a collaborative effort in greening the project throughout its life cycle, a need which has prompted this research. Given that it is an urgent necessity for the industry to enhance the awareness of protecting the environment and become more sustainable, this motivates this research to explore the potential of green procurement for building projects in Malaysia. This research produced a green-oriented procurement model that will potentially provide planning strategy for both the project stakeholders to procure a building project that aims to meet the project's green performance goal.

To further clarify the significant needs of this study, Perera, Chowdhury, and Anandajit (2007) highlighted that the degree of green procurement implementation might vary significantly throughout global practices, and thus, specific case studies may enhance the understanding based on specific context. As argued by Roy and Koehn (2006), the outcome from preceding research in developed countries may not be applicable for developing countries due to the difference in the nature of construction, between developed and developing countries. This research adopted a structure equation model (SEM) to identify and quantify the key aspects of green-oriented procurement of a building project in Malaysia. The variables and lists of practices were identified from the literature review process and face-to-face preliminary interviews involving experienced practitioners in green construction in Malaysia. Selection of the interviewees was based on their credentials, such as their experience in green construction and their qualification in green construction. A questionnaire used is a source of main data collection for this research. The survey involved multi-key stakeholders such as client, designers, procurement officers and quantity surveyors that are involved in a green project in Malaysia.

This research significantly contributes to the literature on green-oriented procurement in the context of the Malaysian construction industry as research context (Further explanation in Section 8.2.1). Since research related to green-oriented procurement is very limited, a fresh and current overview of green-oriented procurement can potentially create awareness and enhance knowledge among the practitioners. Moreover, the produced green-oriented procurement final model was potentially adopted as a reference for some key groups in Malaysia, such as

researchers, policymakers and developers, as a basis for future studies to support sustainable development.

1.2 RESEARCH PROBLEM AND JUSTIFICATION

The Malaysian government has planned to implement sustainable building and infrastructure development in Malaysia, by establishing policies and strategic planning to support the industry moving towards sustainable construction (CIDB, 2009; EPU, 2014, CIDB, 2015). Current green practices within the building industry are fragmented based on individual firms' perspective and initiatives, rather than the collaborative effort throughout the whole project (Ellegaard et al., 2010). Literature has been acknowledged procurement as a strategic tool to integrate the green practices as a collaborative effort in the project delivery (Zhu, Geng and Sarkis, 2013). Thus, it is important to recognise procurement as an important tool in establishing the concept of green throughout the project stages. Furthermore, project procurement has been identified as one of the important success factors of a construction project. A good procurement planning and delivery can lead to better project achievement.

However, the current procurement practices do not favour green practices (Kamar, Alshawi, and Hamid, 2009; Uttam, Balfors, and Mörtberg, 2011; Uttam, Faith-Ell, and Balfors, 2012; Zhang, Shen, Wu, and Qi, 2011). Literature has identified challenges, as listed below, and thus is calling for a new approach in the procurement delivery.

First, the main criticism pertains to cost increase due to incorporation of green practices. Sourani (2008) have mentioned that green practices' implementation is a separate contract for a project and poses an additional cost. In other words, green practices are treated as an additional task and will increase overall project cost (Sourani, 2008). This scenario will be a barrier to penetrate green practices into the major segments of construction market (Lam et. al., 2009). Furthermore, financial constraint is one of the major barriers faced by industry players (Tick and Shing, 2010). Thus, it is important to highlight incorporation of green practices must be treated as part of project requirements and the cost related to green practices must be internalised (Sterner, 2002).

Second, current procurement practice is criticised due to lack of persuasion to improve green performance in terms of policy setting, project needs statement, binding contract clauses and monitoring towards environmental goals. Policies to encourage green

adoption and compliance need to be set up at project level, especially during the inception stage. Yang and Zhang (2012) noted that policies and guidelines towards environmental compliance are of the utmost importance. To ensure compliance, a green requirement needs to be included in the tender requirement, and as part of the contract. Testa et al. (2016) also recommended the use of external guidelines and toolkit measures for green procurement implementation. However, the external guidelines and toolkits must be able to bring all three important green performance factors together (Hall et al., 2011). As part of green procurement requirements, policy setting, binding contract clauses and environmental evaluation will be the persuasive factors towards achieving project green performance.

Third, current procurement practice did not focus on green adoption and lack of attention given to nurture the green culture among project team in delivering the project (Qi et. al, 2010). A low level of knowledge and commitment will handicap the organisation in its expectation of procured services and product needs (Gulch et al., 2006). Moreover, changing stakeholder mindsets requires changing long-existing industry practices (Wooi and Zailani, 2010, Preuss and Walker, 2011). Creating awareness and strengthening knowledge of green procurement issues appears to offer the greatest opportunity for the adoption of green procurement. The introduction of green-oriented procurement will be an effective tool that can help to spread awareness among construction industry practitioners. Most important, is the formulation of policies and guidelines at project level, which will encourage the participation and commitment of stakeholders.

Furthermore, green-oriented procurement is still very new to the Malaysian construction industry (Adham, 2014) and leads to an opportunity for further research needs. According to McMurray et al. (2014), lack of guidance in how to implement it will be the barrier in promoting green procurement. Varnäs et al., (2009) stated that developing a guideline will assist a project team to procure a green project. Previous study has proven that failure to identify sets of green practices and identify factors that are important in developing procurement strategy will be the barrier to producing a green project (Sourani, 2008). Sourani (2008) also mentioned that failure to identify the extent of green practice adoption within the project context is one of the barriers to green project delivery. Thus, this research carries out its aim to explore the potential of green-oriented procurement, by identifying the key factors and practices of green-oriented procurement for construction projects.

Green-oriented procurement is an emerging research area and the published academic research pertaining to green procurement of a building project is underdeveloped

(Bygballe LE, Jahre and Swärd, 2010). Most studies related to green procurement, in the context of Malaysia, focus on green purchasing at the level of individuals, households, firms and also government procurement (Adham and Siwar, 2012, ElTayeb, Zailani, and Jayaraman, 2010, Musa et al., 2013, Wahid, Rahbar and Shyan, 2011). Hassan (2014) discusses the way forward for a green construction project in Malaysia by proposing the adoption of green procurement. However, there is no model, framework or guideline proposed by Hassan (2014). This study is among the first to attempt to provide a green procurement model for a construction project, in the context of the Malaysian construction industry. Of utmost importance, this study provides empirical facts about prioritising green practices for green-oriented procurement that will assist the project stakeholders in making decisions regarding the extent of green practices in their project.

Adetunji, Price & Fleming (2008) revealed the fact that green procurement practices have not managed to capture the interest and attention from construction sector practitioners. This could probably, as suggested by Min and Galle (1997), be due to the fact that most of the practitioners who manage procurement do not know the potential of green procurement to green the project. Lack of familiarity, knowledge and interest among stakeholders in green procurement pertaining to construction, could be the flaws that could lead to low support of the sustainability agenda (Matar, Georgy, and Ibrahim, 2008; Varnäs, Balfors, and Faith-Ell, 2009). Two pieces of empirical research that have been conducted, pertaining to the barriers of adopting green procurement, have revealed that the level of knowledge and awareness on green procurement in Malaysia is still very limited (Adham and Siwar, 2012; McMurray et al., 2014). Therefore, the outcome of this research potentially creates awareness and better understanding on green procurement for a construction project specifically, and the concept of sustainability in general.

Although the fact that green procurement has been successfully implemented in other developed countries, Perera et al. (2007) highlighted that the degree of green procurement implementation might vary significantly across global practices. Thus, specific case studies may enhance understanding based on specific context. As argued (McMurray et al., 2014; Roy and Koehn, 2006), the outcome from the preceding research in developed countries may not be applicable for developing countries, due to the different nature of construction between developed and developing countries. This fact is also being highlighted by Brammer and Walker, (2011) and McCrudden (2004), that there is a wide variation in the implementation of sustainable procurement among countries, which has further validated the need for this research.

1.3 RESEARCH AIM AND RESEARCH QUESTIONS

Considering that many questions can arise due to the scarcity of systematic and rigorous studies on green-oriented procurement in the Malaysian construction industry, further research is needed in this area. This research aims to develop green procurement strategies that possibly can be used for both government and private stakeholders to procure a building project.

This research will examine the following research questions:

1. Which practices, associated with green-oriented procurement of a building project in Malaysia, are important?

2. Do these practices have any significant relationship with the green performance of a building project in Malaysia?

   For research question 2, two hypotheses posed in this research as follows;

   H1: Stakeholder values have a positive and significant impact on green-oriented procurement
   H2: Green-oriented procurement has a positive and significant impact on a project's green performance

3. How can project stakeholder use the identified key practices of green oriented procurement to improve project's green performance?

1.4 RESEARCH OBJECTIVES

Specifically, the objectives of this research are:

1. To identify the factors and practices that are associated with green-oriented procurement of a building project.

2. To determine the key factors and practices for green-oriented procurement of a building project in the Malaysian construction industry.

3. To examine the impact of green-oriented procurement on the green performance of a building project.

4. To model the key practices of green-oriented procurement and the impact of green-oriented procurement on the green performance of a building project.

1.5 RESEARCH SIGNIFICANCE

There is an urgent call for the construction industry to incorporate the environmental management in their procurement delivery throughout the project life cycle. Based on the literature, procurement is suggested as the vital tool to manage the environmental issue. A key task of this research is to produce a model for green procurement in the Malaysian construction industry. Thus, the first step taken by this research was identifying the key practices of green-oriented procurement and secondly, examining the impact of green-oriented procurement on a project's green performance.

Thus, findings from this research are expected to contribute to the body of knowledge and industry in the following ways;

1. To the best of this researcher's knowledge, this research area is relatively new in Malaysia and has not been studied extensively; the result from this study will provide new insight into the current procurement practices in Malaysia, which can be a basis for future studies. Also, it can potentially be tested in another country with some modifications, especially in the South-east Asian region, where rapid development is taking place.

2. This research will provide answers to the research questions and, as a whole, will provide empirical evidence to the existing knowledge and literature on a green concept for the construction industry.

3. More importantly, the green procurement model as the final product of this research, will potentially provide a strategy that is useful as a reference for some key groups in Malaysia such as researchers, policymakers and government agencies. Hopefully, it will also contribute to an understanding of the strategies in procuring the building project.

4. Since knowledge in green procurement is still in its infancy, conducting this research will create awareness and enhance the knowledge among researchers and practitioners in supporting a sustainable development agenda.

1.6 RESEARCH SCOPE AND LIMITATION

The scope of this research is restricted to building projects, in particular, focusing on the procurement practices. The scope is delineated by focusing on the important viewpoints of the green practices of a building procurement as the research content. The research outcome is the identification of important factors and practices for green procurement and their impact on a project's green performance. This research highlighted the green procurement issue as the significant tool in implementing the sustainability concept in an organisation.

This study involves the experienced practitioners that were involved in the procurement planning stage of a green building project in Malaysia. It includes the procurement officer, quantity surveyors and the designer team. This study is primarily based on the perception of experienced practitioners related to green practices for construction projects without specific references in terms of size and locality factors. The respondents of this research are those who were involved in the green building project who held decisive roles during the project's planning stage and had some knowledge pertaining to sustainable development and green construction. The results apply to Malaysia specifically, although they could be generalised to apply to other developing countries with some modification regarding cultural and political measures.

1.7 THESIS OUTLINE

A brief summary of eight chapters of this thesis is provided in this section.

Chapter 1 begins with an introduction that presents the background and prefaces the research problem with a justification for this research. Research aim, questions and objectives are presented as a research direction. The first chapter further discusses the

research limitations and points out the significance of this research through its contribution to knowledge in the field of heritage management.

Chapter 2 introduces the green concept in the construction industry and the project's procurement in line with the current sustainability concept. This chapter also discusses the current green practices within the research context, the Malaysian construction industry.

Chapter 3 confers the selection of the research methodology, outlines the research design and the selection of the research methods, namely, the questionnaire and the Structural Equation Modelling. This chapter also provides an overview of the research methods, which justifies the selection that aims to answer the research question of this research.

Chapter 4 discusses the preliminary model derived from Chapter 2 and presents the preliminary interview outcome. The analyses on based on preliminary interview and literature produced a revised model that is used in the next stage of this research.

Chapter 5 describes the analysis of data and results of the data cleaning, preliminary analysis and the descriptive outcome from the questionnaire.

Chapter 6 presents the SEM basic literature used to analyse data in this research. It presents the result of each variable of the measurement model to examine the validity and reliability of the construct. The structural model results also presented, and hypotheses results are discussed.

Chapter 7 presents the discussion on the outcome based on the final model and answers the three research objectives.

Chapter 8 summarises the answer to the research questions and objectives. This chapter also highlights the significance, to justify the importance of this research. The limitations of the research are outlined, and recommendations for future research are suggested.

1.8 CONCLUSION

This chapter discusses the research background, including highlighting the problem statement regarding green procurement for the construction industry. The association between the needs of a paradigm shift for construction delivery and the roles of procurement highlights the potential of the green procurement approach as a solution. The objectives of this research were then formulated based on the research questions. A description of the research outcomes, research significance, an overview of research methodology and research scope and limitations are explained briefly to provide an insight to the thesis. The thesis structure is presented to illustrate the chapters' interconnection and a brief summary. The next chapter presents the literature review.

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

Chapter 2 aims to presents the existing state of knowledge as background literature related to the research objectives as mentioned in the previous chapter. The literature review starts with a description of some global concepts about project organisation and the stakeholder management perspective with relation to building projects, under Section 2.2. An overview of the importance of building development in providing physical infrastructure is explained under Section 2.2. The section continues by discussing the current thinking regarding the adverse impacts of building projects towards the environment and the need of a paradigm shift to tackle this issue (Section 2.3). This chapter further explains the importance of greening the procurement as a whole to produce a greener project in Section 2.4. This section also describes the definition and the concept of green procurement. Following this, in Section 2.5, the review narrows down and focuses its examination on the Malaysian context.

2.2 INTRODUCTION TO BUILDING PROJECT

Turner (1993) provided the definition of a project as an attempt where human, material and financial resources as a process are organised in a novel way to undertake the project's quantitative and qualitative objectives, which have the unique scope of the specification with a contract cost and within agreed project duration. The project is a process that transforms resources into an output within certain guidelines and requirements.

Building is perceived as important for a nation's physical development to provide shelter for social and business purposes, for example, providing a building for the purpose of education, housing, retail, and manufacturing. Building builds on a complex design and multifaceted activities spanning throughout project's life cycle, starting from inception and ending in the handing over stage. However, recent practice has taken into consideration the operation stage, until the building is being demolished. It also involves various types of material that have come from various industries, using the complex and heavy machinery. The traditional way of measuring performance in the project is known as "the golden triangle of project

objectives"; that is the cost, time and quality. However, some projects have expanded project performance into various aspects including sustainability aspects. These multiple activities, stakeholders, materials, and machinery need to be managed wisely within a certain period of time at a specific location. For construction, time is crucial, as well as is the cost involved to achieve project performance. From the view of a project organisation concept, a construction project can be controlled through careful planning. In construction, planning phase refers to the early part of the project life cycle and is deemed to be a crucial stage (Grilo and Jardim-Goncalves, 2011). This stage is crucial because of the cascading effect towards the later part of the life cycle (Abu Hassim, Kajewski and Triganarsyah, 2011).

The building project is a temporary organisation within a certain period. There will be a temporary team, and a pre-determined task will motivate the team. Lundin and Söderholm (1995) have underlined four important concepts in a temporary organisation theory: time, task, team, and transition. He also argues that the concepts are quite different from the concepts of permanent organisation. Permanent organisation refers to long-term goals, organisation of long-term survival, broad working organisation and continual development. Of primary importance in the concept of the temporary organisation are the team members or project stakeholders. Project stakeholders come from various permanent organisations and backgrounds and are expected to convey their expertise and experience to the team. They are also expected to interact in the team environment, which has been brought together by a common interest. Lastly, the temporary organisation is mostly concerned with the progression and specified achievement. The pre-determined objective must be set to guide the whole team to understand their mission within the temporary organisation (Refer to Figure 2.1).

Normally in one project, a group of stakeholders with different roles and specialities will be gathered. Atkin and Skitmore (2008) helped to clarify that stakeholders are separated into two groups, which are the internal and external stakeholders. An internal stakeholder actively participates in an organisation's decision-making process, such as the client, customer and supplier. Meanwhile, the external stakeholders, such as local community and the public, are those affected by the organisation's activities. Some hold the power that will decide the direction of the project decision and progression and some show a high level of interest that will influence the decision made by the key stakeholders. It is important to understand each stakeholder role and how they might affect the project decision and progress.

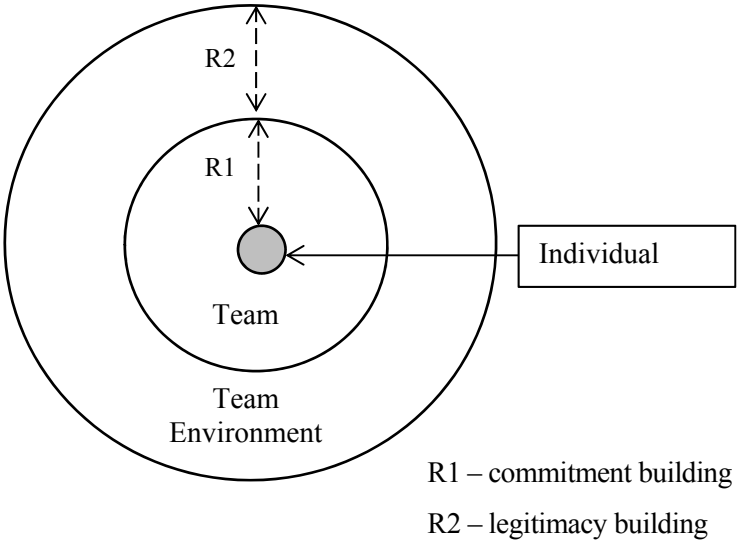

Figure 2.1 Team concept in temporary organisation
Source: Author's illustration based on Lundin and Soderholm (1995)

El-Gohary, Osman, and El-Diraby (2006) divided construction project stakeholders into three main groups: responsible stakeholder, impacted stakeholder and interested stakeholder. Responsible stakeholder refers to "an organisation or individual who has responsibility or liability concerning the development project, such as the design teams and contractor". Meanwhile, an impacted stakeholder is "an organisation or individual who is directly or indirectly affected by the development process, such as the end user of the building". An interested stakeholder is "an organisation or individual that is not directly impacted by the project, but who would like to participate and provide his opinion in the infrastructure development process, such as the public".

From a stakeholder concept perspective, the commitment of every stakeholder is crucial (Weiner, 2009). Each project consists of various stakeholders from different educational backgrounds and expertise. These stakeholders have also come from a permanent organisation and have been assigned temporarily for a project that is organisation-based. Thus, commitment building from the individual towards the team is crucial. These commitments are evaluated in term of capability, knowledge, and commitment, according to Lundin and Soderholm (1995). Each individual must be willing to learn some new practices and experiences involving a skill or a routine that has been set up by the project owner. These stakeholders are expected to have complex bundles of skills and accumulated knowledge to be shared among the team to achieve the project objectives. Meanwhile, from the literature in the project organisation theory, every stakeholder must clearly understand

the project direction and expected performance. The project teams should have a common interest and understand the bigger picture on the project's aims. Communication is essential for maintaining the commitment of all stakeholders.

2.3 CALLING FOR PARADIGM SHIFT TO INCORPORATE GREEN PRACTICES IN BUILDING PROJECT

2.3.1 Impact of construction activities on environment

The world's population has more than doubled since 1950, where most growth has taken place in developing countries (UNEP, 2003a). This expansion pattern leads to a greater demand for building and infrastructure. The economic contributions of the construction sector generally toward the national gross domestic product (GDP) are also proven to be significant (Field and Ofori, 2006). In other words, construction and economic growth are inseparable and interrelated. However, buildings and infrastructure development contribute significantly to global environmental problems (Elforgani and Rahmat, 2011). On the other hand, it is also impossible to hold the emergence of physical development to protect the environment. Daly (1990) proposed a practical idea on maintaining a balance between economic growth and environmental protection.

The strategy to tackle the adverse impact of physical development and economic activities on the environment was seriously discussed in the Brundtland Report 1987. The Brundtland Report 1987 mentioned that development and environment should be discussed as a single issue to improve resource management and reduce resource degradation, pollution and waste (WSSD, 2002). Based on that, it has also grown as a starting point for sustainability researchers of various backgrounds. Thus, this research promotes the idea of providing well-planned structures built with sustainable methods, and materials that can be highly beneficial for the country and the current and future communities.

In environment-related conferences, issues of pollution create great discussion (Johannesburg Plan of Implementation, Rio Declaration). The construction process has been revealed as the one of the largest indoor and outdoor environmental polluters (Ding, 2008; Geng and Doberstein, 2008; Hezri and Hasan, 2006; Ofori, 2000). Construction's pollution is referred as "particles, noise, vibration and vaporous discharges" (Kukadia, Upton,

Grimwood, and Yu, 2003), such as emissions of air and water pollutants, dust and noise during construction (UNEP, 2003a). Recent studies, however, emphasise that the pollution issue for construction should cover not only outdoor pollution, but indoor pollution as well. A study based in America revealed that most of the building occupants spent about 90 percent of their times indoors (EPA, 2009) and reported that over 30 percent of conventional buildings have poor indoor air quality. The building development also responsible for carbon dioxide emission causes an imbalance in the ecosystem that impacts the climate and ozone depletion (Hes, 2005). The EPA (2009) reported that 38 percent of carbon dioxide emission in the United States of America (USA) in particular, comes from building construction and operation. Specifically, according to Tan (2008), Asia, which mostly consists of developing countries, was projected to have a carbon emission contribution that was increasing from 17 percent of the world's total carbon dioxide emission to 34 percent in 2015. One of the main reasons is that the material used for building construction, such as cement, has been identified as one of the significant contributors for carbon dioxide emission.

This industry is also identified as the most significant energy consumer globally and uses almost half of our natural resources as revealed by previous scholars and institutional reports all around the world (del Río Merino et al., 2009; Elforgani and Rahmat, 2011; Oh and Chua, 2010; UNEP, 2003a, b). As reported by Pitt et al. (2009), in the United Kingdom (UK), built environment consumes about 50 percent of the UK's total energy usage. Another example is taken from a study conducted in the United States of America (USA), where building development was responsible for 39 percent of the total energy consumption in 2005. While in Malaysia, as one of the emerging economic regions, the building sector consumed approximately 8,000 GWh of energy in 2008 (Sood, Chua, and Peng, 2011). In other words, the production of building material consumes energy. Also, the construction phase consumes even more energy in terms of the usage of machinery, etc., and lastly, during the operation of a completed building, consumes energy regarding heating, lighting, power and ventilation (Akadiri, 2011).

The current development expansion pattern will destroy and disturb natural habitats over more than 70 percent of the earth's surface by the year (UNEP Earthscan, 2002), and be the major exploiter of renewable and non-renewable natural resources (Abidin, 2010). The UK construction industry has been revealed as the highest sector, consuming approximately 420 million tonnes of materials annually (Plank, 2008). The fact is that the construction industry depends heavily on the natural environment for the supply of building materials such as timber, sand, and aggregates for the building process. This extraction of natural

resources causes permanent changes to the natural environment from both an ecological and a scenic point of view (Ofori and Chan, 1998).

Past research revealed that the construction industry also generates a large amount of waste (del Río Merino et al., 2009; Shafii, Ali, and Othman, 2006) approximately 10 percent to 40 percent of the world's waste and pollution. Huge waste creation occurs from construction industry activities in the different phases of the construction process such as from the extraction of the raw materials until the disposal of the waste materials in landfills, As mentioned in Nagapan et al. (2012), and Nissinen, Parikka-Alhola, and Rita (2009), this contributes to unsustainable construction. The increase in the volume of construction and demolition waste has burdened local waste management systems and contributed to environmental degradation.

The adverse impacts of construction on natural environment calling for urgent changes in the way construction project operate and manage. Past literature suggested the need for a paradigm shift to promote the integration of green project deliver to achieve the intended performance for a construction project. This will be discussed further in the next section (Section 2.3.2).

2.3.2 The needs for a paradigm shift

A paradigm shift is simply understood as the fundamental change in an organisation's view of how things work. The main idea for this paradigm shift is that industry needs to change through a rethinking of new approaches. Smith (2005) stresses the point that change is a constant process for any organisation that needs to move to a new and different state. According to Ofori (1992), there should be changes in thinking, behaving and producing within the construction industry, in order to progress towards sustainability. Various innovative approaches involve changes being introduced to current construction methods and resources used; however, what is needed is a change in the building process itself. Environmental practices must be internalised and become part of the culture of the construction industry. Culture according to Parodi (2015) refers to "any event which is not entirely caused by nature, and which has emerged from the conditions of convention, communication and collectively." Culture also refers to the interaction of the collective as well as the individual within the collective. Making sustainability part of a culture will need the successful implementation of sustainability concepts focusing on both the collective aspect and encouraging individual participation.

Berry and McCarthy (2003) recommended that the project stakeholders must recognise the roles of construction projects in creating sustainable culture and communities. It is important to trigger individual awareness first, as this should then create collaborative awareness among project teams. The cooperation of government, through its policy setting, instruction, and programs, is a crucial precursor to commencing implementation. Training is equally important regarding raising awareness to shift towards green purchasing. Once this is achieved, a series of training programmes concerning key approaches and practical guidelines need to be developed to guide stakeholders. However, this requires a change in stakeholder mindsets and values, which is difficult to achieve in Malaysia since it requires changing long-existing practices.

Many studies suggest that, in nurturing an awareness of this greener path, it is vitally important to start from its education and inclusion in school curricula, while none have been given priority as yet (Abidin, Yusof, and Othman, 2013). This change requires support from construction stakeholders and guidance from every stakeholder (Eisenhardt and Martin, 2000). In progressing, Kibert (2012) suggests the industry must shift to a cradle-to-cradle approach and requires the support from various stakeholders in the project and its culture change. These stakeholders are expected to have complex bundles of skills and accumulated knowledge to adopt this change (Cole, 2005).

2.3.3 Philosophy, theory and practices of green construction

The gradual deterioration of global environments has been highlighted in many major environmental conferences, and urges for action have been made from a variety of sources. Early recognition of the problem is the seminal 1987 Brundtland Report's advocation, which states that the competing issues of physical development and environmental sustainability must be considered together in improving resource management and reducing resource degradation and pollution for the benefit of future generations (WSSD, 2002). The United Nations Conference on Human Environment in 1973, also known as the Stockholm Declaration, has to stimulate environment issues and make them a global agenda (Preston and Leng, 1989). The Stockholm Declaration was the first event initiating the link between the environment and the development agenda (Dresner, 2008). The World Commission on Environment Development (WCED), commonly referred to as the Brundtland Report 1987, once again reaffirmed the Stockholm declaration and made it clear that the environment and development are inseparable.

The Kyoto Protocol provides a framework that highlights the issue of continued deterioration of global environments. The protocol binds developed countries on greenhouse gas emission limits; for developing countries, emission of greenhouse gases (GHG) is allowed according to their development needs, but they are still committed to reducing emissions under the International Treaty. In 1992, the Rio Declaration on Environment was signed by 154 countries at the 'Rio Conference' or the 'Earth Summit'. Rio Agenda 21 is one of Rio's international instruments, whereby important official agreements move the development of the environment to become a global commitment (Dodds et al., 2012). Rio also produces various international law instruments that deal with specific issues and create the UN Commission on Sustainable Development (CSD), which is responsible for disseminating the effort to integrate the environment and associated development (Dodds et al., 2012). During the declaration of the new global Sustainable Development Goals of the 2030 Agenda for Sustainable Development, United Nations' leaders said that they were determined to protect the world from the degradation problem. One of the focuses is through sustainable consumption and production by sustainably managing natural resources (United Nations, 2015). The effort will set out the path towards sustainable development that ensures the lasting protection of the planet and its natural resources, by focusing on the need to change to sustainable consumption and production.

The theories of sustainable and green operations do not have a judgemental view on the essentiality of business, production processes and products. The concept of sustainability has been introduced and has become a basic starting-point for the sustainability that is being adopted by various parties, including policy makers, scholars and industry practitioners. The sustainability triple bottle line (TBL) includes three concepts: environment, economic and social (Shelbourn et al., 2006) (refer Figure 2.2). Robins (2006) indicated that economic sustainability happens when development is financially feasible and provides value for money. Meanwhile, environmental sustainability is a practice that ensures that the environment is not degraded. Social sustainability focuses on improving the quality of life of society and individuals, in areas such as health, wellbeing, shelter, education and culture. The major focus is on environmental impact, such as through emissions, energy and water consumption and waste (Nunes et al., 2012).

The Brundtland definition of sustainable development specifies both environmental and social sustainability, but the latter dimension has had limited discussion (Ashby, Leat and Hudson-Smith, 2012). The social aspect is concerned with improvement in terms of social management in the project to add value by increasing the human capital of individuals,

including project stakeholder's skills and abilities, relationships and social values (Sarkis et al., 2010). Carter (2005) revealed that those organisations that are environmentally responsible significantly contribute to the overall organisational performance. Carter and Rogers (2008) corroborate this view.

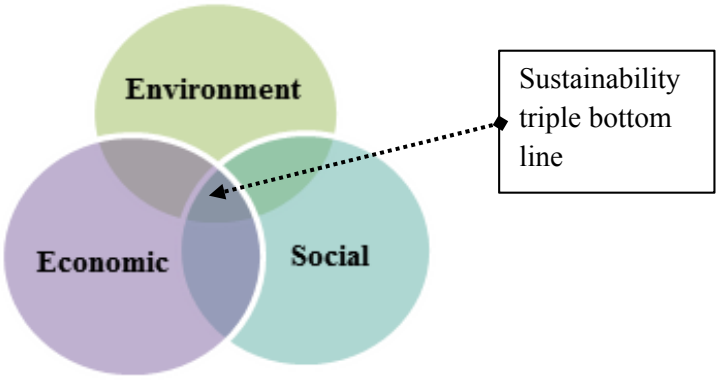

Figure 2.2 Classic model of sustainability
Source : Adapted from Shelbourn et al. (2006)

From an environmental management point-of-view, the natural environment is part of organisational responsibility. This means that every permanent and temporary organisation in every sector or field must put environmental protection as their responsibility; this includes any permanent and temporary organisation within the construction industry. Furthermore, as discussed in the previous Section 1.2.2, construction project organisation has a close relationship with the natural environment and the adverse impact of construction on the natural environment has been long criticised. Thus, managing these adverse impacts of building projects towards the environment is crucial. Wu, Yan and Huang (2012) classify the natural environment as the customer for the construction industry, where environmental consideration should be part of the project's performance. The environmental consideration must be incorporated throughout the building development process including the conception, preparation, construction and end phases. The end-product should be able to provide a comfortable and healthy indoor and outdoor environment and be able to minimise the impacts on the natural environment (refer Figure 2.3).

Rogers, Jalal, and Boyd (2006) highlighted these sets of dimension. From the context of the built environment, these sets of dimension are interpreted as a building response to achieve sustainability. Hussin, Abdul Rahman and Memon (2013) provided a

basic principle of sustainable practices by highlighting the need to integrate environment, economic and social aspects together (refer Table 2.1). An environmental aspect mainly aims to reduce greenhouse emission, reduce pollution levels, manage natural resources and manage and dispose of waste. An economic aspect relates to the concept of value for money, which also internalises green cost. A social aspect relates to generating social benefits, which impact on the social well-being of the organisation and the stakeholders. In order to integrate green practices, a "building green" concept is introduced.

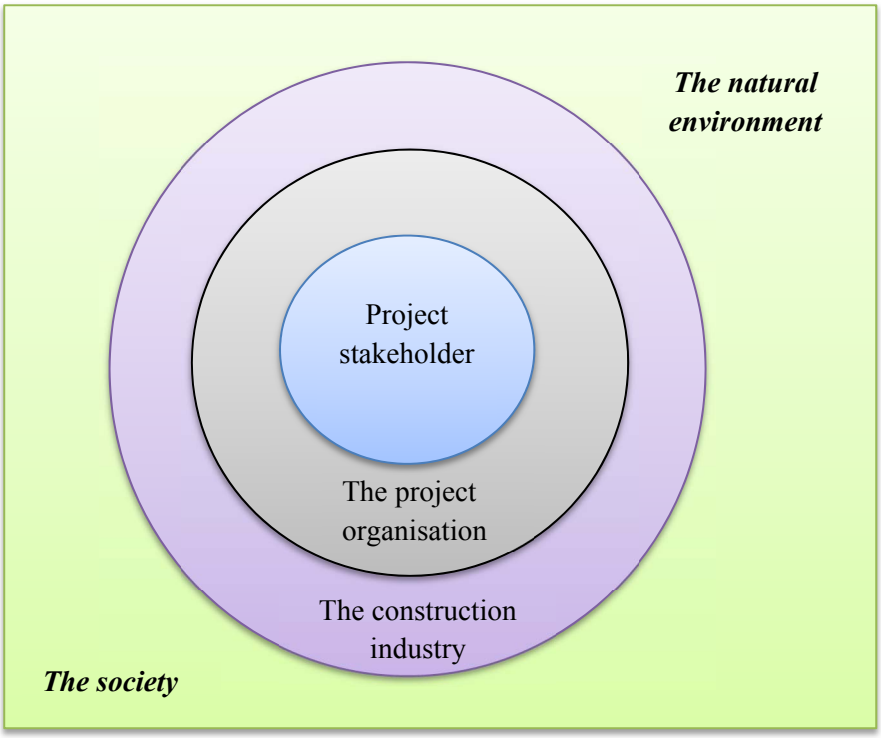

Figure 2.3 Natural environment and society and the construction industry
Source: Author's illustration

"Building green" is the idea brought into building projects that will produce a new concept of project output that is a "green building." Building green refers to taking into account sustainable practices to achieve another dimension of project performance known as green performance (Ofori, 2006). Green performance coined the principle to create growth that will not come at the cost of future generations (CIDB, 2015) and based on the sustainable TBL concept, known as environment, economic and social (Hussin, Abdul Rahman and Memon, 2013). The concept of the green building itself should be regarded as a process rather than just the product due to the long duration involved, including taking care of the complete project life cycle (Wu and Low, 2010). The construction of a green building

involves careful planning and is not merely a matter of assembling a collection of cutting-edge, green technologies or materials.

The characteristics of green buildings frequently include measures to reduce energy consumption, to improve indoor air quality, water efficiency and construction technique efficiency (Hussin, Abdul Rahman, and Memon, 2013). Regulations for the energy efficiency in buildings is important, since energy efficiency and conservation are relevant to the carbon emission problem (Casals, 2006) and are addressed as an important essential component in the agreement contained in the Kyoto Protocol, to address greenhouse gas emissions (nrg4SD, 2011). The energy efficiency design includes the design for the building envelope (Okba, 2005), selection of building material and thermal comfort (Ooi et al., 1998). Indoor Air Quality (IAQ) design relates to the ventilation requirement for air quality performance (Elforgani and Rahmat, 2011). For instance, a design team should be monitoring and controlling the carbon dioxide level in the interior space of a building.

Green building design also includes the efficient use of water, which significantly influences the overall building project performance (GBI, 2009). Recycled water using rainwater harvesting is an efficient approach to achieving perfect water utilisation. The measurement for this also includes the attempts to increase efficiencies, such as design or water fittings and metering, and a leak detection system (GBI, 2009). Consideration must be given to site selection and the characteristics that may contravene environmental issues (Robichaud and Anantatmula, 2011), such as avoiding and preserving environmentally protected areas through the restoration of existing sites and redevelopment of brownfields (GBI, 2013). It is important that the final decision in selecting a site involves the decisive stakeholders as well as the community's input. Environmental management mainly aims to conserve existing natural areas, restore damage and maximise open space. Apart from that, transportation is also a main consideration for site planning (Roos, 2012). During construction, the vehicles or transport used must be classified as green vehicles that produce low emission and are fuel-efficient. Table 2.1 summarises the application of a building green principle to achieve the project's green performance, as previously discussed. This list of green practices to achieve green performance is stipulated in Table 2.1.

Table 2.1 Application of sustainability principles in construction project to achieve project's green performance.

Robins (2006)	**Intended green performance based on sustainable principles** *Adapted from Berry and McCarthy (2003); Kibert (2012); Ahn and Pearce (2013); Hussin, Abdul Rahman, and Memon (2013); CIDB, (2015)*	**Green practices**
Environmental Aspect	Reducing greenhouse emissions Reduce pollution levels Manage natural resources Waste Management	Green design Selection of materials Sustainable site management Waste management
Economical Aspect	Value for money Internalise green cost	Green purchasing Consider lifecycle costs Internalise external costs Value for money
Social Aspect	Enhance a participatory approach by involving stakeholders Promote public participation Provide high customer satisfaction	Improve quality and productivity Qualified stakeholders Integrated approach Public participation Project Image

Source: Author compilation

2.4 CONSTRUCTION PROCUREMENT IN GREENING THE BUILDING PROJECT

2.4.1 Understanding procurement

Procurement commonly refers to the act of buying something. Organisation procurement as defined by Hochschorner (2008) looks at procurement as a process undertaken by an organisation to do purchasing of goods and services that are vital for an organisation. It is regarded as a process because it involves multi-phased activities including identification of needs,

planning, designing, purchasing, payment and disposal. The act of procuring materials and services are normally through a process called tendering or bidding. Review of the literature specifies that research on procurement leans towards the importance of procurement in providing strategic goals of organisations, which shows its potential as a strategic tool to achieve organisation goals (Holcomb and Hitt, 2007). During the 1970s, procurement was having a passive role in an organisation and was described as an administrative function (Ammer, 1974). However, current literature that has seen procurement as one of the strategic tools in management, has suggested the importance of understanding fundamental procurement strategic management.

The organisation buying behaviour theory could provide insights on the procurement strategy, specifically at the pre-contract stage. The pre-contract stage, regarded as planning stage, is essential in ensuring successful procurement delivery (Abu Hassim, Kajewski and Triganarsyah, 2011). Early literature from the organisation's buying behaviour theory posed three questions during the pre-contract stage, that are;

- who are the participants,
- what is the procurement process model,
- what will influence procurement's specific decisions?

Also, under this organisation buying behaviour theory, the actors are those people considered important in the procurement process came from a different background of expertise. The theory also stipulated that those involved in procurement bounded rationality and differing motivations and preferences. This scenario leads to a conflict of decision making including drawing up a specification, choosing a supplier and deciding what to buy. However, it also argues that this conflict can be easily resolved with problem solving and persuasion (Sanderson et al., 2015).

A procurement practice evolved over time to meet market trends such as globalisation, changes in consumer pattern and technology advancement (Tassabehji and Moorhouse, 2008). To achieve competitive advantage, current procurement practices are focusing on being proactive and value-added rather than focusing on the passive cost strategy. A procurement delivery is strategies to achieve the best value for the organisation and benefits of other impacted stakeholders, such as the society and environment. This shift is driven by awareness of the stakeholders on the corporate social responsibility (CSR) and organisational inter-organisational relationship. To cope with the market challenges and maintain organisational competitiveness, specific procurement strategies and skills are demanded. The technical skill of the stakeholders of

the organisation are said to be the predictor of the procurement performance. Apart from that, management skills help in terms of strategic purchasing.

2.4.2 Overview of construction procurement

The term 'building procurement' refers to an amalgam of activities undertaken by a client/owner when seeking to obtain the construction or refurbishment of a building (Franks, 1998). Procurement is an essential process of any construction project that involves activities related to providing goods, services, and consultancy aims to achieve the project objectives and predefined requirements (Ruparathna and Hewage, 2015a). The overall framework of constructing a building must also include the structure of responsibilities and authorities of the stakeholders (Love, Skitmore, and Earl, 1998). Construction procurement is important for any building or infrastructure project because it influences the overall project performance. According to these two authors, Mohsini and Davidson (1991) and Valdes-Vasquez et al. (2013), building procurement is the key that contributes to the overall project success

Procurement for construction projects is very complex and unique. The procurement process involves much more than just buying or purchasing but also involves a complicated management process at all stages of development (Hughes et al., 2006). Hughes and Laryea (2013) underlined reasons on why construction procurement is considered as complicated, including the planning on building material purchasing decided as early as the pre-planning stage; it involves a huge amount of investment on high risk purchasing and a large proportion of suppliers are involved throughout the course of project development.

There are a few types of procurement delivery in construction projects. Each type of procurement delivery has its benefits and risks. There is no indication of which procurement delivery is better for one type or another; it all depends on the project's goals and objectives (Sutt, 2011). The most common procurement delivery methods are traditional (lump sum contracting), design and build, construction management, partnering and public private initiative (Ruparathna and Hewage, 2015a). Among all, the traditional (lump sum) is still the primary procurement method for a construction project in various locations, such as Australia (Love at al., 2010) and Malaysia (Jaafar and Radzi, 2013). According to Eriksson and Westerberg (2010), the selection of procurement type will be related to the client preference and depending on the extent of familiarity and knowledge.

Construction procurement consists of several important stages. Six primary activities are associated with procurement processes, which establish actions and deliverables associated with the process, such as determining the objective, deciding on procurement strategies, soliciting and evaluating tender offers, awarding and managing the contracts and confirming compliance with requirements (Watermeyer and TC59WG, 2011). According to the United Nations Development Programme Procurement Support Office (UNDP, 2008), the general procurement process can be classified into ten main activities from planning to contract management. These ten main activities have been further divided by Sanchez et al., (2014) into three main phases: Strategic planning, project development and project implementation (refer Figure 2.4).

Ackoff (1970) mentioned, "planning involves the decision-making process performed in advance of action, which endeavours to design the desired future and effective ways of bringing it". Proper project planning helps the stakeholders involved in fulfilling the project objectives, to coordinate and communicate the project and to facilitate project control. Abu Hassim, Kajewski and Triganarsyah (2011) mentioned that procurement planning is an essential task that needs to be arranged to ensure project procurement is well planned and well executed. The planning helps to determine what needs to be procured, what the requirements are in term of construction projects' three major goals, which are cost, time and quality, and who will get involved.

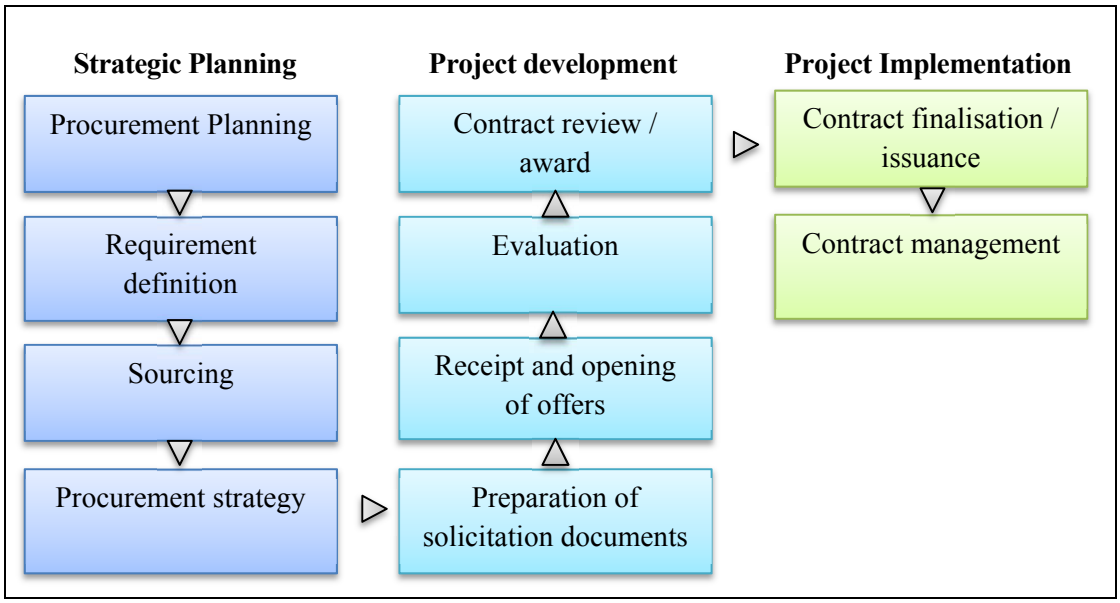

Figure 2.4 Construction procurement phases
Source: Adapted from Sanchez et al., (2014)

Kang et al. (2013) further revealed the results of their study showing that more pre-project planning contributes to better cost performance, and the impact of pre-project planning on cost performance. This view was similarly mentioned by Hanna and Skiffington (2010) and Menches et al. (2010). Hanna and Skiffton (2010) conducted research on the effect of the pre-construction planning of a sheet metal project on the project performance. They revealed that a project with careful planning could achieve a profit margin of approximately 23 percent while projects that were not properly planned experienced an average profit margin of 3 percent.

Procurement for construction projects involves various actors throughout the stages. A financial funder, normally known as a client, may or may not have any knowledge on construction projects. The professionals such as the architects and engineers as well as the designers, quantity surveyors etc., will be appointed to assist the client to deliver the project in meeting its objectives. The professional may come from a different permanent firm and be engaged temporarily within an organisation to meet certain objectives and in limited time.

2.4.3 Introducing the green-oriented procurement concept

The procurement that is concerned with green concept and consideration is referred to as 'green-oriented procurement'. 'Green' is defined by various authors, including Albino, Balice, and Dangelico, (2009) and Winkler (2010) as "the acknowledgment, incorporation and implementation of environmental practices, initiatives or systems designed to minimise environmental impact during their life cycle." The term 'green-oriented procurement' has been used interchangeably with several other terms such as 'sustainable procurement'(Addis and Talbot, 2001; Grob and McGregor, 2005; Hughes and Laryea, 2013; Meehan and Bryde, 2011), 'environmental purchasing' (Coggburn and Rahm, 2005)', 'green purchasing' and Handfield et al. (2002) used the term 'environmentally-conscious purchasing'.

This research has reviewed and compiled definitions used by researchers and organisations in the literature. In the search for the definitions, this research used the keywords as listed below, using various search engines including Google Scholars, Scopus, EBSCO, Sage Journals online and ISI for journals. The key words used are;

- "green" AND "procurement," "green" AND "purchasing,"
- "sustainable" AND "procurement," "sustainable" AND "purchasing,"

- "environmental" AND "procurement," "environmental" AND "purchasing,"
- "environmentally-conscious" AND "procurement," "environmentally-conscious" AND "purchasing,"

The definitions are further divided into a few themes to capture the key term used to describe green procurement (refer Figure 2.5). Green procurement is defined by various studies and organisations based on their local context and organisational needs. Compilation of the definition and identification of the key objectives of green procurement from previous literature helps this research to understand further the concept and the importance of green-oriented procurement for the organisation. Thus, the term 'green-oriented procurement for a building project' in the context of this research is understood as;

> *"the act of obtaining goods, services, engineering and construction work or disposal and recognition, as well as the integration and implementation of environmentally-friendly practices throughout the processes involved in producing a construction output such as building and infrastructure. It also incorporates the framework and structure of responsibilities and authorities for stakeholders within a building project."*

A summary from Figure 2.5 suggested that green-oriented procurement is a potential instrument to realise environmental benefits. The adoption of green-oriented procurement helps to create a demand for green materials, products and services in the green market. This demand will be able to diffuse and maximize green materials and services in the market. A green product or service can claim to have a minimal environmental footprint compared with the standard product or the similar type of service. This environmental footprint refers to the overall impact on the environment, including energy and water consumption, as well as effects on health and other aspects of the human environment. Green materials have some advantages, namely the significant recycled content and the ability to be made from renewable biological resources or be created using processes that use a lower amount of energy and produce a low amount of pollutants.

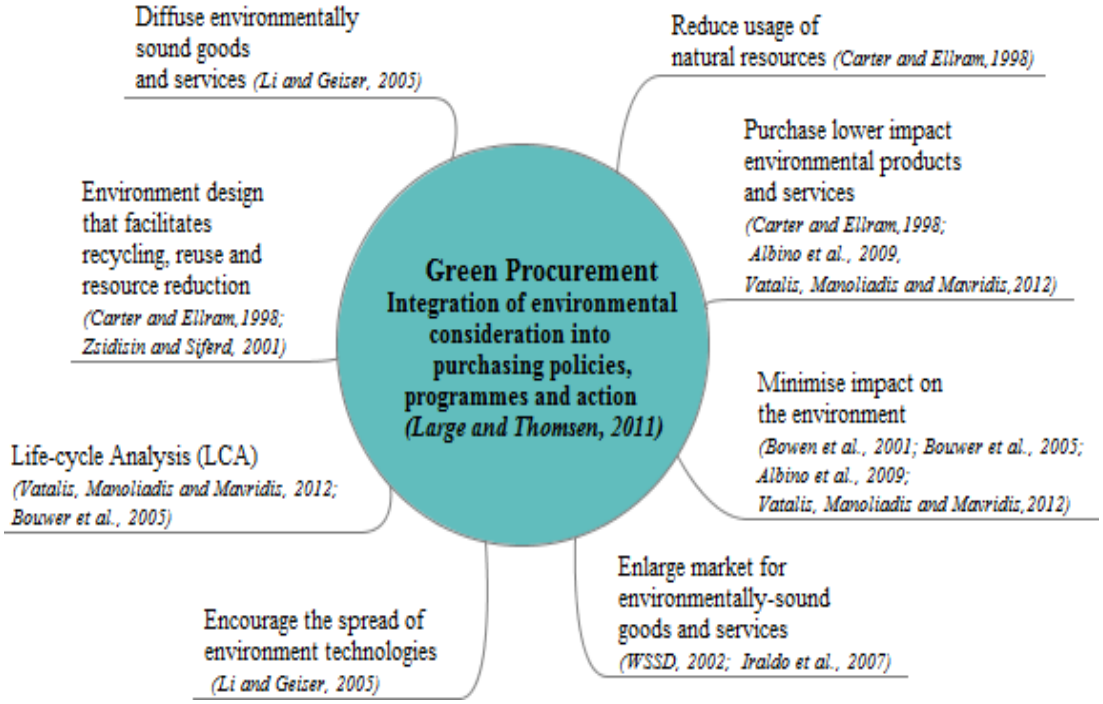

Figure 2.5 Key words used in green procurement by various studies and organisations

Source: Authors' compilation from various sources *(Adapted from Albino et al., 2009; Bouwer, 2005; Carter, Ellram, and Ready, 1998; Li and Geiser, 2005; Vatalis, Manoliadis, and Mavridis, 2012; Zsidisin and Siferd, 2001).*

Green-oriented procurement builds on the traditional procurement practice, which it seeks to extend through the adoption of sustainability principles. Green-oriented procurement aims to procure a building project that recognises, incorporates and integrates green practices throughout the project delivery. As is well known in development practice, early decisions are the most vital and influential to determine project success. Procurement is seen as one of the influential agents of change with important multi-dimensional tools capable of the integration of green practices throughout the process (Bratt et al., 2013; Preuss, 2009; Ruparathna and Hewage, 2015b; Zsidisin and Hendrick, 1998). It also a strategic tool to incorporate environmental policies and guidelines into a building project (Faith-ell, 2005). Indeed, procurement in being increasingly introduced to complement current initiatives to ensure the growing adoption of green construction practices. Large and Thomsen (2011) mentioned that the key idea of a green procurement is the integration of environmental considerations into the purchasing policies, programs and action.

As discussed by Vanegas (2003), a sustainable project outcome needs to be supported by an uninterrupted chain of supporting management mechanisms and multi-

disciplinary collaboration from strategic planning to attain sustainable design, construction, and operation. Procurement is identified as important tools that can help to manage, incorporate and monitor these sustainable or green requirements of the project. Grob and McGregor (2005) explained this concept further by listing the stages of progression from a standard practice towards green practices as discussed in Table 2.2. Procurement practices must be responsive to environmental obligations, whether they arise from laws, regulations, contract, industry standards or internal policies. Grob and Mcgregor highlighted the needs for an organisation to develop their strategies or use available external tools to make sure they meet minimal compliance requirements (2005). This model also highlights that purchasing of materials and services should meet the basic environmental criteria, but it should aim to be competitive and obtain value for money. For a procurement to progress from the compliance phase to the strategic proactive phase, the organisation must consider purchasing based on the Life Cycle Costing (LCC) principle that leads to efficiency and cost saving.

Figure 2.6 Position of green procurement along the continuum
Source: Fischer, (2010), p.5

Grob and McGregor (2005) highlighted that rejection and non-responsiveness will be treated as equal to standard procurement practices (Refer Figure 2.6). Standard procurement practice describes that the procurement practices that did not consider environmental consideration are not a priority for purchasing decisions. They might be aware of the importance of green principles but have chosen to ignore this. Fischer (2010) provided a green procurement continuum to benchmark the extent of procurement practices (refer Figure 2.6). Fischer views the rejection and non-responsiveness as mentioned by Grob and McGregor as standard industry practices and of extreme impact. However, Fischer (2010) highlights the point that this benchmark will vary, depending on the situation of the green standards in the industry and locality factors.

Table 2.2 Phases of progression towards sustainable procurement

Phase	Procurement characteristics
Rejection	• Single focus-financial bottom line • Commitment to directly purchasing sustainable materials is not enthusiastically encouraged by the organisation • Environmental consideration is not a priority for purchasing decisions
Non-responsive	• Aware of mandatory requirements, as well as progress from other similar organisations but elect to avoid them • Aware of the possibility of incorporating sustainability, but views it as an extra-budgetary item
Compliance	• Responsive toward external requirements, e.g., legislative • Develop a compliance strategy based on existing framework, e.g., ISO9001 • Purchase to (or "intending to") reduce possible risk and avoidance of legal action • Develop a mechanism to ensure compliance
Strategic proactivity	• Go beyond compulsory requirements to investigate practices leading to efficiency and cost saving • Assess the lifecycle of all bought and produced products • Develop a compliance strategy based on an existing framework, e.g., ISO14001 EMS series, which requires auditing and measurement systems • Obtain commitment from top management to implement sustainable procurement and supply chain procedures • Stakeholders that are qualified and educated in sustainable supply principles.
Sustainable organisation	• Public reporting of purchases • Recognised by the industry as a leader • Sustainable procurement as a key organisational behaviour • Organisation engages stakeholders and the community in developing new products and services.
Efficiency	• Waste production as the resources • Resource consumption and procurement as key performance indicators • Involved in voluntary programmes for sustainable procurement

Source : Adapted from Grob and McGregor (2005)

2.5 POTENTIAL FACTORS AND PRACTICES FOR GREEN-ORIENTED PROCUREMENT

2.5.1 Exploring the potential factors and practices –relevant theories

Johnsen, Miemczyk and Howard (2016) revealed that the research pertaining to sustainable purchasing is rapidly emerging. Previous study shows that the incorporation of green practices in an organisation can be achieved by applying theories from other disciplines and fields (Adetunji, Price, and Fleming, 2008). However, Appolloni et al. (2014) argue that current research relating to green purchasing is lacking a theoretical basis and this has been identified as a void in the literature of green supply chain management (Sarkis, Zhu, and Lai, 2011). According to Touboulic and Walker (2015), the trend to build new perspectives within the context of the procurement supply chain based on the existing theories is limited in the literature. The development of a strong conceptual basis can help clarify the scope of study as an academic and practice-based discipline. The theory represents a way of seeing things and its relation to empirical reality is widely known (Touboulic and Walker, 2015).

In response, this study adopts the idea proposed by Handfield et al. (2002). According to Handfield et al. (2002), the research on green procurement should be focusing on the theory of environmental management. The idea is, procurement should be oriented in an green operation that aims to fulfil the environmental objective of an organisation (Zhang, Wu and Shen, 2015). Ashby, Leat and Hudson-Smith (2012) seconded this idea in their article, in which the green operation provides a basis for the firm to address the need to preserve the natural environment. This leads to the question, what can be done? Of utmost priority in relating to the question is, identify the useful and practically green operation to be adopted. Environmental management address a few key practices such as the holistic approach to life cycle analysis (LCA), design for the environment that includes products and process, the need for recycling or in a broader term known as waste management and green purchasing (Ashby, Leat and Hudson-Smith, 2012).

The green-oriented procurement in the context of the construction project also highlighting the stakeholder roles as crucial factor. Johnsen, Miemczyk and Howard (2016) revealed that the most dominant theory applied in addressing green purchasing is the stakeholder theory. Hoejmose and Adrien-Kirby (2012), examining the trend in the literature of environmentally responsible procurement, found out that most research is referring to the

stakeholder theory to examine the factors that will affect procurement delivery. The stakeholder theory helps this research to classify the stakeholder based on their category and their effect in shaping purchasing behaviour towards achieving organisational goals. The stakeholder who poses a decisive power could take precedence to guide the green procurement implementation with the expectation that they must possess a certain capability and level of commitment to meet the project objectives.

The exploration of green-oriented procurement based on two main theories, the environmental management and the stakeholder theory will be further discussed in the section of this thesis.

2.5.2 Determinant for green-oriented procurement

Green procurement builds on the traditional procurement practice, which it seeks to extend through the adoption of sustainability principle (Refer Fig. 2.2 Classic model for sustainability). Appolloni et al. (2014) and Shen, Zhang, and Zhang (2016) posed a notion that green procurement has become a focus through which to collaborate on the environmental issue within the building industry. Project stakeholders need to identify the key factors or practices that help them to determine the green orientation of their procurement. The opportunity to integrate green practices into procurement potentially been unlocked by the identification of factors and practices that are associated with shaping the green-oriented procurement of a building project. In this section, a conceptual model is proposed, and the important factors and practices that help to determine green-oriented procurement are highlighted. Existing literature has revealed that effective green practices implemented that adopt the life-cycle costing have the potential to control project costs (Hochschorner, 2008), improve internal and external standards through performance assessments (Tucker and Pitt, 2009), achieve compliance with environmental and social legislations (Grob and McGregor, 2005) and also enhance reputation (Noor and Pitt, 2009).

This research explores a few existing frameworks including the Environmental-responsible-organisation (ERO) framework by Pun (2006) (Figure 2.7). The ERO model was developed based on the environmental management practices in an organisation. Although Pun's ERO framework was conducted in the context of a manufacturing organisation, it has a potential to be extended in the context of construction projects. The core idea of the ERO framework is to pave the way in developing green-oriented culture in an organisation. Pun

(2006)'s proposed three key factors that help to determine the orientation of an organisation are the policy, the product/process and evaluation. Pun's framework, known as the Environmental-responsible-operation (ERO) framework, highlighted the importance of policy that helps the organisation to set environmental goals, demand for the stakeholder's commitment, and encourage knowledge seeking and sharing. The second factor is related to the product and process of the organisation. The green principle must be internalised within the process of acquiring the products and services and show concern on the issue of waste management and pollution control. Evaluation factors are mainly to measure the compliance of the sustainability indicator through performance measurement tools, financial justification, and stakeholder's feedback.

This research reviewed Grob and McGregor's research finding categorisation of progression towards sustainable procurement (Grob and McGregor, 2005). Their research - based on the concept of sustainability and the organisation - has suggested the stages of progression of a standard procurement practice towards more sustainable practices (refer Table 2.2). There are six progression stages suggested, which consist of six phases: rejection, non-responsiveness, compliance, efficiency, strategic proactivity and sustainable organisation. This research focuses on the point where the procurement reaches the compliance stage.

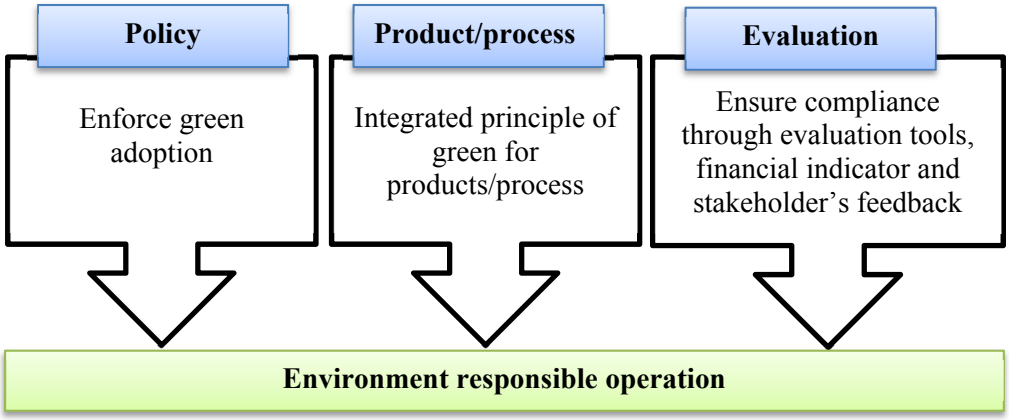

Figure 2.7 Determinant factors for organisation's environment responsible operation (ERO)

Source: Adapted from Pun (2006)

Grob and McGregor (2005) mentioned that procurement that is concerned with the sustainability concept must integrate the sustainability principle within its practices. They also highlighted that there must be policies that encourage environmental obligations, such as the laws, regulations, contract, industry standards or internal policies. It is also essential

for a green procurement to be supported by their evaluation mechanisms or use available external tools to make sure they meet minimal compliance requirements. Apart from that, their findings indicated that most important is the purchase of materials, and that services must be based on pre-determined environmental criteria by the project team (refer Figure 2.8).

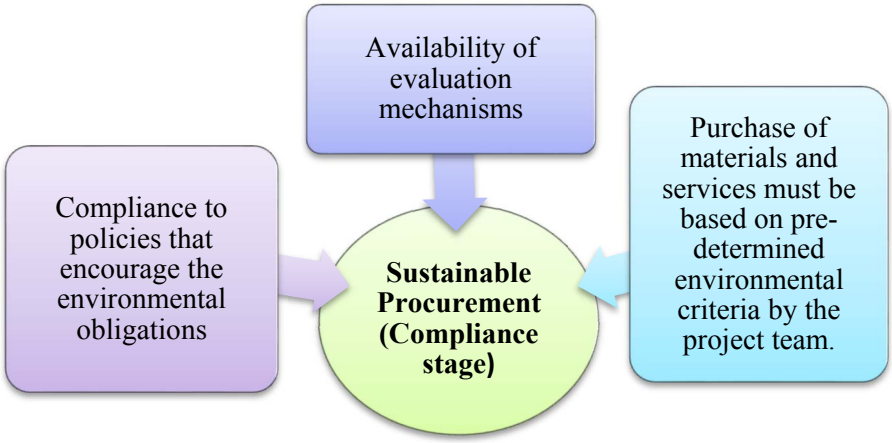

Figure 2.8 Compliance phase for sustainable procurement
Source: Author's illustration based on Grob and Mcgregor (2005)

Based on Pun (2006) supported by categorical factors that determine the green orientation of procurement, further exploration of the literature was made on these three main factors as follows. It should be noted that the review aims to seek to identify and compile the current practices to create a general list of green procurement practices in Malaysia as a requirement to achieve objective number 1 of this research.

Policies and guidelines

Green polices and guidelines aim to encourage the environmental obligations, whether they arise from laws, regulations, contract, industry standards or internal policies. Past studies indicated that green policies and guidelines are the important determinant for an organisation's green direction (Bratt, 2011, ElTayeb et al., 2010, Testa et al., 2012, Walker and Brammer, 2009 and Zhang et al., 2000). Bakir (2013) conducted research to determine the factors for green procurement for the Singapore government. Their research revealed that eco-labelling, ISO 14001, product design and life cycle analysis is a critical determinant

for environment procurement orientation in Singapore. Similarly, Adham (2014) has proven that policies and guidelines are an important factor in driving green adoption in an organisation. Adham conducted research to explore the current practices of green government procurement in Malaysia.

Some previous studies have revealed that industry standards, such as the Environment Management System (EMS), International Organisation for Standardization (ISO) 14001 certification and green labelling, act as green guidelines. These create a dynamic role in embedding green practices throughout the process (Bratt, 2011; Testa et al., 2015). EMS and ISO certification help in informing that the organisation is operating within the environmental requirement. Eco-labelling is an effective way of informing consumers of the green impact of products based on achieved, prescribed environmental standards, so that they can make informed purchasing decisions (Li and Geiser, 2005 and Bratt, 2011). The establishment of comprehensive building performance assessment, such as rating tools, also functions as the guideline for the practitioner to produce a green construction. The checklist has environmental criteria against which building performances become resources of reference to plan their green project delivery as well as the establishment of project green criteria and specification (Sood et al., 2011; GBI, 2015).

Policies on environmental rewards and incentives suggested by Ofori (2006) identified as the effective tool for the sustainability-related practices. Zhu et al., 2013 highlighted that it is important to increase the knowledge on the incentives and rewards to increase the effectiveness towards green procurement. Renukappa et al. (2013) suggested that the reward could be in term of monetary and non-monetary. The non-monetary reward refers to the public recognition through press releases (Renukappa et al., 2013) and green award (Adham, 2014). However, Zhu et al., (2013) also highlighting that the incentives and reward systems could have a negative relationship in the adoption of some specific procurement practices such as supplier monitoring based on the study conducted in China.

Various studies have suggested the importance of defining the term “green” within the project context to ensure that all project stakeholders are working on the same objectives (Hes, 2005; Marcelino-Sádaba, González-Jaen, and Pérez-Ezcurdia, 2015; Zhang et al., 2015). Providing a clear direction helps each party to discharge their tasks efficiently based on the main project goals. For a better result, the formulation policies and guidelines at the project level need to be formulated, to cater for project needs and limitations. For example, a project must have their own definition of green orientation and the extent of the practices

that they expect in the project delivery. As revealed by Soumari (2008), failure to identify the green needs and extent of practices will lead to the green procurement adoption failure. Green interpreted differently, and its priority, depends on the project objective. Thus, a project needs to generate a green indicator that will be the basis of planning decisions and decisions made for procurement delivery. To summarise, the potential green procurement practices under policies and guidelines are listed in Table 2.3.

Table 2.3 Green procurement practices under policies and guidelines

Policies and guidelines	Key references
Formulation and enforcement of government regulation and law	*(Appolloni et al., 2014; Bakir, 2013; Pun, 2006; Field and Ofori, 2006; Harty and Laing, 2009; Liu et al., 2012; Meehan and Bryde, 2011; Qi et al., 2010)*
The industry standards (e.g., Code of practice, eco-labelling, EMS, ISO 14001, environment rating tools etc.)	*(Bratt, 2011; Elforgani and Rahmat, 2011; Li and Geiser, 2005; Sood et al., 2011; Testa et al., 2015)*
Policy on incentives and reward (e.g. tax exemption, sustainable leader award)	(Adham, 2014; Renukappa et al., 2013; Zhu et al., 2013)
Formulation of policy and guidelines at project level to suits project needs and capability	*(Hes, 2005; Marcelino-Sádaba et al., 2015; Yang and Zhang, 2012; Zhang et al., 2015; Soumari, 2008).*

Source: Author's compilation

Integration of green concept for the product and process

As mentioned previously, greening the procurement means recognising and integrating the principle of green into the procurement process and throughout procurement phases. There are a few practices that have been identified that are listed below;

1. Project green specification

In the sustainable construction framework proposed by Hill and Bowen (1997), environmental indicators should be included in the project specifications and contract documents. A green specification is simply identified as having the 'greenness element' in the project through tender or contract requirements (Nissinen et al., 2009; Lam et al., 2009). Green specification aims to provide an adoption guideline of green practices to achieve a project's green performance. The green specification is a set of contractual requirements incorporating environmental practices, including the social and economic aspects. In other words, green specifications should be a tool to green the process as set out in the World Commission on Environment and Development report (WCED, 1987). Green specifications are part of technical specifications that have stipulated a detailed description of the characteristics that the product or service must perform (European Commission, 2004a), such as the material selection, chemical content and functional characteristics of products (Bouwer et al., 2006).

The green specification can be the basis for projects as standard environmental purchasing criteria. Nissinen et al. (2009) produced a checklist for environmental criteria and divided the list into three categories: (i) qualitative selection criteria, (ii) technical specification and (iii) award criteria. Qualitative selection criteria include the availability of specific environmental management measures (EMM), environmental policy, environmental management system (EMS), environmental training and level of knowledge. The technical specification commonly addresses obligatory requirements such as eco-label criteria, energy use, recycle program and environmental impact assessment (EIA).

2. Purchasing green product and services

The purchasing of green products and services is complicated and requires commitment to green delivery throughout the entire process (Niesten and Lozano, 2015; Seuring and Müller, 2008). The purchasing and producing of green materials and services needs to collaborate with suppliers as well the sub-contractors to ensure better green project efficiency.

Most green certification urged the green building to reuse materials to decrease demand for virgin materials, reduce the creation of waste, and reuse recycled materials during production. Ofori (2000) suggested that the products purchased must be environmentally

friendly and disclose their environmental attributes. According to Ofori (2000), the purchasing of these environmentally friendly products could be guided by eco-labelling. Product eco-labelling shows that a product has achieved the prescribed environmental standard and informs consumers that the product is environmentally sound (Li and Geiser, 2005). Eco-labelling helps the purchaser to make a decision by identifying the green impact of products (Bratt, 2011). Examples of such labelling are Energy Star (USA), Environmental Choice (New Zealand) and Green Mark (Singapore) (Nik Abdul Rasyid, 2009).

From a policymaker perspective, eco-labelling may serve as a guideline to substitute products with high impacts on the environment for products or services which have a lower impact on the environment (Bratt, 2011). Thus, eco-labelling should be mandatory in establishing procurement criteria to support greater participation from the industry to produce green products and services (Grolleau, Ibanez, and Mzoughi, 2007). This labelling also acts as a guide in assessing the products to create benchmark criteria for evaluation, and scoring depends on the project requirement. The benchmark criteria can be categorised as a basic requirement, advanced requirement and spearhead requirement. Basic requirement refers to criteria that are easy to verify and could be met by many products in the market. Meanwhile, advanced requirement refers to the criteria that set higher demands for environmental performance. The spearhead requirement refers to the criteria developed for procurers who wish to procure the environmentally best alternative that the market has to offer (Bratt, 2011).

3. Green cost

The cost for incorporating sustainable design elements will depend greatly on a wide range of factors such as building design, project location, local climate, site conditions, and the familiarity of the project team with sustainable design. As mentioned by Morris (2007), there is no single answer to a question “What does green cost?” Morris (2007) suggested that to analyse green cost it depends on the good cost planning with a clear value supported with a committed project team and can be delivered in a cost-effective way. Sustainability goals, and budgets must be decided during the project planning.

There are two types of green purchasing; First is known as price preferences, which is when the client is willing to pay extra for green products (Marron, 1997; Oosterhuis, 2003). Second are set-asides, which is when specific minimum targets for green purchasing are developed. A distinction can be made between mandatory requirements and evaluating

factors (Faith-ell, 2005). Mandatory requirements need to be fulfilled in order to be rewarded and the evaluation is usually based on the highest environmental standard. This evaluation is based on the so-called evaluating criteria. The relationship between economy and environment also discussed through the concept of the most economically advantageous tender and value for money (Nissinen et al., 2009; Palmujoki, Parikka-alhola, and Ekroos, 2010).

4. Life cycle analysis (LCA)

LCA was first discussed in the 1970s at the Midwest Research Institute in the United States (Klöpffer, 1997). LCA measures the environmental impact of materials and products throughout the product and services life cycle such as fabrication, usage, and end-of-life options (Hendrickson et al., 1998). LCA has three components: inventory analysis, impact analysis and improvement analysis (Pun, 2006; Klöpffer, 1997). In inventory analysis, extensive information pertaining to materials recorded includes the production process, usage of energy and waste management. Impact analysis discloses quantitatively and qualitatively the product's adverse impact on the environmental impacts such as pollution (Pun, 2006). In building construction, LCA considers the performance of the building through its life including individual elements, which will affect the overall benefits when used together (Pitt et al., 2009). Infrastructure project development can be divided into five key phases: planning, design, construction, operation, recycling and disposal (Trigunarsyah and Skitmore, 2010). It now can be seen that using LCA in evaluating products is beneficial for the environment as well as the project.

5. Waste Management

Waste management includes the collection, removal, processing, and removal of materials that are solid, gaseous, liquid, or even hazardous, which are generally produced through human activity (ecolife, 2012). Obviously, the issue of construction waste is regarded as a global problem and the incorporation of sustainable construction principles into waste management is identified as the effective way to control waste problems (Nagapan et al., 2012). Legislation and policy can be supportive tools in adopting sustainable waste management as a way forward in handling construction waste. The literature also suggested that the waste management should also include the reverse logistic concept, where the product used was returned to the focal company with the intention to properly dispose of

the products, as well as potentially create value through recycling and reusing the material (Bakir, 2014; Ashby, Leat and Hudson-smith, 2012). Reuse of materials in construction context can be in term of reuse the materials for the project or transferred to other projects such as the reuse of project hoardings, concrete framework, bricks etc. Reuse of materials could reduce the amount of waste dumped into landfills. In Bakir (2013), the material packaging also is highlighted as important due to its contribution to the waste stream. Packaging of materials includes the primary packaging (normally contact with the goods), secondary packaging (larger packaging such as boxes to carry the goods) and tertiary packaging (packaging used to transport of large quantities of goods).

6. Green process and management

The project development process consists of multi-stages starting from inception to the disposal stages, which includes various stakeholders from different backgrounds and expertise. The practice of green construction as suggested by Hill and Bowen (1997) required the adoption of advanced technology including the introduction of electronic-based practices. The electronic-based practices are those such as e-procurement, e-project management and building information modelling. As revealed by Walker and Brammer (2012) collaborative communication throughout the project supply chain has a positive impact on the aspects of sustainable procurement and e-procurement practices; it is suggested as one of the practices that facilitates the aspect of environmental purchasing. Building information modelling (BIM) is introduced to considerably improve productivity and efficient management of information generated throughout the lifecycle of buildings more efficiently (Naoum and Egbu, 2015). A BIM approach will improve the quality of major changes in visualization, coordination and planning processes of the building (Grilo and Jardim-Goncalves, 2011). According to Harty and Laing, (2009), BIM is a digital based tool supporting the sustainability principles such as reducing the use of paper, promoting e-procurement, and collaborative communication.

To summarise, the potential green procurement practices under products and process are listed in Table 2.4.

Table 2.4 Green procurement practices under green product and process

Product and process	Key references
Green specification (e.g. green design, eco-labelling, green products, green cost)	*(Faith-Ell et al., 2006; Grolleau et al., 2007; Lam et al., 2009; Nissinen et al., 2009; Ofori, 2000; Ruparathna and Hewage, 2015b; Sterner, 2002)*
The application of the life cycle analysis (LCA)	*(Pun, 2006; Klöpffer, 1997; Bohari et al., 2015; Nissinen et al., 2009; Pitt et al., 2009; Sterner, 2002)*
Green process (e-procurement, e-tender, BIM)	(*Ahmad, Thaheem, and Anwar, 2015; Bynum et al., 2013; Grilo and Jardim-Goncalves, 2011; Hassan, 2014; Naoum and Egbu, 2015)*
Waste management principle (e.g. recycling, reverse logistic and on site waste management)	*(Bakir, 2013; del Río Merino et al., 2010; Nagapan et al., 2012; Yeheyis, Hewage et al., 2012; Zsidisin and Siferd, 2001)*

Source: Author's compilation

Environmental Evaluation

Monitoring and control are the most important processes with which to control quality performance in construction (Chua and Oh, 2011). Monitoring by developing benchmarks leads to the effectiveness of green adoption that helps to build the reliability of an organisation (Varnas et al., 2009). Project stakeholders need to review green progress and identify opportunities regularly throughout project delivery in order to achieve better green performance. The assessment is widely used to ensure its compliance with the guideline at various procurement stages such as design, tender, construction and completion. A clear measurement of performance will determine how well green progress has done and what improvements are needed to be made along the way. Some organisations have formal mechanisms to ensure compliance and to track non-compliance issues.

Table 2.5 Green building rating tools

Country	Rating tools	Year
United Kingdom	Building research establishment environmental assessment method (BREEAM)	1990
United States of America	Leadership in Energy (LEED)	1998
Japan	Comprehensive Assessment System for Building Environmental Efficiency (CASBEE)	2001
Australia	Green Star	2003
Singapore	Green Mark	2005
New Zealand	Green Star NZ	2006
Malaysia	Green Building Index (GBI)	2009
Indonesia	GREENSHIP rating tools	2009

Source: Author's compilation, adapted from Chua and Oh (2011), Ding (2008), Sood et al. (2011)

This requires policies and regulations by the government to be formulated and enforced efficiently. A few tools have been used to benchmark or as the basis of evaluation, such as the Life Cycle Analysis, the eco-labelling, the ISO 14001, and EMS. This industry standard, apart from acting as the reference and guideline, can also be used to benchmark certain expected levels of green performance. Legislative requirements are common external requirements that drive organisations towards sustainability (Adham and Siwar, 2012; Grob and McGregor, 2005). Qi et al. (2010) found that a government's environmental regulations and policies are a significant influence in the adoption of green practices. Policies and regulations must be in place, and more importantly, they should be effectively and efficiently enforced (Sood et al., 2011, Ruparathna and Hewage, 2015b). The policies will set a minimum standard for the builders or developers to follow. Local governing bodies must also play an important role in the execution of green building policies and regulation (Sood et al., 2011).

The most common practices mentioned in the literature are the third-party rating tools and assessment tools. The different between assessment tools and evaluation tools is that assessment tools are based on quantitative performance indicators, while rating tools determine the performance level of the building. There is still a limited number of assessment tools, but rating tools such as BREEAM, BEPAC, LEED and GBI (refer Table 2.5 for full definitions) are widely used in the industry. However, a common criticism addressed is that some assessment tools exclude or minimise the financial aspect in the evaluation framework, which did not support the principle of sustainable development in terms of economic aspects. The project may be environmentally sound, but very expensive to

build and the fact is that financial return is fundamental for all projects (Ding, 2008; Faith-ell, 2005). Most projects suffered the misconception of green building, whereby projects with green certification ended up more costly than normal building (Olubunmi et al., 2016). Post-project feedback helps to improve project future performance. Winch and Kelsey (2005) suggested the need for a project to have systematic feedback to be a basis for learning and improvement, especially during a planning process. Furthermore, benchmarks of industry best practices for sustainable construction help to define the expected requirements (Zimmermann et al., 2005).

It is important to define the desired performance requirements and the outcomes (Roos, 2012), for example, the opportunities and impacts of the selected materials. This environmental criterion also has to be integrated into procurement and contracts to ensure that it becomes part of the development (Sterner, 2002). Some organisations have formal mechanisms to ensure compliance and to track the non-compliance matters. Tender evaluation is one of the evaluation tools to examine environmental criteria based on the project's environmental requirement listed in the technical specifications (Varnäs, Balfors, and Faith-Ell, 2009). The technical specifications incorporating green criteria, however, should not create unjustified obstacles to an open competition. Previous studies focused on environmental demands in calls for tenders. However, they failed to reveal whether environmental criteria influence the final decision (Palmujoki, Parikka-alhola, and Ekroos, 2010). Also, the actual content of 'environmental aspects' in demand for calls for tenders is often undefined, and, therefore, not suitable as an award criterion (Bouwer et al., 2005; Paprika-Alhola et al., 2007).

Pre-qualification aims to select strictly stakeholders that are qualified to perform a task (Hatush and Skitmore, 1997) and preferred by clients to minimise the aforesaid risks (Palaneeswaran and Kumaraswamy, 2001). In this case, the selection of stakeholders includes the design team and the contractor team. ISO14001 and Environmental Management System (EMS) are the most common and globally used indicators to benchmark a qualified stakeholder or organisation pertaining to green practices. This instrument is used for environmental management and also to signal the firm's improved environmental performance to the stakeholders (Bouwer et al., 2006; Qi et al., 2011; Varnäs et al., 2009). However, Roos (2012) argued that the selection process must be kept simple to encourage participation from small and medium-sized enterprises in fostering fair competition. Further, Varnäs et al. (2009) suggested that the role of EMS in project-based construction organisations should be further investigated. As argued by Ammenberg and

Hjelm (2002), EMS does not guarantee high-level performance because it can be difficult to differentiate between contractors who can actually perform and who can produce promising documents (Faith-Ell, Balfors, and Folkeson, 2006).

To summarise, the potential green procurement practices under products and process are listed in Table 2.6;

Table 2.6 Green procurement practices under environmental evaluation

Environmental evaluation	Key references
Compliance with government regulation and law in term of environmental protection	*(Adetunji et al., 2008; Appolloni et al., 2014; Grob and McGregor, 2005; Qi et al., 2010; Sood et al., 2011; Walker, Di Sisto, and McBain, 2008)*
Benchmarking with industry standard (e.g., Eco-labelling)	*(Ofori, 2000; Varnäs et al., 2009)*
Project's internal audit (e.g., project green specification, tender selection)	*(Grob and McGregor, 2005; Nissinen et al., 2009; Shen et al., 2016; Sterner, 2002b; Varnäs et al., 2009)*
Encouraging and considering public feedback and opinion	*(Ofori, 2000; Qi et al., 2010)*

(Source: Author's compilation)

2.5.3 Stakeholder values as enabler for green-oriented procurement

In the temporary organisation setting, team members or stakeholders are important for ensuring projects meet the predetermined objectives. A successful project implementation demands a greater involvement and commitment of project stakeholders with a complex planning and execution. El-Gohary et al. (2006) stressed the point that the stakeholders can be a decisive factor that can "make or break" a project. Thus, meshing the needs to go for greener development and project stakeholders is very important (Morris, 1997). Past research has proved that the lack of awareness and understanding of sustainability issues among project stakeholders is the key barrier to adopting sustainability in a project (Samari et al., 2013; Wooi and Zailani, 2010; Zhang et al., 2011). Bakir (2013)

revealed the organisational value and stakeholder's value could help the sustainability agenda advance.

Stakeholder values were created as an individual factor and a guiding principle towards action (Deal and Kennedy, 1983). The value in this research refers to the organisational and individual level of commitment and capability towards the project's objective. Commitment by individuals in an organisation was regarded as a strong belief in the organisation goal and values. Stakeholders in the building projects came from different backgrounds of education and specialisation. They came from a different permanent organisation, being part of project's temporary organisation within a certain limit of time and with a specific mission. Each stakeholder is also being driven by individual interest and priority. Thus, it is important for the stakeholder to be able to understand their common interest in the project and build a strong commitment. This commitment should also include all categories of stakeholders, especially those who have the decisive power.

The capability is defined as "the knowledge residing in the routines of an organization to integrate and coordinate its specific resources, skills, and competencies to perform various activities" (Zollo and Winter, 2002). A study by Toor and Ogunlana (2008) pointed to categories' competence among the main critical success factors of a project, along with commitment and communication. Embedding green in the project delivery changed the way a project is being delivered. These stakeholders are expected to have complex bundles of skills and accumulated knowledge to adopt this change (Cole, 2005). Identification of new practices involving a skill or a routine can be made through learning (Winter, 2003). Learning in the context of individuals and organisations for effective performance has been strongly emphasised. Robichaud and Anantatmula (2011) proposed continual training throughout the project phases to make sure the project's green performance is achieved. Also mentioned by Qi et al. (2010), the organisation needs to have a management team who possesses a certain level of knowledge about environmental issues. Therefore, training on environmental issues should be an important practice.

Collaboration with other projects and external organisations such as the government and professional green facilitators can help the stakeholder's awareness and capability grow further. Learning within an organisation also can be achieved by knowledge sharing among the project team. Knowledge sharing refers to the social interaction main aims to exchange employee knowledge, experiences, and skills through the whole department or organisation

(Lin, 2007). Lin (2007) revealed that the individual factors, namely enjoyment in helping others and knowledge self-efficacy, are of the utmost value in encouraging knowledge sharing among the project stakeholders. Also, top management support is essentially important to encourage this knowledge sharing practices.

2.5.4 Summary of potential factors and practices for green-oriented procurement and green performance

Table 2.7 highlighted the possible green practices of building procurement. This list compiles the current green practices based on exploration in the literature and based on an internet search world-wide, aims to create a general list of green procurement practices in Malaysia. This list is further validated using preliminary interview (Chapter 4) and empirically tested using SEM AMOS (Chapter 6) to ensure the validity and reliability of each practices.

Table 2.7 Opportunities to integrate sustainable concepts into procurement practices

<table>
<tr><th colspan="2">Green practices for construction project (Refer Table 2.1)</th><th>Potential practices of green-oriented procurement (Refer Table 2.4,2.5 and 2.6)</th></tr>
<tr><td><u>Environmental Aspect</u>

• Reducing greenhouse emissions
• Reduce pollution levels
• Manage natural resources
• Waste Management</td><td>• Green design
• Selection of materials
• Sustainable site management
• Waste management</td><td rowspan="3">1. Formulated green policies and guidelines
• Formulation and enforcement of government green regulation and law
• Industry standards
• Policy on green incentives and reward
• Formulation of policy and guideline at project level to suits project needs and capability

2. Green products and process
• Green specification
• The application of the life cycle analysis
• Green process
• Waste management principle

3. Evaluation strategy to ensure compliance
• Compliance with regulation and law
• Benchmarking with industry standard
• Project’s internal audit
• Encouraging and considering public feedback and opinion

4. Stakeholder values
• Client commitment
• Project stakeholder commitment
• Getting support from supplier
• Project stakeholder competencies
• Stakeholder ability to understand bigger picture of green construction
• Pre-qualification based on past credentials in green construction
• Conducting in-house training/briefing
• Acquiring external collaboration or training
• Sharing experience among stakeholders in project</td></tr>
<tr><td><u>Economical Aspect</u>

• Value for money
• Green cost</td><td>• Green purchasing
• Consider lifecycle costs
• Internalise external costs
• Value for money</td></tr>
<tr><td><u>Social Aspect</u>

• Enhance a participatory approach by involving stakeholders
• Promote public participation
• Provide high customer satisfaction</td><td>• Improve quality and productivity
• Qualified stakeholders
• Integrated approach
• Public participation
• Project Image</td></tr>
</table>

2.6 GREEN PRACTICES FOR BUILDING PROJECTS: MALAYSIA CONTEXT

(Part of this section has been published in Bohari, A. A. M., Skitmore, M., Xia, B., Teo, M., Zhang, X., & Adham, K. N. (2015). The path towards greening the Malaysian construction industry. Renewable and Sustainable Energy Reviews, 52, 1742-1748).

2.6.1 Overview

Malaysia has been driven towards becoming an industrialised country since the 1980s (Kamal et al., 2012). According to the Population and Housing Census of Malaysia (2010), the total Malaysian population is approximately 28.3 million compared to 23.3 million in 2000; hence, creating more demand for development (Malaysia, 2010). Malaysia is currently described as having "upper-middle-income economy" (The World Bank, 2013) and is targeted to achieve high-income economy by the year 2020 (Adham and Siwar, 2012; Malaysia, 2010). Malaysia is one of the rapidly developing construction industries as mentioned in the Australian Business Council for Sustainable Energy (ABCSE) 2007 (Shari, 2011). Its construction industry recorded growth that is expected to rise by 4.4 percent per annum, benefitting primarily from construction-related activities (refer Figure 2.9). The Malaysian construction sector is projected to contribute 2.9 percent to the Gross Domestic Product by 2015 with 3.7 percent annual growth from 2011 to 2015.

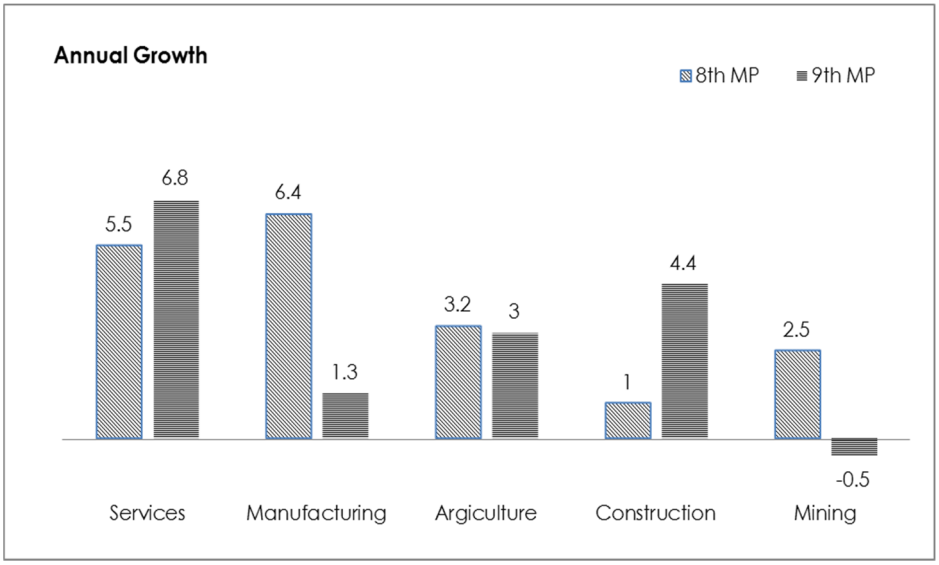

Figure 2.9 Sectoral performance under the Eighth and Ninth Malaysian Plan

Source : EPU (2010)

2.6.2 Greening Malaysian construction projects- policy and practice review

In greening the construction industry to overcome its adverse impact on the environment, industry must shift to a greener approach (Kibert, 2012) that requires the support of the various stakeholders throughout the industry (Adham, Merle, and Weihs, 2013). Kameyama et al. (2008) suggested that governments need to provide a platform to support the change in terms of formulating policies and guidelines. In Malaysia, the green approach focuses on reducing levels of carbon emission, encouraging energy efficiency and the use of green technology. Government formulated policies including The Malaysian five-year Development Plan, the NGTP, the National Energy Policy (NEP) and the National Policy on Climate Change (NPCC) align towards the sustainability agenda. The NPCC for instance, pushes industries as well as the construction sector in making extensive contribution in managing the infamous climate issue (Ding, 2008).

Another policy that was launched was the National Renewable Energy Policy and Action Plan (NREPAP) in 2010. Under this policy, all the refurbishment and renovation works for federal office buildings need to integrate energy efficiency technologies such as the use of solar PV in claddings. A special reward is offered by the government to other commercial building owners to encourage them to incorporate the energy efficiency practices. Every five years, the Malaysian government will announce their five-year development plans (see Table 2.8) where they highlight the need for sustainability (Kahlenborn, Mansor, and Adham, 2013).

Under the five-year Malaysian plan, the government shows their commitment by incorporating their mission and plan to work towards sustainable development. For instance, to encourage the awareness on environmental protection, environment management was introduced under the Sixth Malaysian Plan (6MP). One if the significant policies announced under the 9MP path towards a greater impact on environmental management is the National Green Technology Policy (NGTP). For the past development plan (10MP), the government enthusiastically addressed the importance of managing the environment to reduce the emission of greenhouse gases and conserve existing resources. In the most recent Malaysian development plan, the 11MP (2016-2020) government of Malaysia reaffirms their commitment towards a vision on the prosperity and improved wellbeing of its people. Specifically, it aims to have a resilient, low carbon, resource efficiency and social inclusion kind of development.

Table 2.8 Malaysian Development Plans – Environmental goals and impacts on the construction industry

Plan	Environmental goals	Impacts on the construction industry
Sixth (6MP; 1991-1995)	Efficient management of the environment to ensure a balanced development	• Mandatory legislative requirements for environment protection
Seventh (7MP; 1996-2000)	Integration of environment consideration in economic planning process for economic growth and environmental conservation	• Mandatory legislative requirements for environment protection • Introduction of Environmental management systems (EMS) consistent with International Organization for Standardization (ISO) 14001 certification
Eighth (8MP; 2001-2005)	Achieving sustainable growth by promoting the cleaner technologies and overall environmental management practices	• Introduction of Low-carbon Building Initiatives Malaysian Standard (MS1525:2001) • Formulation of National Strategic Plan for Solid Waste Management • Introduction of ISO 14001:2004 Environmental Management Systems
Ninth (9MP; 2006-2010)	Greater focus on pollution prevention and increasing environmental protection efforts with the establishment of key agencies and policy	• Formulation of NGTP (2009) (Green technology financing scheme, Green Township, Eco-labelling, Green procurement, and Life cycle costing) • Revision of Uniform Building By-Laws to incorporate MS1525:2007 and ISO • Introduction of IBS as cleaner technology • Introduction of voluntary rating tools (Green Building Index)
Tenth (10MP;	Massive transformation aims to turn Malaysia into a high-income developed nation and sustainable nation	• Economic Transformation Programme (ETP) • Introduction of Energy Management

2011-2015)		System (ISO 50001:2011) • Establishment of framework of the design process for energy saving single family residential/small commercial buildings • Introduction of energy-efficiency and the use of renewable energy for non-residential buildings – Code of Practice (2nd Revision) (MS1525: 2014)
Eleventh (11MP; 2016-2020)	Reaffirm the Government's commitment to a vision of growth that is anchored on the prosperity and wellbeing of its people.	• Towards advanced economy by 2020 that has a resilient, low carbon, resource efficiency and social inclusion matter

Source: Adapted from Bohari et al. (2015), p174.

The Malaysian Construction Industry Master Plan (CIMP) is a ten-year plan (2006–2015) paving the way towards sustainable construction. The blueprint document focuses on nurturing the awareness and improving performance including development sustainability (Ugwu and Haupt, 2007). The CIMP addresses the issues of sustainability by emphasising environment practices and aiming "to foster quality and an environmental-friendly culture" (Kahlenborn et al., 2013).

In September 2015, the government released another important document, the Construction Industry Transformation programme 2016-2020 (CITP 2016-2020), that aims to improve construction industry performance (CIDB, 2015). The CITP 2016-2020 underlined four strategic thrusts, the second thrust highlighting the strategic plan for environmental sustainability. The document highlighted that the current state of practices is inefficient and lead to environmental degradation. One problem highlighted under this CITP 2016-2020 is that the traditional way of delivering a project is not on the sustainable path that produced high carbon emissions and high-energy usage. The problem of waste is one of the main concerns. The CIPT 2016-2020 will prepare the platform to drive an innovative way to facilitate the industry to adopt sustainable practices. The key outcome as underlined under this program is in the large infrastructure in Malaysia that is meeting sustainability requirements and a reduction of the carbon level.

Policies need to be interpret in the context of each project's needs and capability to ensure successful implementation (Roy and Koehn, 2006). One example is the requirement

to minimise the energy usage as highlighted in the national policy of NEP and NGTP. The revised Uniform Building By-Laws Code of Practice (MS1525:2014) (second revision) was introduced to the construction sector as an effort to urge the industry to cooperate with energy efficiency in building requirements. Thus, the projects needed to discuss this requirement as part of their project requirement and plan a strategy to achieve the requirement within project needs as well as their capabilities and limitation.

Based on a review of the current policies in Malaysia, this research has identified a number of potential green practices that can mitigate the adverse effects of construction in Malaysia as follows (refer Table 2.9). This table has been published in Bohari et at., (2015) and updated with recent policies and guidelines announced by the government.

Table 2.9 Green practices in Malaysia

Green Practices	Description and Potential Impacts
ISO 14001:2004 and Environmental Management Systems (EMS)	"This instrument was mentioned in the 7MP is used as part of the environmental management within construction projects or companies, and also provides a signal to stakeholders that the firm has improved environmental performance (Qi et al., 2011; Testa, Annunziata, Iraldo, and Frey, 2014; Varnäs et al., 2009). It has been recognised globally and plays an active role in ensuring green practices throughout the development process."
Uniform Building By-Laws (UBBL) Code of Practice (MS1525:2001)	"The UBBL Code of Practice was introduced under the 8MP to provide basic guidelines on green design for non-residential buildings with the aim of highlighting the concepts of energy efficiency and low-carbon construction. It necessitates every project to comply with its requirements in order to obtain building plan approval by the authority. Under the NGTP, the existing UBBL was revised to seek a more sustainable living environment with the use of green technologies in buildings. In the current 10MP, the UBBL Code of Practice (MS1525:2014) (2nd revision) introduced the requirements of energy efficiency and the use of renewable energy for non-residential buildings. Under the latest CITP 2015, there is an urgency to reduce waste during construction for nation's environmental sustainability (CIDB, 2015)."

Waste management	"Waste management is one of the priorities that have been highlighted in order to achieve environmentally-friendly development. The National Strategic Plan for Solid Waste Management was launched since the 8MP and urged every organisation to practice sustainable waste management. The Malaysian construction sector reported a 5 percent productivity growth in 2013 supporting the prediction that the rate of construction waste generation will continue to increase. Practices such as the recycling of materials (e.g. formwork for concrete works, environmentally-friendly packaging and efficient waste management on site) should be underlined as mandatory requirements in project implementation."
Green labelling	"Green labelling helps the stakeholders to identify green products and assists in formulating green specifications for a project, as highlighted under the NGTP. Through the Standards and Industrial Research Institute of Malaysia (SIRIM), the Malaysian Government is also developing eco-labelling for local products which will be internationally recognised in support of green procurement (Hussin et al., 2013). To support greater participation of the industry in the production of green products and services, green labelling should be mandatory in establishing green criteria (e.g. selection of construction materials)."
Green technology	"Under the NGTP, the Industrialised Building System (IBS) was introduced as a green technology that helps to improve the current environmental problems in the construction industry (e.g., through increased site cleanliness). The IBS Roadmap 2011–2015 focuses on encouraging the involvement of the private sector in adopting IBS in construction. According to Oostra and Claeson-Jonsson (2007), the IBS has been successfully implemented in many parts of the world including Japan, the UK, Sweden and the Netherlands. The CITP 2015 encourages acceleration in the adoption of IBS, mechanisation and modern practices that supporting the green technology (CIDB, 2015)."
Voluntary rating tools	"As suggested by Lehtiranta et al., (2010) the focus on the green concept is not only relevant in the construction stage but is continuous

	throughout the entire process. It has to be initiated as early as the strategic planning stage and continue to the project implementation stage. The Green Building Index (GBI) is similar to established assessment and rating tools around the world such as BREEAM, BEPAC, LEED and HK-BEAM. The GBI was developed specifically for the Malaysian tropical climate, with consideration of its environmental and developmental context, as well as its cultural and social needs (Hussin et al., 2013). It is a voluntary rating system for environmental assessment that is used to assess the environmental design and performance of Malaysian buildings."
Green procurement	"Green procurement initiatives commenced under NGTP (2009) through the *MyHIJAU* program. Greening the procurement process means to recognise, integrate and implement environmentally-friendly practices throughout all the processes. For construction, green procurement has been recognised as a vital tool to manage environmental issues. Practising green procurement means that organisations should commit to minimising the environmental consequences of construction activities. It underlines the practice of acquiring a selection of products and services that minimise environmental impact and also requires the assessment of the products at all the various life cycle stages. This green practice also extends to the impact on social performance regarding creating awareness and promoting green efforts. In Malaysia, the mechanism is to be developed under MEGTW and the Ministry of Finance. The Government Green Procurement (GGP) Short-Term Action Plan (EPU, 2014) paves the way towards Malaysia's long-term GGP strategy. The National Sustainable Consumption and Production (SCP), Policy framework, will be in the form of the SCP Blueprint and input to the 11MP (2016–2020)."

Source : Adapted from Bohari et al. (2015), p1746

2.6.3 Green project progress in Malaysia

From the perspective of environmental responsibility, buildings are one of the key sources to reduce carbon emissions around the world (CIDB, 2015). In Malaysia, commercial and residential premises consume 15 percent of total energy (Malaysia Energy Statistic Handbook, 2014) (Suruhanjaya Tenaga (Energy Commision), 2014). Malaysia has begun to embark on "building green" to produce green buildings by establishing and supporting green policies and strategic planning. The National Green Technology Policy (NGTP) announced under the 2009 Ninth Malaysian Plan (Bohari et al., 2015), is a statement of the Government's urgent need to implement "green" initiatives. The National Renewable Energy Policy and Action Plan (NREPAP) was launched in 2010, making the use of building-integrated renewable energy a requirement in upgrading federal government buildings and providing special rewards for commercial and agriculture building owners integrating renewable energy technologies (i.e. solar photovoltaics in building claddings) into their new or refurbished buildings. The CITP urged for an innovative approach to sustainable construction facilitating industry adoption of the sustainable practice. It also urged that the industry drive compliance to environmental sustainability rating and requirement (CIDB, 2015).

Initiatives in the Tenth Malaysian Plan (10MP) 2011-2015 include the development of environmental sustainability such as in green townships, starting with Putrajaya and Cyberjaya (Bohari et al., 2015). The Government has also introduced the "Revision of the Uniform Building By-Laws" to incorporate the "Malaysian Standard: Code of Practice on Energy Efficiency and Renewable Energy for Non-Residential Buildings (MS1525)". Every new project must meet the minimal requirements stipulated in the MS1525 to obtain building approval. Specifically, the government encourages the application of renewable energy and energy efficiency in buildings, such as solar photovoltaics and rainwater harvesting in the projects.

Regarding green building development, Malaysia is progressively improving. According to the Green Building Index executive summary in March 2016, there were 350 Green Building Index certified projects. However, only 15 projects, around 4 percent of the total number of approved projects, have platinum certification. Regarding geographical distribution, most projects are located in central Malaysia, such as in Kuala Lumpur and Selangor (GBI, 2016). In the recent Eleventh Malaysian Plan (11MP) 2016-2020, a few additional strategies were introduced for green growth. One such strategy aims to enhance

shared responsibility through comprehensive communication, education and awareness programmes, and platforms for knowledge sharing. The 11MP also focuses on strengthening governance to drive transformation through the regulatory and institutional framework. These two strategies aim to tackle the difficulties based on those experienced during the pilot implementation process (SCP Malaysia, 2015).

Malaysia introduced the GBI in 2009 as a voluntary environmental rating system for buildings. The Green Building Index (GBI) is the first voluntary rating system for evaluating the green performance of a building in Malaysia. There are several categories of GBI certification depending on the type and function of the building assessed. Buildings included under the GBI Assessment Criteria for Non-Residential Existing Building (NREB) are factories, offices, hospitals, universities, colleges, hotels and shopping complexes. It is adapted from existing rating tools, focusing on the rating tool produced by the Singapore government, known as Greenmark, as a tropical weather country and modified to suit the Malaysian context.

According to the guidelines issued by GSB (2011), GBI has six main criteria as listed below and each criterion is weighted with the score. The building rating is awarded based on the scoring derived from the GBI checklists below;

- Energy Efficiency (38 points);
- Indoor Environment Quality (21 points);
- Sustainable Site Planning & Management (10 points);
- Materials & Resources (9 points);
- Water Efficiency (12 points); and
- Innovation (10 points)

The score indicates the greenness of the building; the higher the score, the higher the greenness of the building. For a platinum certified building, the score must be above 86 points, a gold certified building is between 76 and 85 points, a silver certified building is 66 to 75 points, and a certified building is within 50 to 65 points. However, as mentioned previously, the current rating tools may produce environmentally sound buildings, but they do not consider the financial impact to build, whereas the financial impact is one of the important concerns in a project (Faith-ell, 2005; Ding, 2008; Siew, Balatbat, and Carmichael, 2013). Most projects suffered the misconception of a green building, whereby projects with green certification ended up more costly than normal buildings (Olubunmi et al., 2016).

2.6.4 Green procurement the current progress in Malaysia

Green growth is a concept that has been interpreted by the World Bank as:

> *"Growth that is efficient in its use of natural resources, clean in that it minimises pollution and environmental impacts and resilient in that it accounts for natural hazards and the role of environmental management and natural capital in preventing physical disaster."* (Bowen, 2012, p 8)

There are clear indications that Malaysia is very eager to embark on the path of sustainability. As stipulated by the Malaysian Prime Minister, for instance, in the recent 11th Malaysian Plan (SCP Malaysia, 2015), green growth is both a headway and a necessary ingredient of an advanced nation. The development of strategies designed to engage green growth also indicates that Malaysia is very keen to be on the path of sustainability. Sustainable consumption and production are one of the strategies undertaken by the government. It is a concept that stimulates economic growth without compromising the environment or risking the needs of future generations. In the Malaysian context, green procurement was introduced in the Tenth Malaysian Plan (Musa et al., 2013). The Ministry of Energy, Green Technology and Water (MEGTW) or in Malay terms known as Kementerian Tenaga, Teknologi Hijau dan Air (KeTTHA), together with the Ministry of Finance of Malaysia (MoF), is responsible for green procurement adoption in Malaysia. The term green procurement in the context of Malaysia under myHIJAU programme is defined as;

"Procurement activities of products, services and works considering environmental criteria and standards that conserve the natural environment and resources, which minimizes and reduces the negative impact of human activities." (SCP Malaysia, 2013, p.6)

The definition of SCP Malaysia has been the basis for every industry to guide their procurement system towards a greener path. Green procurement in Malaysia currently focuses more on environmental impact, and this has prompted the industry to procure more sustainable products and services (Adham and Siwar, 2012; Kahlenborn, Mansor and Adham, 2013). A few initiatives exist to encourage the public and private sectors to adopt green procurement in their procurement systems, such as the eco-labelling and green supplier data directory produced by KeTTHA. Malaysia has launched some pilot projects under the umbrella of a short-term action plan as a preliminary step towards green procurement. The

government has also issued instructions and circulars on the need to obtain the best value for money in any government procurement. The costs other than primary investment, such as energy costs, should be taken into consideration (Kahlenborn et al., 2013).

Although the green procurement objective, strategy and mechanism are available in government strategic planning, studies of the actual delivery and practice of green procurement have not yet been conducted in Malaysia. For the construction industry, specifically, there are currently no specific guidelines on green procurement. Although "building green" is a major priority, knowledge of green procurement is unclear and fragmented (Ding, 2008).

2.6.5 Benchmarking Malaysia with selected Asian countries; green procurement progress

In the CITP 2016-2020, the government of Malaysia revealed that Malaysia aims to be a model for sustainable construction in other developing countries (CIDB, 2015). Malaysia has pledged to be on the sustainable path and reduce the level of carbon emission per GDP by 40 percent, measured from the 2005 level by the end of the 11MP cycle (UN climate change conference, 17th December 2009). One of the focuses is establishing sustainability requirements within the procurement process for every public building and infrastructure (CIDB, 2015). In the Johannesburg Full Plan of Implementation Chapter III, it is stated that a government should consider integration of environmentally sound goods and services in their decision making on planning, investment and public procurement (OECD, 2003; Faith-ell, 2005; McCrudden, 2004).

Green purchasing practices have operated with support from respective governments all over the world (Li and Geiser, 2005). Malaysia can draw from the experience of other countries in implementing a green procurement dictating strategy. According to Ho, Dickinson, and Chan (2010) and Adham (2014), Germany has implemented green procurement since the 1980s, the Netherlands and Denmark respectively in 1991, the United States in 1993 and Canada in 1995. Nowadays, more countries, especially the developed countries, have a national policy on green procurement and have benefited in terms of economic, social and environmental improvement (Bouwer et al., 2005). Considering the similar climate among the Asian countries, this study complied with the green procurement practices among the Asian countries (refer table 2.10). In Asia, countries such as Singapore,

Japan and South Korea are categorised as developed countries that have successfully been adopting green procurement. Some developing countries are still on the same path as Malaysia in term of progress on green procurement, such as Thailand and Indonesia (Ho et al., 2010).

The following Table 2.10 introduces and summarizes green purchasing strategies and practices implemented in selected Asian countries and thus, helps to benchmark Malaysia with other countries.

Table 2.10 Overview of the green procurement adoption in selected Asian countries

Country	Green procurement/purchasing	Launching	References
Japan	The law on Construction Material Recycling, Law on Promoting Green Purchasing, the Green Purchasing Law launched in May, 2000, by Japanese government. Government of Japan developed green procurement policy, implementation plan and published GGP guidelines alongside with the product criteria. In 2007, the purchasing law was extended towards procurement of services and in 2008, Basic Policy for the Promotion of Procurement of Eco-Friends Goods and Services became the basis for green procurement at national government level.	2001	*Ho, Dickinson, and Chan (2010); JFS (2004)*
South Korea	Green Purchasing Law (July 2005) authorises the Ministry of the Environment to set up "Purchasing Guidelines for Environmentally-friendly Products", and directs public agencies to prepare and announce	July 2005	*IGPN (2010); Ho, Dickinson, and Chan (2010); Adham (2014)*

	purchasing strategy plans and initiatives and report on these annually		
China	From January 2007, the central government and provincial governments asked to give priority to environment-friendly products listed in a "green product inventory". The products list released in late 2006, include construction materials that have been approved by the China Certification Committee for Environmental Labelling. This green labelling marked the launch of Chinese Governmental Green Procurement (GGP) that guides and provides support for carrying out government procurement on Environmental Labelling Products.	2006 as part of China's 12th Five-year Plan on National Economic and Social Development	*OECD (2014)*
Thailand	NESDB produced important documents National Sustainable Consumption Strategy and the National Sustainable Production Strategy Green procurement as second component of SCP Policy. The objective of the second component of the SCP Policy Project is to promote Green Procurement among local authorities and, the private sector. The Cabinet Resolution of Thailand launched the Green Procurement Promotion Plan (G3P) on 22 January 2008, aiming to guide their	10th NESDP 2007-2011 in 2009	*Switch Asia (2016a); Adham (2014)*

	government purchasing towards green purchasing.		
Indonesia	National 10-year framework programme on sustainable consumption and production (10YFP) by the government of Indonesia under the Ministry of Environment and the Ministry of National Development Planning (BAPPENAS) including a policy for green public procurement. One of the sectors where the government is particularly active is sustainable buildings and constructions. The government is applying green public procurement practices in the building and construction area.	10YFP SCP Indonesia on 5.6.2013.	*Sri Handayani, Merle and Bauer, (2013); UNEP (2013)*
Vietnam	The Law on Green Procurement was launched in 2015. As stated in the document, Green growth strategy by public expenditure should lead the development and use of green economy standards. From 2015, all public works and projects should adhere to green economy standards: according to sectoral and professional composition, energy consumption, materials and eco-design should incorporate the effects of climate change.	2015	*Ty, Anh and Perera (2009); Green growth report (Prime Minister Decision on the Approval of the National Green Growth Strategy, 2012)*
Philippines	The promotion of green products has not boasted much success in the	N/A	*Switch Asia (2016b)*

	Philippines yet, despite instructions to all government agencies to rely on eco-friendly products for their procurement under the National Eco-Labelling Programme-Green Choice Philippines (NELP-GCP). The SCP Programme will strengthen collaboration between the private and public sector and focus on the implementation of Green Procurement in selected government agencies and Local Government Units (LGUs) and support to the Green Philippines eco-labelling programme.		

Source: Author compilation

2.7 GREEN-ORIENTED PROCUREMENT FOR BUILDING PROJECT INITIAL MODEL

Based on the literature review conducted, based on the Malaysian context and beyond, the initial green-oriented procurement for a building project in the context of the Malaysian construction industry has been identified in Figure 2.10. This model aims to explore the potential of green-oriented procurement practices and leads towards the establishment of green-oriented procurement practices for a building project in the Malaysian context. Also, this model aims to demonstrate how green-oriented procurement impacts on the overall project's green performance.

Based on the literature, there are three key aspects that determine GPO; policies and guidelines (POL), the environment evaluation (EVA) and green product and process (PP). POL is basically incorporating policies and guidelines given by government and industry as well as policies and guidelines formulated at project level. For EVA, it includes evaluation using external evaluation tools such as external rating tools and project internal compliance tools. Meanwhile, PP looks at the current green practices that are related to procurement of

building projects as suggested in the literature, such as the purchasing of green materials, eco-labelling etc.

There are two hypotheses posed by this initial model;

H1: Stakeholder values have a positive and significant impact on green-oriented procurement

The SV is hypothesised to significantly impact on the GPO. This second construct includes factors related to stakeholder values. Stakeholder values are regarded as an important enabler and a key to shaping the green-oriented procurement for any project. The stakeholder values are included under this construct, such as the stakeholder commitment, capabilities and knowledge-sharing practices.

H2: Green-oriented procurement has a positive and significant impact on a project's green performance

The dependant variable for this model is the intended green performance of a building project. The GPO is hypothesised to be significantly related to a project's green performance (GP). GP in this research is measured in terms of subjective indicators that show the level of acceptance, satisfaction and improvement. Although González-Benito and González-Benito (2005) stated that researchers use both subjective and objective measurements, due to limitations such as unavailability of actual financial data and the limitation of the actual green performance assessment, this research uses respondents' opinions based on their experience in green projects. Similarly, Bakir (2014) used subjective measurement in his research, due to the difficulty of measuring the objective performance due to conflicting goals between the organisations. Subjective evaluation that is used to measure a project's green performance has three indicators: environment, financial and social. These three indicators are well supported by previous research and the theories contained therein'.

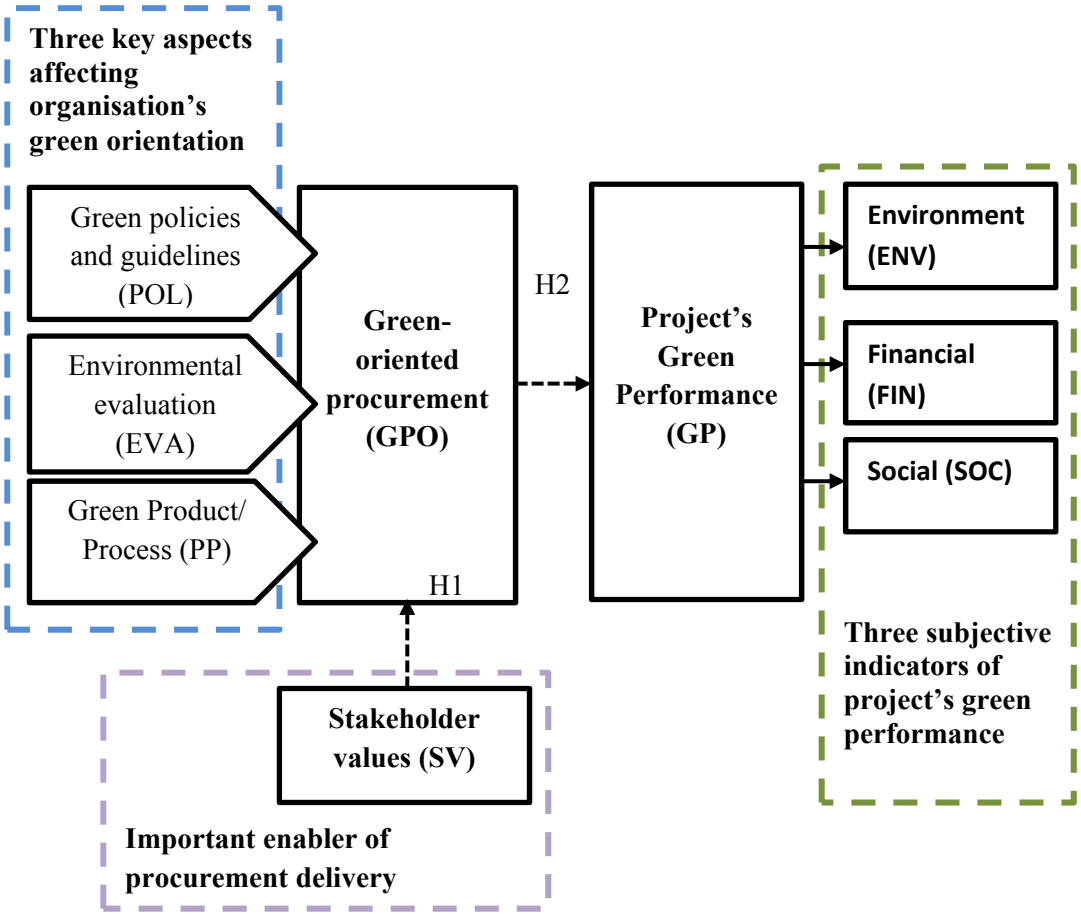

Figure 2.10 Initial model for green procurement for building projects in Malaysia

2.8 CHAPTER SUMMARY

The literature review was conducted as part of the methodology of the first phase of this research, the information gathering. Specifically, it provides a basis to answer three research questions as follows;

- Which practices are important, associated with green-oriented building procurement in Malaysia?
- Do these practices have any significant relationship with the performance of green project performance in Malaysia?
- How can project stakeholder use the identified key practices of green oriented procurement to improve project's green performance?

Building construction is the essence of development in every country, though, at the same time, it has an adverse impact on the environment throughout its lifecycle. There have been calls from international organisations and the government of Malaysia itself; that project delivery must incorporate environmental consideration to minimise its impact on the environment and in accordance with the Brundtland Report.

Based on the literature review discussed previously, green building procurement is a growing area of research. Previous studies discussed green practices separately, and so far, the focus has been on strategies to promote green building, assessment and rating tools, waste management and green technology. Currently, there is a limited research pertaining to green building procurement focusing on the building project and in the context of the Malaysian Construction Industry. In response to this, this research focuses on identification of factors and practices for a possible integration in building procurement in order to deliver a green project. This research contributes to a better understanding of the relationships between green practices, the stakeholder values and project's green performance. The research findings have the potential of providing a useful guideline, as a source of new information for construction stakeholders.

Therefore, this research argues that policies and guidelines, green product and process, evaluation process and stakeholder's values all have significant impact on the green orientation of a building procurement. Additionally, green building procurement will significantly affect a project's green performance.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 INTRODUCTION

Chapter 3 discussed the research design and methodology applied in this study, to explain and justify the methodology adopted. This chapter is divided into eight sections; Section 3.2 discusses the brief explanation of the research design and methodology adopted. Section 3.3 explains the research process and the protocol adopted in three phases of this research. The detailed discussion on research phase 1, phase 2 and phase 3 is presented in Sections 3.4, 3.5 and 3.6 respectively. Issues related to ethics are discussed in Section 3.7. Lastly, the selected research development process discussed before the summary encapsulates the discussion in this chapter.

3.2 UNDERSTANDING RESEARCH PHILOSOPHY, METHODOLOGY AND RESEARCH PLAN

To assist in meeting the aims and objectives of their research in the most appropriate ways, researchers need to adopt a research paradigm or philosophy. Keraminiyage, (2013) explains a comprehensive range of possible approaches through a modified model based on Saunder's Research Onion and Kagioglou's Nested Approach (Refer Figure 3.1).

The research paradigm or philosophy refers to the general approach or strategy used to conduct research. Crewell (2009) mentioned four different views of research paradigms that can be used in the field of modern social science research and can be applied when undertaking research (Saunders, Lewis, and Thornhill, 2009). Some research uses the postpositivist view (inductive, developed theory and qualitative), some use the positivist (deductive, quantitative data collection and interpretation) and some researchers combine both systems (mixed method), which is called a pragmatic worldview (Creswell and Clark, 2011). Pragmatism places the research problem in the central position and suggests reseacher applies all available approaches to understand the problem and find the necessary solution (Crewell, 2009).

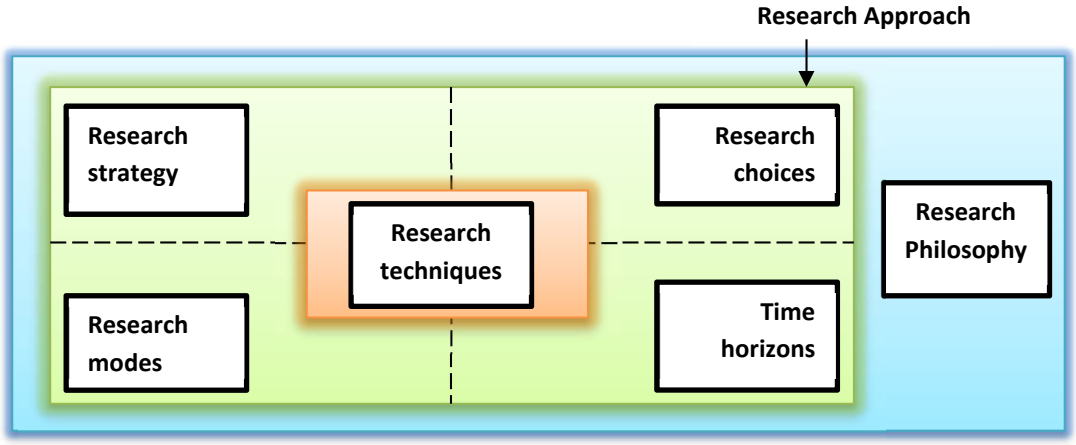

Figure 3.1 The modified model

Source: Keraminiyage (2013)

This research is carried out to deliver a possible solution to a practical problem, namely to improve the current procurement system for a green project, while the fundamental research normally focuses on generalisation of theory. According to Kothari (2005) and Creswell (2009) the approach undertaken by this research is an applied research. As pragmatism places "the research problem" at the central position, this research would be considered as pragmatic research. The researcher that holds this worldview will use multiple methods of data collection to best answer the question, and will employ both quantitative and qualitative data collection (Creswell, 2006) (Refer Table 3.2).

Creswell (2009) proposed that research based on pragmatism will collect both quantitative and qualitative data and integrate the data at different stages. Thus, this research seeks to explore the green-oriented procurement practices in the Malaysian construction industry to understand different situations and generate ideas for further empirical investigations. This research adopted qualitative data to investigate the "how" questions. At the initial stage, this research adopted the face-to-face interview among experienced practitioners to discuss and determine which practices were suited to the research context. The interview method selected allowed the researcher to directly communicate with experienced and knowledgeable practitioners to gain insights and suggestions, as well as take advantage of their valuable experience. A quantitative method was adopted to test the items to identify the most important factors and practices for green-oriented procurement and the impact on the project's green performance. Research questions posed include what (e.g. what

are the important factors and practices for green-oriented procurement) and how much (e.g. importance of each factor and practice, in influencing a project's green performance). Such information can only be obtained from the industry practitioners. Thus, a questionnaire method was adopted and distributed to the targeted respondents. A survey was used to answer research questions by gathering the facts from large-scale sets of data. This provides a systematic measurement, thus increasing the possibility of replicating the study.

The complete research approach of this research is illustrated in Table 3.1.

Table 3.1 Research approach

Research Philosophy	**Pragmatism**
Research strategy	**Survey**
Time Horizons	**Cross sectional**
Technique	**Interview and Questionnaire**

Based on the above discussion, a plan for this research project is developed as shown in Figure 3.2. Figure 3.2 illustrates the framework of the research process that guides all the steps undertaken by this research. The research process is divided into three main stages: Stage 1 information gathering, Stage 2 main data collection and Stage 3 model refining and validation. Further explanation on each stage is given in Sections 3.4, 3.5 and 3.6.

Table 3.2 Quantitative, qualitative and mixed methods approach

Items	Qualitative approaches	Quantitative approaches	Mixed-method approaches
Does the study tend to or typically use these philosophical assumptions	Constructivist/ Advocacy/ Participatory/ knowledge claims	Post-positivist knowledge claims	Pragmatic knowledge claims
Does the study tend to or typically employ these strategies of inquiry	Phenomenology, grounded theory, ethnography, case study and narrative	Surveys and experiments	Sequential, concurrent and transformative
Does the study tend to or employ these methods	Open ended questions, emerging approaches, text or image data	Close-ended questions, predetermined approaches, numeric data	Both open and closed ended questions, both emerging and predetermined approaches and both qualitative and quantitative data analysis
Does the study tend to or typically use these practices of research, as the researcher	• Positions himself and herself • Collects participants' meanings • Focuses on a single concept and phenomenon • Brings personal value into the study • Studies the context or setting of participants • validates the accuracy of findings • makes interpretations of the data • creates agenda for changes or reform • collaborates with the participants	• tests or verifies theories or explanations • identifies variables to study • relates variables in questions or hypotheses • uses standards of validity and reliability • observes and measures information numerically • uses unbiased approaches • employs a statistical procedure	• collects both quantitative and qualitative data • develops a rationale for mixing • integrates the data at different stages • presents visual pictures of the procedures in the study • employs the practices of both qualitative and quantitative research

Source: Cresswell (2009)

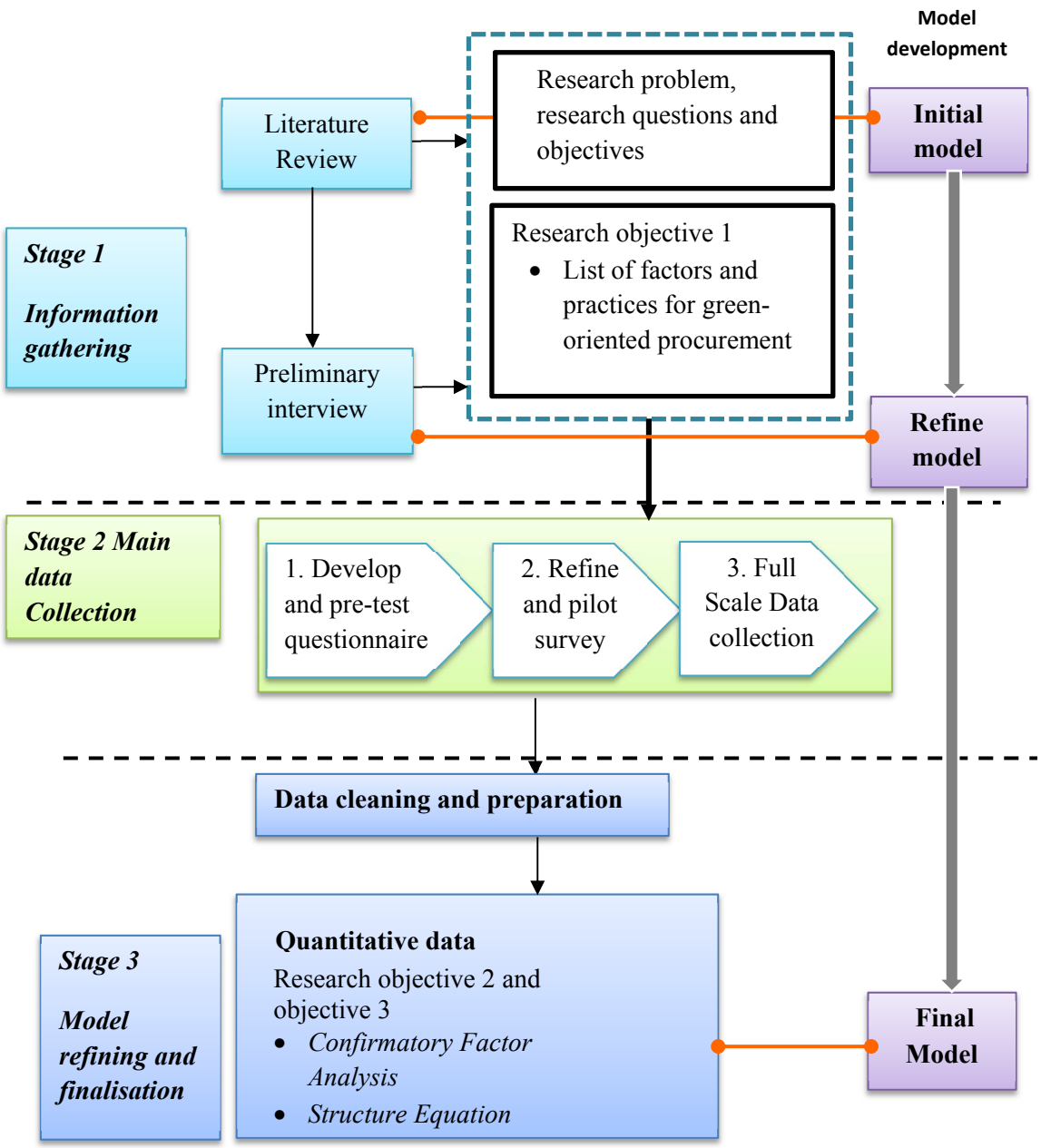

Figure 3.2 Research process

3.3 RESEARCH DEVELOPMENT STAGE 1: DATA GATHERING

3.3.1 Literature review

This stage is essential to identify the background of the research project and to provide some basic understanding based on the existing research. The purpose of the literature review is to understand the topic, identify the research problem and extend prior studies by providing a framework for establishing the importance of the study. This literature review was taken as an ongoing process that started from the identification of the research topic and ended at the cut-off date tentatively at model verification stage. Based on this, the research direction was identified and the research aim, questions and objectives are formulated.

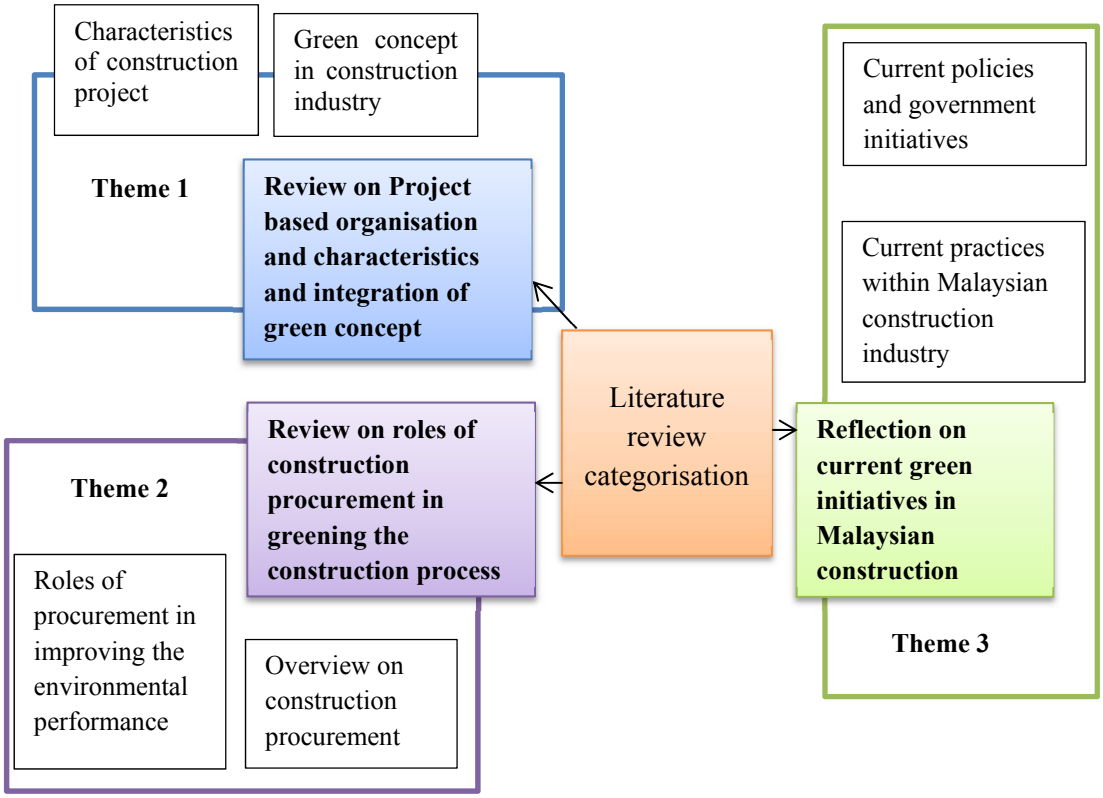

Figure 3.3 Literature review categorisation

The review was conducted, covering all relevant publications including academic and organisational reports. This stage was carried out through an understanding of topics, such as having insight about the concept of embedding green into construction projects and the roles of procurement to achieve environmental performance and the research environment (Refer Figure 3.3). From the literature, the green-oriented procurement concept, practices and characteristics were identified and confirmed, using the preliminary interview technique.

3.3.2 Preliminary Interview

Preliminary interviews are necessary to help the researcher to confirm, refine and rephrase the research problem and the factors derived from the literature. To grasp a better understanding of current practices and phenomena in the Malaysia construction industry, interviews are then conducted with experienced practitioners. Findings at this stage reveal nothing conclusive but may help in defining the problem and be used to improve the questionnaires being used in main data collection. As highlighted in studies including Perera et al. (2007) and Roy and Koehn (2006), the implementation factors involved vary according to local conditions and the unique needs of the Malaysian context. The key profiles of the interviewees are shown in Chapter 4 of this research. All the interviewees are those who are involved in green-certified projects under the voluntary Green Building Index (GBI) rating tools. Since the green building is still an emerging concept in Malaysia, their experience is very valuable for future guidance and improvement. The interviewees are the key stakeholders involved from the planning stage to project hand-over.

Data were collected using face-to-face semi-structured interviews at a place and time predetermined by the interviewees. Potential interviewees were contacted to seek their agreement, and the objectives of the interview were explained by the researcher. Upon receiving verbal consent, a pre-interview information sheet was sent by email, highlighting what to expect at the interview and seeking agreement to proceed further. The interviews were conducted face-to-face and took 30-40 minutes to complete. The questions were designed to allow interviewees to provide additional information and feedback; the main elements addressed being:

- The understanding of the “green” concept and sources of knowledge of environmental issues;

- The motivation to be involved in green ventures;
- The green practices of green projects compared to other types of projects;
- An open question for any other things the interviewee wished to add or discuss.

All the interviewees were assigned codes to protect their anonymity and the interviews were recorded and transcribed verbatim. The transcripts were proofread to ensure their validity. One of the interviews was conducted in the Malay language, with a back-translation process used to ensure the accuracy of the translation. A summary of the transcription was then emailed to the interviewee to ensure its accuracy and to ensure the meaning was within the context (refer Figure 3.4).

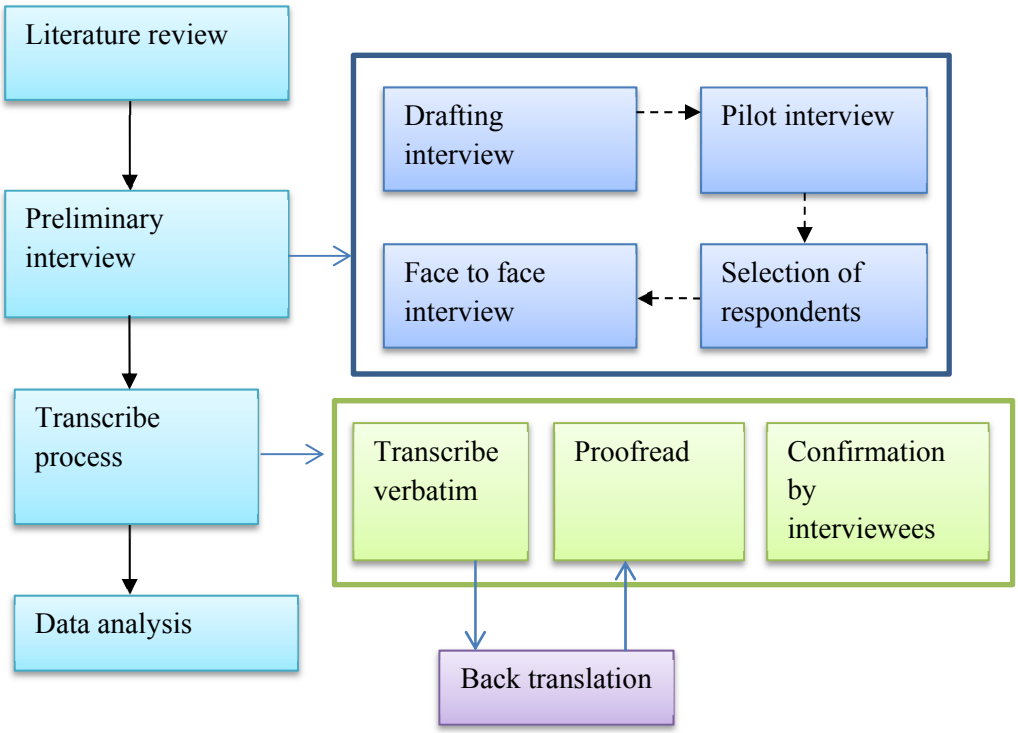

Figure 3.4 The preliminary interview process

3.3.3 Preliminary model development

Based on the literature review and preliminary interview, sixty-five lists of green practices of green-oriented procurement were identified and further validated through the preliminary interview with experienced practitioner in Malaysia. The interviews helped to refine and validate the lists and reduced the list of green practices due to factors such as insignificance and redundancy. The interviewees also proposed another ten new lists of

practices. The findings from the literature review and preliminary interviews became the basis on which to draft the survey instrument that was used in the second phase of this research, the main data collection phase.

3.4 RESEARCH DEVELOPMENT STAGE 2: MAIN DATA COLLECTION

This section outlines the specific criteria for respondents for main data collection of this research and the administration of the respondents.

3.4.1 Respondent selection

The selection of the respondents for this background study was based on their experience in the green building project at the planning stage, using a random sampling approach. The unit of analysis in this study is the internal stakeholders that were involved in the green building project during the planning stage, which includes the client, the project design teams, the quantity surveyors, the green advisors and some cases, the main contractor within the Malaysian construction industry.

Research produced a potential respondent list, complete with each mailing address and contact details such as email, and phone number. The researcher gathered information from various sources, such as publicly available information, internet searching and personal contact with the key person on the project. Based on the list, the researcher approached the potential respondents using a varied approach such as mail invitation, phone call and email to seek their cooperation. The mail invitation was randomly sent to the potential respondents' mailing address together with the English and Malay version questionnaire and a self-stamped envelope. For the online survey, potential respondents were approached through their email and given the online survey accessible address. The online survey was also designed as both an English and a Malay version. The respondent could choose to respond based on their convenience either using email, self-stamped envelope or through an online questionnaire.

The challenges faced are getting access to the respondents and securing their cooperation to participate in this survey. One of the ways to increase the response rate is to

get support from the industry key players such as the government and its statutory bodies such as the Public Works Department, the Construction Industry Development Board, the Sustainable Energy Development Authority Malaysia and the Malaysian Green Building Corporation. The researcher also applied for permission to conduct research in Malaysia from the Prime Minister's Office under the Economic Planning Unit. To convince the respondents, the researcher highlighted that the respondent's details and feedback would be highly protected to protect their confidentiality. Although a high return rate is essential for this research, the researcher understood that the respondents have a right to decide not to participate at any point in time during the data collection.

3.5 QUESTIONNAIRE DESIGN AND DEVELOPMENT

Term questionnaire refers to documents that include a series of open and closed questions, to which the respondent is invited to provide answers (Rowley, 2014). Questionnaires offer an objective means of collecting information about people's knowledge, beliefs, attitudes and behaviour (Boynton and Greenhalgh, 2004). There are three kinds of research such as profiling and descriptive research, predictive and analytical research and lastly, developing and testing measurement scales (Rowley, 2014). This research aims to generate a profile of the samples by which to examine key factors of green-oriented procurement for building projects by posing some questions, around what they do and what they think. This research also aims to understand the impact of the variables that might influence green performance.

Questions were formulated based on findings derived from the previous stage, the literature review and preliminary interview. In this research, a questionnaire was developed through three stages, pre-drafting process, piloting stage and finalising stage. Pre-drafting stage was based on the literature and preliminary interview includes the drafting process that has been conducted carefully and compiled 85 variables and ancillary information such as respondents' demographic and project background (refer Figure 3.5). Closed questioning was chosen for this study because it's proven to be likely to increase response rate (Rowley, 2014). Questions were clustered under a few sections to ensure the respondents easily understood questionnaires.

The five- point Likert scale used in a previously established study by researchers (Adham and Siwar, 2012; Bakir, 2013; Salam, 2008; Walker and Brammer, 2009) in the

research area of sustainable procurement motivated this research in adopting this technique. However, this research adopted six Likert-scales where the additional scale is termed "Don't know." Selecting the 'don't know' option indicates the respondent's lack of knowledge, or lack of thought around an issue. A structured questionnaire consisting of a five sections design is shown in Table 3.3.

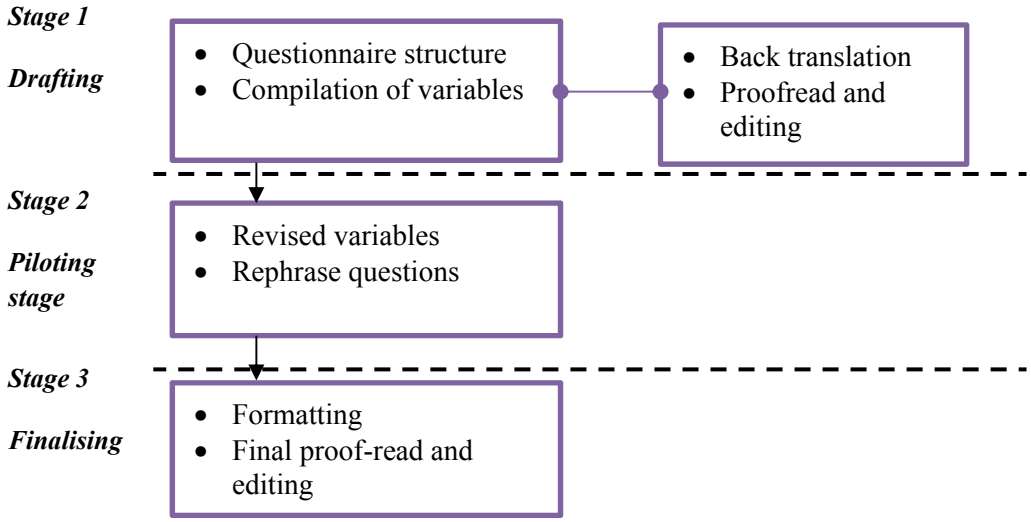

Figure 3.5 Questionnaire development process

This questionnaire was produced in English and Malay language due to differences in language used in the local context. Khalaila (2013) suggests translation from one language to other raises many equivalence issues, for cross-cultural research must be done with care, including the validity and reliability of the instrument. Translation equivalence indicates that the measurement instrument is interpreted similarly by respondents in different countries. The focus should be on constructing items in the local language that convey the intended meaning. Achieving translation equivalence is a very complicated process, especially since equivalent words may not be available in other countries (Steenkamp and Ter Hofstede, 2002) or a dictionary defines one word in a number of ways or terms in the target language (Khalaila, 2013).

This research adopted careful back-translation by bilingual techniques. In the back-translation method, the target translation is translated blindly back into the original language by an independent translator. In this procedure, translators are employed at two stages. One stage is translating from the source to the target language. The second stage is translating back the data from the target to the source language without knowing the original source

language version (the back translation) (Brislin, 1970). As suggested by Douglas and Craig (2007), the back-translation version is then compared with the original version in the source language to show translation accuracy. The two English versions were then compared for significant inaccuracies, to the extent that the researcher agreed that the two versions of the questionnaires were identical and had no errors in meaning. The discrepancies found were then corrected to produce the final version of the questionnaire (refer Table 3.4).

Table 3.3 Questionnaire sections

	Section	Description
1	Respondents demographic background	Gather information on respondent's demographic background i.e. academic qualification, professional background.
2	Project information	Seeking information related to project background i.e., type, size, location and client.
3	Perception of overall project's performance	Investigate participant's perception regarding project's green performance which includes the environmental, social and economic aspects.
4	List of green practices for building procurement	This section listed green practices for construction procurement that gathered from the literature and preliminary interview and were categorized in four main constructs • Policies and guidelines • Green product and process • Environmental evaluation • Project stakeholders' values.
5	Invitation to participate in the next stage of the research	This section invites the respondents to be involved in the next stage of the project.

Table 3.4 Back translation record

	Original version	**Malay Language final**	**Back translation 1**	**Back translation 2**	**Discussion with bilingual experts**
Section 1 Demographic Background (Q7)	Peer training	Latihan bersama rakan sekerja	Training with colleague	Co-worker training	Peer Training
Section 3 Environmental Aspect (Item 4)	Using Water recycling	Menggunakan kitar semula air	Using recycled water	Using recycled water	It should be "water recycling system."
Section 4. A.1	Government legislative requirement	Keperluan perundangan kerajaan	Government legislative requirement	Government regulatory requirements	The suggestion was made to incorporate both as "legislative and regulation" and translated as *Keperluan perundangan dan peraturan kerajaan.*
Section 4. A.5	Obtaining a green building Index rating	Memperolehi persijilan Indeks Bangunan Hijau	Obtaining Green Building Index position	Obtaining the Green Building Index ranking	It should be "Obtaining Green Building Index certification"
Section 5. B.16	Recycling waste	Kitar semua sisa pepejal	Recycled waste	Recycling waste	Recycling waste
Section 5. C.5	Using external environmental rating tools	Menggunakan sistem penilaian alam sekitar dari organisasi luar	Using external environmental assessment tool	Using the assessment environment tool of the external organisation	Rephrase Malay version to *Menggunakan sistem persijilan alam sekitar dari organisasi luar*
Section 5. D.4	Project team Competencies (technical)	Kecekapan pelaksana projek (teknikal)	Efficiency of project implementer (technical)	Efficiency of project team (technical)	No change required.

3.5.1 Pre-test and pilot test

A pre-test was conducted a few times before the questionnaire as the survey instrument tested at the pilot and full-scale survey. Blair, Czaja, and Blair (2014) also highlighted that there are no definitive answers about the best pre-test methods and it is based on researcher judgement. It is a procedure used to determine whether the questionnaire works in the manner intended by the researcher (Blair, Czaja and Blair, 2014; Rea and Parker, 2012). It also gives researchers some idea whether the questions are straightforward and easy to complete (Rowley, 2014). The way questions are worded is critically important as well. Ambiguous and confusing words and phrases tend to generate a feeling of uncertainty to the respondent. Meanwhile, the double barrelled questions make the respondents confused and can lead to ambiguous and biased results (Rea and Parker, 2012).

A pre-test was conducted five times before the questionnaire was finalised and sent for the pilot test. The pre-test was conducted among the experts, academia and research colleagues. The major amendment made during the first pre-test includes the layout of the questionnaire and rewording of the sentences. The double-barrelled questions were identified and some words used were too vague and confusing. There were too many items, and it took a longer time to complete. Most of the pre-test respondents agreed that they felt bored half way through answering the questionnaire and complained that the questionnaire was long. After the fifth pre-test, the questionnaire was finalised and ready to be sent for the pilot test.

The practitioners and experts were asked to participate in the pilot test for this research. Experts mentioned are those identified as survey experts, language experts and subject-matter experts. During the pilot test, 10 invitations were extended and only six agreed to the face-to-face interview. Using a face-to-face interview approach, this research acquires instant and extensive feedback in term of the flaws in the questionnaire, the adequacy of the questionnaire and the face validity of the questionnaire. One week before the interview, a set of survey envelope including the cover letter, debriefing questions asking for respondent's feedback and the questionnaire were sent to the respondents via email.

The following points were addressed in the debriefing questions:

a) Do the survey participants understand the questions?

b) Do the questions posed adequately address the green practices for a construction project?

c) How long does it take to complete the questionnaire?

d) Are there any technical problems in accessing and navigating the online survey?

The feedback from the experts used to refine the items and the questionnaire as a whole are presented in Table 3.5.

Table 3.5 Outcome from pilot survey

Respondents	**Methods**	**Time taken to complete the questionnaire**	**Comments / Suggestions / Recommendations**
Expert	Face to face	30 minutes	• Revise instruction for Section 2 • Reduce demographic background item
Expert	Face to face	25 minutes	• Improve the cover letter layout • Suggest a bigger font • Revise instruction for section 4 • Reword a few items for better clarity
Actual respondent	Face to face	20 minutes	• To redesign Section 4 to avoid confusion • Some items in demographic background have no options available
Expert	Face to face	35 minutes	• Likert scales to redesign
Actual respondent	Face to face (online survey)	30 minutes	• Font size used is too small • Suggest to change layout and colours of online interface
Actual respondent	Face to face (online survey)	25 minutes	• Malay option is not accessible • English version font is too small

3.5.2 Questionnaire administration

The questionnaire was self-administered and distributed to the respondents randomly to their office address. Before sending the questionnaire, phone calls were made to identify the actual potential respondents and to seek their agreement. In early August 2015, 250 questionnaires were sent out. Three weeks after that a soft reminder was sent via email asking for each respondent's cooperation to fill in the questionnaire, with the online survey link also attached. According to Wright (2005), online survey services make conducting a survey much easier and faster. Online surveys can offer a number of advantages including the ability to provide access to individuals in distant locations, ease of reaching large numbers of potential respondents and the ability to reach participants who are difficult to contact. The online survey was developed and administered using the Queensland University of Technology (QUT) online software known as QUT Key Survey. To take the web-based survey, the respondent was provided with the link to the survey at https://survey.qut.edu.au/f/184721/2b68/. The activation date set the cut-off date for the data collection. The QR bar code was also provided to those who wished to access the survey via their smart phone (refer Figure 3.6).

Figure 3.6 QR Code for online survey using QUT Key Survey

3.6 RESEARCH DEVELOPMENT STAGE 3: MODEL REFINING AND FINALISATION

Raw data from Stage 2 (main data collection) of this research was analysed using statistical software. This section was divided in two as follows;

3.6.1 Data preparation, data cleaning and preliminary analysis

For stage 1, data preparation and cleaning was conducted to ensure data are reliable for the analysis. This consists of screening questionnaires to identify illegible, incomplete, inconsistent and ambiguous responses (Bakir, 2014). The process includes coding the data, screening the missing cases, outliers and checking on the normality distribution, validity and reliability.

Table 3.6 Summary of the steps taken to clean the data

No	Problems	Solution	Results
1	Data with invalid responses	The questionnaire was put aside and marked as rejected due to invalid responses	The inclusion of the invalid questionnaire in the analysis will lead to a biased result. Thus, rejecting the questionnaire will reduce the number of responses but provide a quality analysis outcome
2	Missing data	The questionnaire put aside and marked as rejected due to missing data	
3	Outliers	Deleted from the SPSS data and marked as outliers	
4	Data normality	Using statistical technique: skewness and kurtosis	The analysis was found to be normally distributed (further explanation in Chapter 5: Preliminary analysis)
5	To measure internal consistency of items	Using statistical technique: Reliability test (Cronbach's alpha)	The analysis revealed that the data is reliable with Cronbach's alpha value within the recommended range. (Further explanation in Chapter 5: Preliminary analysis)
6	To describe characteristics of respondents	Using Descriptive Analysis to make sure the respondents characteristics are balanced	The analysis provided the overview of the respondent's background and pattern.

The completed questionnaires were numbered to ensure easy detection for further reference. Out of 131 questionnaires collected, only 102 of the questionnaires were used for further analysis. The data was entered into SPSS version 23 for windows. To ensure the accuracy and data entry error, the data entered in the SPSS compared with the returned questionnaire. The data from SPSS was transferred onto the Excel software to ease the checking process. The data also had been screened using categorical variables using frequency analysis to identify the missing cases and the minimum and maximum values (refer Table 3.6).

3.6.2 Quantitative data analysis

The data then was further analysed in Chapter 6 to test the construct measures and to test the hypotheses set forth in this research. The Structure Equation Modelling (SEM) technique was significant for theory testing and development and validation of constructs in the proposed model (Anderson, 1987; Anderson and Gerbing, 1988). It started with the Confirmatory Factor Analysis (CFA) and followed with the structural model. Both tests were meant to validate a proposed model using SEM. SEM is one of the important multivariate techniques where SEM combines multiple regression and factor analysis techniques. It expresses the linear relationship between latent constructs, which are divided into two types, the exogenous (independent) or the endogenous (dependent). The relationships between variables, sub variables and measured items are expressed as coefficients termed path coefficients, or regression weights (Reisinger and Mavondo, 2007).

The main reason this research uses SEM is to test and analyse interrelationships among latent constructs and their measured variables. SEM has been widely used in a number of disciplines, including psychology, management, environmental studies, and marketing. SEM also has been used in a number of construction management studies (Xiong, Skitmore, and Xia, 2015). Construction management researchers frequently wish to identify the variables, the correlations between the variables and the causal-path between the variables. With SEM comprehensive approach, all these questions can be answered clearly.

This research specifically used CB-SEM where it involves a maximum likelihood procedure whose goal is to minimize the difference between the observed and

estimated covariance matrices. There is no golden rule on what software a researcher should pick when developing a CB-SEM approach. There are several packages that are available in the market, however, the CB-SEM using AMOS is used due to the availability of software at the university and familiarity with the software. AMOS is well-known as a user-friendly statistical package that helps the researcher to focus more on solving the research problem.

3.7 ETHICAL CONSIDERATION

The ethical consideration obtained to carry out this research follows the Queensland University of Technology guidelines and is classified as human low-risk according to the Ethics' code of practice. The application was submitted to the University Human Research Ethics Committee for approval in March 2015. The application was approved two months from the date lodged with the approval number 1500000214. This research involves the participation of individuals, the principles of ethics such as honesty, integrity and respecting individual rights. In collecting the data, there is no coercion employed and it is all carried out on a voluntary basis. Respondents are assured of informed consent, no harm, confidentiality and anonymity. The participants are also informed that they have the right to withdraw as a participant at any point of the research process. In this case, in data collection through the questionnaire, implied consent is adopted where once the participants return the questionnaire; they have been considered as giving their consent to participate. This research also obtained permission to conduct a study in Malaysia by the Economic Planning Unit under the Prime Minister's Office with the research permit no: UPE 40/200/19/3227. The main purpose of applying this permission is to gain consent from the government to access the information within their departments as related to this research.

3.8 SUMMARY

This chapter presented the research methodology adopted for this study. The research design and appropriate data collection methods were described, together with sample selection procedure. The applied data analysis and statistical analysis technique

was discussed along with the limitations and assumptions. The purpose of the methodology is to link the research questions and outcomes. The present study used the quantitative method to cover the research questions by distributing a survey form of a questionnaire. The data was analysed using SPSS version 23 and SEM approach with AMOS software to build up the model fit. The design also includes the use of SEM to measure the impact of the variables as presented in Chapter 5 and 6. The following chapter (Chapter 5) presented the preliminary data analysis including the descriptive analysis, the outliers and the data normality. The collected data were analysed and interpreted according to the protocols that were established in this chapter.

CHAPTER 4: PRELIMINARY INTERVIEW

(Part of this section has been published in Bohari, A. A. M., Skitmore, M., Xia, B., and Teo, M., (2017). Green-oriented procurement for building projects: Preliminary findings from Malaysia. Journal of Cleaner Production, 147, 690-700).

4.1 INTRODUCTION

This section presented the outcome of a preliminary interview conducted. This interview was conducted to validate findings derived from the literature review (Chapter 2) and explore the current and unique practices from the Malaysian construction industry. The findings from the literature review and preliminary interviews are the basis from which to form survey questions that will be used to finalise the green procurement model for construction projects in Malaysian construction industry.

4.2 PRELIMINARY INTERVIEW

To grasp a better understanding of current practices and phenomena in the Malaysia construction industry, interviews with expert practitioners were conducted to explore the research area. The interviews are important in order to obtain a better understanding of current practices and phenomena in the Malaysian construction industry. Early consultations with construction practitioners have been widely used in construction studies to confirm the appropriateness of the factors involved (Meng, 2012).

4.2.1 Interview procedure

Purposive sampling was used to select experts exhibiting the characteristics and expertise appropriate for this study. Due to the limited numbers of the green project in Malaysia, eight prominent green building projects were identified and invited to participate in the study. Of the eight projects, four projects agreed to participate in this research. This interview was also participated in by one of the green procurement experts

in Malaysia to understand the current state of the green procurement practices in Malaysia as well as the future direction of green procurement in the construction industry. Five interviews were conducted, which falls within the recommended range of Romney, Weller, and Batchelder (1986). Further explanation is given under sub-section 4.2.2.

The interviewees were selected based on their experience in dealing with green projects specifically during the planning stage. One project is platinum certified by Malaysia's Green Building Index, one silver, and another two are gold certified. They are all early adopters of this innovative approach. Early adopters are the trendsetters in the industry, and it is, therefore, important to gather their first-hand experiences to understand the actual state as a guideline to build more comprehensively green projects in future. As highlighted in studies including Perera et al. (2007); Roy and Koehn (2006), the implementation factors involved vary according to local conditions and the unique needs of the Malaysian context.

Data were collected using semi-structured interviews at a place and time predetermined by the interviewees. Potential interviewees were contacted in order to seek their agreement, and the objectives of the interview explained by the researcher. Upon receiving verbal consent, a pre-interview information sheet was sent by email highlighting what to expect at the interview and seeking agreement to proceed further. The interviews were conducted face-to-face and took 40-60 minutes to complete. The questions were designed to allow interviewees to provide additional information and feedback, the main elements addressed being:

- The understanding of the "green" concept
- The drivers or motivating factors adopting green practices;
- The practices of green projects that are focusing on procurement practices;
- An open question for any other points the interviewee wished to add or discuss.

All the interviewee's assigned codes were to protect their anonymity and the interviews recorded and transcribed verbatim. The transcripts were proofread by the researcher to ensure their validity. One of the interviews was conducted in the Malay language, with a back-translation process used to ensure the accuracy of the translation. With the back-translation method, the interview conducted in the Malay language is first translated into English and then translated blindly back into the original language by an independent translator. The back-translation version was then compared with the original

version in the source language. The comparability between the back-translation version and the original version is considered to indicate translation accuracy (Douglas and Craig, 2007). A summary of the transcription was then emailed to the interviewee to ensure its accuracy. This was done in such a way as to ensure the meaning was not compromised by being taken out of context. The data were manually analysed and grouped under the initial codes or themes. The themes were identified based on the findings of the literature review.

4.2.2 Interview key profiles

The key profiles of the interviewees are shown in Table 4.1. All the interviewees have been involved in at least one green building project. All the interviewees are those who are involved in green-certified projects under the voluntary Green Building Index (GBI) rating tools. Since the green building is still an emerging concept in Malaysia, their experience is very valuable for future guidance and improvement. The interviewees are the entire key stakeholders involved from the planning stage to project hand-over.

Table 4.1 Interviewees key profile

Item	R1	R2	R 3	R4	R5
Interviewees position	*Architect*	*Project Manager*	*Architect / Green consultant*	*Quantity Surveyor*	*Green procurement expert*
Organisation	*Consultant*	*Developer*	*Consultant*	*Consultant*	*Government*
Experience in the construction industry	*More than 10 years*	*More than 15 years*	*More than 25 years*	*More than 5 years*	*N/A*
Experience of green projects	*Second projects*	*Second projects*	*First project*	*First project*	*N/A*
Green project status	*Gold*	*Platinum*	*Silver*	*Gold*	*N/A*

This research was conducted with a small and limited sample of interviewees regarding this research topic, because green building is a new practice in Malaysia and hence there are not many experienced practitioners yet. Although the sample size is small and limited, the in-depth nature and the detailed explanations of the issues provided by experienced interviewees is in line with Romney et al.'s (1986) findings. Romney et al.'s recommendation is for four to five interviews when participants have a high level of knowledge in the specific area of research (1986). This interview aims to define the research direction that narrow, to a discussion confirming the lists of factors and practices of green-oriented procurement as well as the intended green performance. Thus, according to Becker (2012), the number of interviews conducted in this research is sufficient. Furthermore, the outcome at this stage is further supported with the quantitative method to generalise the findings at the interview stage (Charmaz, 2012). In other words, this interview was conducted in the limited scope of green procurement practices in Malaysia within the small and homogenous population (green construction); as well as being limited in resources, further enhancement of the number of interviews are needed for future study (Bonde, 2013).

4.3 FINDINGS FROM LITERATURE AND PRELIMINARY INTERVIEW

4.3.1 Policies and guidelines

Various studies have suggested the importance of defining the term "green" within the projects themselves to ensure that all project stakeholder are working on the same objectives (Hes, 2005; Marcelino-Sádaba et al., 2015). Providing a clear direction helps each party to discharge their tasks efficiently based on the main project goals. The interviewees mostly associate the term "green" with the need to integrate environmental protection with construction. They agree that this derives from the awareness that everyone should be involved in the global commitment to address climate change. They also understand that the green concept applies throughout the entire building lifecycle. One interviewee mentioned that green includes considering the economic and social impacts involved – the 'triple bottom line' concept of sustainability (R3). One aspect also highlighted by the interviewees is that they were not guided by any specific definition but more by the need for compliance, evidenced by the interviewees' comments below:

"We don't have any specific definition. The objective is mainly to help the client to achieve platinum certification (R4)."

"Although the team does not have a specific definition and we follow the guidelines given by the Green Building Index, we are all aware that being green is about a global commitment towards [mitigating the effects of] climate change (R2)."

"This project also aims to protect the environment and, consequently, we are given Green Building Index guidelines and asked to work towards the certification. As for us, the duty of the consultant producing green buildings is to protect the environment for the benefit of future generations." (R3)

Although the interviewees are very enthusiastic about the concept of a green project, they agree that this is still very new and at the preliminary stage for the majority of practitioners in Malaysia. Interviewees' opinions skewed towards positive remarks on the need to educate every stakeholder about following this greener path and that failure to understand this will lead to confusion about the priority for green construction. One of the respondents highlighted the importance, "building green" to be the responsibility of each individual, in order to create a culture within the industry itself (R3).

All the interviewees made positive remarks on the role of government in ensuring that green concepts were adopted through the provision of environmental standards, regulatory frameworks and incentives. Two of the interviewees mentioned that the tax exemption incentives offered by the government help to drive private developers (R3, R4). Green Building Index (GBI) rating tools have been widely used by clients and design teams to plan environmentally friendly project delivery. GBI is an involuntary use for appraising the environmental design and performance of Malaysian buildings. The tools provide category-based checklists for applicants to comply with, and are widely used by clients and consultants in Malaysia to deliver green projects. In Malaysia, the industry standards also act as a guide in assessing the products to create benchmark criteria for evaluation and scoring.

Table 4.2 Key points from Literature and Interview (Policies and guidelines)

Key practices	Literature	Key point quoted by the interviewees
Policies and guidelines	Adham and Siwar (2012), Bakir (2013)	*"They need to make it as mandatory, so they need to comply. For example, it's compulsory for every project or government to be green certified." (R3)* *"MS1525 was introduced to building sector to promote green effort and to make sure of compliance by private sector." (R1)*
Policies and guidelines at project level	Hes (2005), Marcelino-Sádaba et al. (2015)	*"We do have the main objective that is to help the client to achieve the platinum certification and support government policy to reduce environmental problems." (R2)* *"Project based guideline and policy should be given." (R3)* *We have the document called needs statement from green consultant." (R2)*
Policy on incentives	Zainul Abidin et al. (2013), Ofori, (2006); Qi et al. (2010), Zhu and Sarkis (2006)	*"Tax exemption is a good incentive to drive private developers." (R3)* *"They believe to be part of green is good for their organisation's image and as a life model for other people." (R4)*
External rating tools: Green Building Index (GBI) Rating tools	Gowri (2004); Ding (2008); Wu and Low (2010)	*"We used requirements by GBI to kick start the environmental consideration for this project." (R2)*

4.3.2 Product and process

All interviewees agree that the obvious difference with green projects is the need to consider purchasing green products and services. A report produced by the Malaysian Department of Business and Innovation (BIS) supports this, revealing that it is the manufacture of construction products and materials that account for the largest amount of damaging environmental emissions in the construction industry - a green product or

service having a significantly smaller environmental footprint than the average or standard product or the same type of service. Zsidisin and Siferd (2001) considered green products as products that consist of features such as those involving environmentally-friendly processes during production; ease of distribution and return; use of non-hazardous materials; sustainable waste management and product durability and reliability.

The interviewees indicate that, in any procurement setting, whether conventional, design and build, or partnering, the environmental criteria of the desired products and services described in the technical specification are used as guidelines for the design team and other stakeholders. These describe a performance-based definition, including material selection, chemical content and the functional characteristics of products (Bouwer, 2005). These environmental criteria need to be integrated into the contractual requirements to ensure that they become part of the development. The interviewees agree that the environmental criteria also form a basis for the evaluation of tenders by stating minimum compliance criteria. As quoted by the interviewees;

> *"... using a conventional building contract, we have to integrate some green specifications required by the client into the contract." (R2)*

> *"... it is procurement with the existing policy and practices but with the intention of incorporating green requirements and specifications." (R5)*

Pre-qualification aims to select stakeholders that are qualified to perform a task and are preferred by the client to minimise risks (Hatush and Skitmore, 1997). In this case, the selection of stakeholders includes the design team and the contractor team. ISO14001 and the Environmental Management System (EMS) are the most common and globally used indicators. These instruments are used for environmental management and also to signal a firm's improved environmental performance to the stakeholders (Bouwer et al., 2006; Qi et al., 2010; Varnäs et al., 2009). However, Roos (2012) argues that the selection process must be kept simple to encourage participation from small and medium-sized enterprises in fostering fair competition. Further, Varnäs et al. (2009) suggest that the role of EMS in project-based construction organisations should be further investigated. EMS does not guarantee high-level performance because it can be difficult to differentiate between contractors who can actually perform and those who simply produce attractive documents (Faith-Ell et al., 2006).

Table 4.3 Key points from Literature and Interview (Product and process)

Key practices	Literature	Key points quoted by the interviewees
Purchasing green products and services	Adham and Siwar (2012); Ahmad et al. (2015); Bakir (2013); Salam (2008); Tseng et al. (2013)	*"We check the details submitted carefully and asked the supplier to provide a green certificate." (R3)* *"We have to ensure the materials choose manage to meet the GBI." (R2)*
Incorporation of green specifications in the contract	Sterner (2002); Nissinen et al. (2009); Parikka-Alhola and Nissinen (2012)	*"... using a conventional building contract, we have to integrate some green specifications required by the client into the contract." (R2)* *"... it is procurement with the existing policy and practices but with the intention of incorporating green requirements and specifications." (R5)*
Purchase value of money	Vatalis et al., (2012); Parikka-Alhola et al. (2006)	*"Based on the green specifications provided, we are looking for green contractors and suppliers. Pre-qualification was conducted, and then we proceeded with a competitive price." (R4)* *"It is very difficult; the market is still very small, with a lack of suppliers. The total cost is slightly high, with an increment of 8 percent, but fair enough." (R4)*
Qualification of stakeholders based on knowledge and experience	Bouwer et al. (2006); Qi et al. (2011); Varnäs et al. (2009)	*"Our main contractor is very experienced in green building practices. That helps a lot since many are still very new to this process." (R4)* *"Although the main contractors have never had experience of building green projects, they engaged an experienced project manager and green expert to be part of their team." (R1)*

4.3.3 Environmental evaluation

Cole (2005) argues that the assessment or rating tools could be effective tools to measure environmental commitment if there is a balancing mechanism to support implementation. This has created a call for tools to guide clients in procuring a green project. Some organisations have formal mechanisms to ensure compliance and to track non-compliance matters.

Lifecycle analysis is normally used as a basis to check the environmental impact of products and services but is mentioned by all interviewees as not being a crucial practice. Meanwhile, green specification and eco-labelling are used as benchmarks in selecting products and services. Tender evaluation is one of the evaluation tools used to examine environmental criteria based on the project's environmental requirements, as listed in the technical specifications (Varnäs et al., 2009). The most common indicators used in the industry are environmental rating tools such as the Green Building Index (GBI), the Leadership in Energy and Environmental Design (LEEDS) and the Building Research Establishment Environmental Assessment Methodology (BREAM). LEEDS is the certification used in the United States and the Building Research Establishment Environmental Assessment Methodology (BREAM) used in the United Kingdom. As quoted by one of the participants;

> " *We are given Green Building Index guidelines and asked to work towards certification." (R3)*

However, the immediate economic aspects involved are also of critical practical importance, with a tender evaluation process being typically used to examine the environmental criteria based on project's environment requirements (Varnäs et al., 2009). In many countries now, construction contract award criteria are based on the most economically advantageous tender (Parikka-alhola, Nissinen, and Ekroos, 2006), which takes into account the whole of the project considerations, for example, the price, technical merit, environmental characteristics and after-sales service.

There are normally two methods being used to assess tender price - price preference and set-aside. Price preference refers to a situation where the client/owner is willing to pay extra for green products (Marron, 1997; Oosterhuis, 2003) while set-asides refer to specific minimum targets being set for green purchasing. As mentioned by one interviewee, the preference is to meet basic requirements as stipulated in the technical

specification of the project, although, at the same time, the client/owner's budget is still a major concern resulting in a situation where what is sought is

> *"The lowest acceptable offer that a supplier can give who can meet minimal technical specifications and still offer a very low price." (R2)*

As one of the interviewees revealed, this meant that their project's client spent about 8 percent more, compared with using conventional methods.

In the case where bidders offer similar prices, consideration is given to their past credentials in terms of experience and qualifications. Pre-qualification procedure used to assess the capabilities of contractors to carry out a contract satisfactorily (Hatush and Skitmore, 1997) is regularly used for this purpose and to make sure that green requirements are fully implemented. Past credentials including experience, knowledge and qualifications for green projects are a major advantage. In order to help with their assessment, the Environment Management System (EMS) and International Standard Organisation (ISO14001) are used to benchmark the organisation. It is important, however, that the selection process is kept simple to encourage participation from small and medium-sized enterprises in fostering fair competition (Roos, 2012).

As previously prescribed, life-cycle analysis (LCA) is often said to be one of the important elements in green procurement and involves three components of inventory analysis, impact analysis and improvement analysis (Pun, 2006; Klöpffer, 1997). The interviewees are less sure, however, with one commenting that

> *"Most contractors and suppliers are still in a grey area about green projects, especially regarding details such as the technical parts (especially materials), implementation on-site and the most difficult one, which is LCA." (R2)*

The interviews suggest that most interviewees have carried out an inventory analysis and impact analysis, as evidenced by the comment that

> *"When we ask for the green certificate, we will carefully check the details submitted, for example, the regional materials and the recycle content, etc." (R3)*

In the inventory analysis, extensive information is collected regarding the early production stage, energy consumption and material requirements, emissions, solid wastes and other residues from the product, process or activity. Impact analysis then both quantitatively and qualitatively addresses the effects on the environment such as resource depletion, pollution and health impacts (Pun, 2006).

Table 4.4 Key points from Literature and Interview (Environmental evaluation)

Key practices	Literature	Key point quoted by the interviewees
Green criteria in assessing tenders	Sterner (2002); Varnäs et al. (2009)	*"The lowest acceptable offer that a supplier can give who can meet minimal technical specifications and still offer a very low price." (R2)*
Life-cycle Analysis	Pun (2006); Kibert (2012)	*"Our capability on LCC is very weak, so at this time, we are discussing LCA briefly." (R3)* *"We know what LCA is all about, but it's very difficult to educate especially when green practices are still a new thing for contractors and suppliers. We managed to pick-up one supplier CSR block." (R2)*
Green labelling	Ofori (2000); Li and Geiser (2005); Bratt (2011)	*"Because [the manufacture of green products] is still a young industry. A lot of products are still unavailable and in the process of labelling. So they have to go for tests, test reports, and labels. Some products are imported." (R4)* *"Green suppliers are limited. Support systems, designers, and factories are not collaborative." (R1)*
External rating tools, e.g., the Green Building Index	Ding (2008); Gowri, (2004); Wu and Low (2010)	*The team does not have a specific definition, but we follow the guidelines in the Green Building Index." (R2)* *We are given Green Building Index guidelines and asked to work towards certification." (R3)*

4.3.4 Stakeholder values

For this particular research, stakeholder values were created as an individual factor. The stakeholder, as mentioned previously, is a very important factor in ensuring a project's success (Adham and Siwar, 2012; Bouwer et al., 2006; IISD, 2012; Li and Geiser, 2005; McCrudden, 2004; and Palmujoki et al., 2010). Stakeholders' values, such as commitment, capability and motivation, help to translate the policy and planning into action. Agreed by all the interviewees, client support is very crucial to ensure green objectives are fulfilled.

> *"Our client is very committed to producing a green building, so we are all very keen and excited." (R3)*

Continuous training and knowledge sharing among the stakeholders are important to improve stakeholder values. As remarked by the interviewees, project teams are required to attend the courses and training provided by external organisations. As quoted by the interviewees,

> *"Most are newbies like engineers need to attend intense GBI courses and site visits." (R3)*

> *"Our project engaged a green consultant overseas to help us with this green strategy." (R1)*

Interviewees R3 are even required to visit local and overseas green projects to benchmark their green progress performance. Also, knowledge sharing within the project team also helps the project to achieve its green objectives. As mentioned by one of the interviewees;

> "*Actually, this is the first time the consultant has been involved in green building. Fortunately, the architect and main contractor are knowledgeable and very proactive in the green part." (R4)*

As similarly mentioned by Robichaud and Anantatmula (2011), knowledge sharing and transfer can be done throughout the project delivery starting from inception until the in-use stage such as project briefing, periodical training and meeting. It provides another means of helping create the awareness among the stakeholders and enhancing their capabilities pertaining to green construction and environmental sustainability.

Table 4.5 Key points from Literature and Interview (Stakeholder values)

Key practices	Literature	Key point quoted by the interviewees
Commitment	Pun (2006); Hassan (2014); Zhang, Wu, and Shen (2015)	*During the pre-award, we manage to convince the supplier of the long-time benefits and intangible costs to reduce the cost in the long run. We are indirectly saving the environment." (R2)*
Capabilities (technical)	Ofori (2000); Pun (2006); Morrow and Rondinelli (2012)	*"We are lucky that our contractor is a pioneer of the green building in Malaysia, green consultancy and green energy facilitation. They are experienced, and you don't need to educate them too much about what needs to be done." (R3)*
Education and training	Carter et al., (1998); Liu et al. (2012); Robichaud and Anantatmula (2011);	*"It is a very young industry, and they are learning lessons from Singapore's green mark and Australia's green star conferences. They do much collaboration overseas." (R3)*

4.4 REVISED CONCEPTUAL MODEL FOR GREEN PROCUREMENT FOR BUILDING PROJECT IN MALAYSIA

This section outlines the revised green procurement model of a building project for the Malaysian construction industry. Through literature that has been discussed in the previous chapter, Chapter 2 and preliminary interviews that will be briefly discussed under Section 4.1 to Section 4.3, a list of green practices is identified and compiled, paving the way for further investigation.

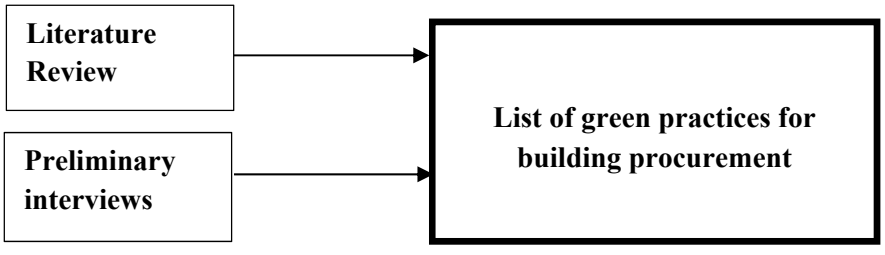

Figure 4.1 Source of reference for green practices for building procurement

The list of green practices for green-oriented procurement was identified and complied with through a wide-ranging literature review as the basis of the next phase of this research. The sixty-four green practices were further validated through face-to-face preliminary interviews with the green construction experience practitioners. During the interview, the experience practitioners were asked to identify the practices that the suggested to be very important and identify those practices that irrelevant and not important for green-oriented procurement in Malaysia. The interviews have resulted in the reduction of the list of green practices derived from the literature because of irrelevance and redundancy based on the interviewees' perceptions. The interviewees have also proposed another ten new lists of green practices. These practices are combined with the factors found through the literature review. The new factors derived from the interview include the needs for a project policy on incentives both by the government, the Industrialised Building System, the Building Information Management, the Green Building Index (GBI) rating and also Uniform Building By-Laws Code of Practice MS1525:2014 MS1525. These factors and practices can then be used as a basis for drafting the questionnaire of this research.

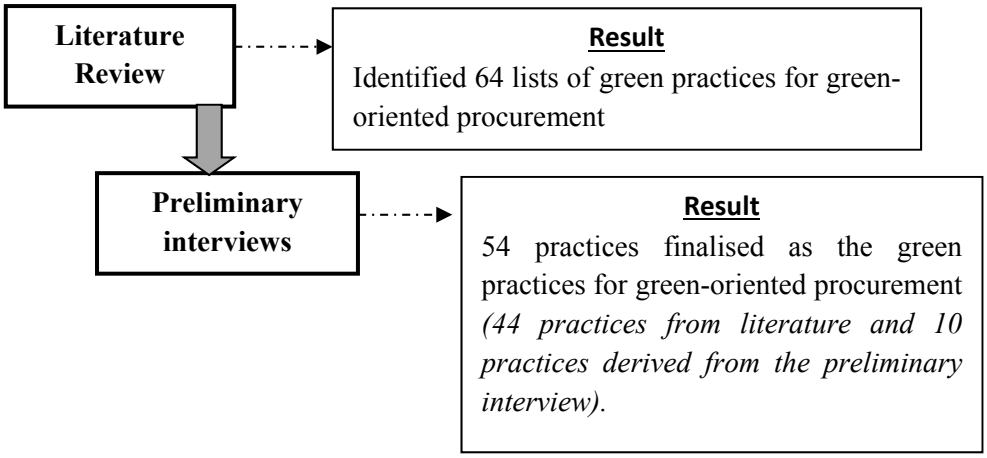

Figure 4.2 Compilation of green practices for green-oriented procurement
(Source: this figure available in Bohari and Xia, 2015).

This research also identified three main constructs as the project's green performance dimension. The three constructs are environmental improvement, financial impact and social wellbeing of the stakeholder and the organisation. There are twenty possible impacts that have been identified from the literature and validated by the interviewees.

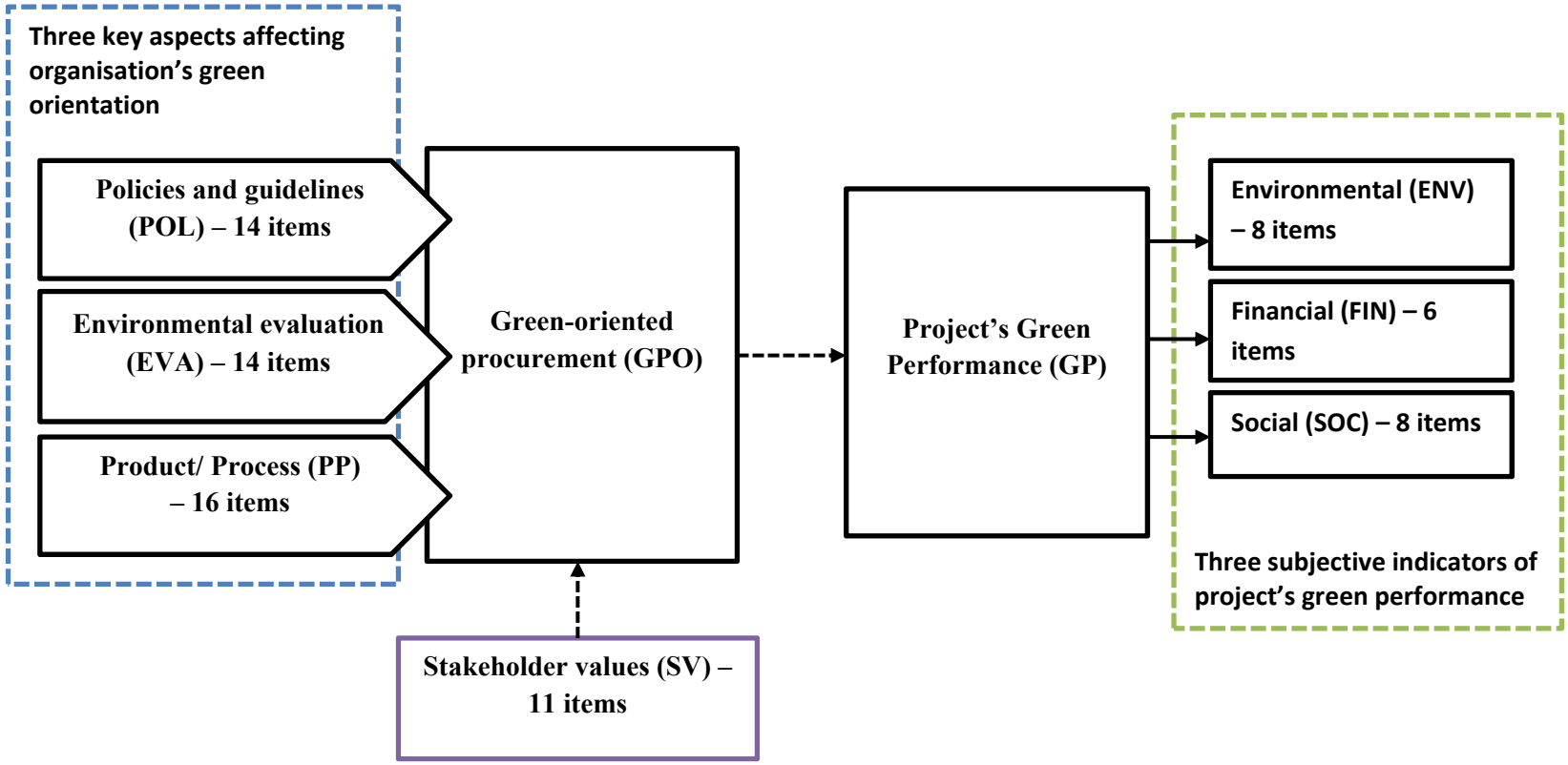

Figure 4.3 Revised model for green-oriented procurement for a building project in Malaysia based on the literature review and preliminary interview

Table 4.6 green procurement model for building projects

Key concept		Description	Author(s), year
Green-oriented procurement	Policies and guidelines	Green polices and guidelines aim to encourage the environmental obligations, whether they arise from laws, regulations, contract, industry standards or internal policies.	*Ofori (2000), Pun (2006), Qi et al. (2010), Meehan and Byrde (2011), Bratt (2011), Liu et al. (2012), Testa et al. (2015), Bakir (2013), Ruparatna and Hewage (2015)*
	Green practices product and process	Integrating and recognizing the green concept into the procurement practices and process throughout procurement phases	*Sterner (2002), Faith-Ell et al. (2006), Lam et al. (2009), Nissinen et al. (2009),Varnäs et al. (2009), Vatalis et al, (2012), Ruparathna and Hewage (2015)*
	Environmental evaluation	Monitoring and controlling the green progress and improvements need to make along the way.	*Li and Geiser (2005), Pun (2006), Bratt(2011), Lehtiranta et al. (2012), IISD (2013)*
	Project stakeholder values	Stakeholder values refer as a guiding principle towards the organizational action (Deal and Kennedy, 1983). The principles mentioned such as the commitment and knowledge of the stakeholders.	*Ofori (2000), Pun (2006), Zhu et al. (2008), Robichaud and Anantatmula, (2011), Meehan and Byrde (2011), Liu et al. (2012)*
Project's green performance	Environmental improvement, economic impacts and social aspects	Green performance is the additional dimension for a project organisation. Green performance in a building project includes environmental aspect, economic and social aspect.	*Morrow and Rondinelli (2002), Ofori (2000), Pun et al. (2006)*

Each item in this list is included in the questionnaire. The final list of green practice items was published in a conference paper in;

> *"Bohari, A. A. M., & Xia, B. (2015). Developing green procurement framework for construction projects in Malaysia. In the Proceedings of the 6th International Conference on Engineering, Project, and Production Management (EPPM2015) (pp. 282-290). Association of Engineering, Project, and Production Management (EPPM)."*

The full list of green practice items is as listed below;

1. Green-oriented procurement (GPO)

Description: For the GPO, there are three key aspects that have a strong impact in determining GPO, which are the policies and guidelines (POL), the environment evaluation (EVA) and green product and process (PP). It is hypothesed that POL, EVA and PP have a significant association with the determination of green-oriented procurement.

i. Policies and guidelines (POL)

- Government legislative requirements
- Government green incentives e.g. tax exemption.
- Enforcement of Environmental Impact Assessment (EIA)
- Enforcement of Uniform Building By-Laws Code of Practice MS1525:2014 (2nd revision) **
- Obtaining a Green Building Index rating
- Policy that encourages participation certified ISO 14001:2004 organisation
- Policy that encourages participation certified Environmental Management Systems (EMS) organisation
- National Strategic Plan for Solid Waste Management policy**
- Having an agreed definition of "green" by project team
- Availability of a green project needs statement
- Availability of policy at project level urging environmental awareness
- Availability of appropriate reward/incentives at project level on green achievement
- Availability of eco-labelling program
- Adopting other completed green project mechanisms

ii. Green Products and Process (PP)

- Compliance with MS1525 guideline**
- Designing building based on project's green specification
- Designing building based on GBI guidelines**
- Selecting materials based on eco-labelling guideline**
- Selecting materials based on project's basic environmental requirement (technical)
- Conducting preliminary study on environmental impact
- Conducting a value management
- Adopting the Industrialised Building system (IBS)**
- Information Technology, e.g., managing project
- Using Building Integrated Management (BIM)
- Using E-tendering
- Providing waste management plan
- Recycling waste
- Using alternative for material packaging
- Using On-site systematic waste management e.g. separate hazardous waste with general waste
- Giving priority to suppliers with long term policy which promotes efficient waste management**

iii. Environmental Evaluation (EVA)

- Government approval at early stage to incorporate green practices
- Conducting Life Cycle Analysis (LCA)
- Providing Life Cycle Report
- Product benchmarking using eco-labelling
- Using external environmental rating tools e.g., GBI**
- Environmental requirements in technical specifications
- Mandatory environmental requirement criteria for tender assessment
- Project's green compliance mechanisms
- Tender evaluation based on price preference
  e.g. willing to pay extra for green products
- Tender evaluation based on set-asides
  e.g. specific minimum targets for green purchasing

- Benchmarking with previous projects
- Public reporting on green performance
- Considering public feedback
- Mandatory legislative report submission
  e.g. Environmental Monitoring Report (EMP)**

2. Stakeholder values (SV)

Description: The SV is hypothesised to significantly impact on the GPO. The stakeholder values are included under this construct such as the stakeholder commitment, capabilities and knowledge-sharing practices.

- Client commitment
- Project team commitment
- Support throughout the supply chain
- Project team competencies (technical)
- The ability to comprehend greater picture of green construction
- Selection of project team based on past credentials in terms of knowledge green construction
- Selection of project team based on past experience in green construction
- Conducting in-house training/briefing
- Acquiring external collaboration or training
- Appointing green specialised consultant/trainer**
- Sharing experience among stakeholders in project

3. Green performance (GP)

Description: The dependant variable for this model is the intended green performance of a building project. Subjective evaluation used to measure project's green performance has three indicators: environment, financial and social. The GPO is hypothesised to be significantly related to a project's green performance (GP).

i. Environmental Improvement (ENV)

- Reduce waste production on site
- Improve building design in term of energy efficiency
- Improve building design in term of Air Quality Index

- Extensive use of water recycling
- Manage resources efficiently
- Better site management
- Better compliance in accordance to litigation
- Minimise potential environmental pollution risks

ii. Financial Impact (FIN)

- Increase overall project cost due to environment –concerned activities
- Increase operational costs to monitor environmental activities
- Purchase to meet minimum environmental criteria
- Purchase value for money
- Tender award based on most economically advantageous tender
- Avoid fines for environmental destruction

iii. Social well-being of the organisation and the stakeholders (SOC)

- Creating awareness among project team of environmentally-friendly culture
- Receiving positive feedback from community
- Enhancing environmentally friendly culture
- Producing educated stakeholders in green project
- Gaining business satisfaction in terms of good image/reputation
- Be recognised as industry leading example
- Gain satisfaction in terms of cost performance
- Gain satisfaction in terms of design performance

** *New practices suggested by the interviewees*

4.5 CONCLUSION

A comprehensive literature review was first undertaken to identify and comply the list of green practices that pave the way for further investigation. Based on rigorous discussion from the literature review and preliminary interview, fifty-four green practices and three main constructs were identified. The preliminary green procurement conceptual model for the green project (see Figure 3.2) combines the three main elements of GPO dimensions. These elements were derived from the literature review and interviews. They were then

adopted in the questions for the survey to identify contractor perception levels in terms of performance. A revised green procurement model for a building project in Malaysia will motivate clients, consultants and other participants to enhance their awareness on green adoption. This model will be further refined and validated using quantitative analysis in Chapter 6.

CHAPTER 5: PRELIMINARY ANALYSIS

5.1 INTRODUCTION

The previous chapter discussed the detailed discussion of the research design and methodology applied in this research. This chapter (Chapter 5) looks at data preparation and cleaning before embarking on the multivariate analysis with SEM. Data cleaning and data preparation is essential to minimise the potential risk of data error and biased result. A few statistical tests were conducted to meet requirements of normality and validity of the data. This process also helps to eliminate the outliers from the set of data.

5.2 RESPONDENTS' DEMOGRAPHIC CHARACTERISTICS

The profiles of the respondents were explored in this section as part of the data assessment. The purpose of analysing the demographic profiles of the respondents is to understand and describe the characteristics of the respondents, such as the respondents' experience and organisational type.

5.2.1 Respondent and Firm profile

Table 5.1 presents a summary of respondents in terms of their position on the project, their level of experience in the construction industry and green construction and how they acquire knowledge regarding green construction. Demographic information has no impact on the level of analysis of this study but reporting this is important to show the reliability of the respondents that are involved in this research.

The current professional background of the participants is quantity surveyor (34 percent), followed by the engineer (29 percent), the architect (15 percent), project procurement officer (1 percent) and others such as green consultants and developers (21 percent). This is important to ensure that the responses received were from a trusted source. Having respondents

with a variety of backgrounds is an advantage because the findings of this research will be from a holistic point of view.

Their background of studies indicated the participants' experience in the construction industry. This research understood that respondents' length of working experience in the construction industry defines their level of expertise and knowledge. Most of the respondents (40 percent) are experienced, meaning they have been involved in the construction industry more than 10 years, which is good for an opinion-based survey analysis. Another 25 percent and 35 percent were within 5 to 10 years and less than 5 years' experience respectively.

Table 5.1 Demographic background

Demographic Features		**Frequency**	**Percent (%)**
Position in the project	*Project Procurement*	1	1.0
	Architect	15	15.0
	Engineer	29	29.0
	Quantity surveyor	34	34.0
	Other	21	21.0
Experience in construction industry	*Less than 5 years*	35	35.0
	5 to 10 years	25	25.0
	More than 10 years	40	40.0
Involvement in green project	*First project*	58	58.0
	More than one project	42	42.0
Training	*During tertiary*	7	7.0
	Project in-house training	48	48.0
	Green expert training	14	14.0
	Peer training	3	3.0
	Self-training	19	19.0
	Don't know	9	9.0

Respondent' Demographic Profile (n =100)

Given the diversity of respondents' professional backgrounds and their roles in their project planning and execution and the fact that all of the respondents have experience in green projects within the Malaysian construction industry suggest that their views represent the Malaysian context. The respondents' experience in green projects signifies the reliability of their response, which added to the data quality. In about 42 percent of the respondents indicated, they have been involved in more than one project, and more than half indicated that they had been involved at least once in green projects. This indicated that the respondents are aware and possess knowledge on the research area.

Nearly half of the respondents, about 48 percent, acquired knowledge on green concepts through project in-house training. Another 19 percent said that they take their own initiative to learn about green practices and 14 percent are trained by professional green facilitators or experts. Another 7 percent learned about this green construction during their tertiary education, and 3 percent mentioned that they acquired knowledge through peer knowledge sharing. This result shows that the project team is very committed to acquiring knowledge on green practices to achieved better green performance. Apart from that, it is a good sign when the respondent's opinion is valid and reliable due to their knowledge in the research area.

5.2.2 Project's profile

Table 5.2 summarises the project profile that is referred to by the respondents in answering this questionnaire. The number of cases and percentage are as shown in table 5.2. As can be seen from the table, the types of building were categorised based on the building function such as industrial, health, commercial and education. It is found that 36 percent of the respondents refer to the project as a commercial building, another 21 percent as an educational building, 21 percent were others such as art gallery, library, etc. Another 15 percent were industrial buildings and 7 percent were health buildings.

Table 5.2 shows that all the respondents were involved in a certified green building project in Malaysia. About 19 percent of the respondents were involved in platinum certified projects under the green building Index rating tool, 12 percent were involved in GBI silver certified building, another 13 percent in GBI gold certified building and in about 24 percent involved in GBI certified the building. Another 18 percent of respondents were involved in a project that was certified by other rating tools such as BREAM and LEED and some indicated that they are were unsure which certification had been used by the project. The findings show that the respondents were experienced in green construction, and their opinions were reliable.

About 49 percent of the respondents highlighted that their projects used traditional methods as a procurement route, while around 39 percent used design and build, 7 percent construction management and 4 percent used private finance Initiatives (PFI). This reflects the fact that traditional methods are the most common type of procurement route used to procure green projects in Malaysia.

Table 5.2 Project's profile

	Project's profile	**Frequency**	**Percent (%)**
Types of building	*Industrial*	15	15.0
	Health	7	7.0
	Commercial	36	36.0
	Education	21	21.0
	Other	21	21.0
Green recognition	*GBI Platinum certification*	19	19.0
	GBI Silver certification	12	12.0
	GBI Gold certification	13	13.0
	GBI certified certification	24	24.0
	Don't know	14	14.0
	Certification by other rating tools	18	18.0
Procurement type	*Traditional procurement*	49	49.0
	Design and build	39	39.0
	Construction management	7	7.0
	Private finance Initiative (PFI)	4	4.0
	Other	1	1.0
	Don't know	9	9.0

Respondents' Demographic Profile (n =100)

5.3 PRELIMINARY DATA RESULTS

The data analyses proceeded with the examination of data entry and execution of data cleaning. The procedure for converting raw data included coding, data entry, screening for missing data, checking the outliers for extreme values and data normality. According to Hair et al. (2010), SEM requires the data to have a normal distribution.

5.3.1 Screening for missing values and screening for outliers

In examining the completeness of the returned questionnaire, all the raw data was entered in the SPSS spreadsheet. Then the data were screened using the missing value syntax and manually identified based on questionnaire coding. About 19 questionnaires contained critical missing data that had at least 30 percent or more of the overall questionnaire. Those cases were omitted from the preliminary analysis (Hair, 2006) and only 102 retained in the database for further examination of normality and outliers.

As Tabachnick and Fidell (2013) argued, an outlier is a case with such extreme values that may distort the analysis. Outlier cases may cause the data set to be non-normal. Therefore, the data set was a screen for the outliers using the descriptive analysis. The first step was taken by removing the uncompleted questionnaire that was not being used for analysis. The usable questionnaires were entered into the SPSS and were checked for outliers using spss boxplot. Two extreme outliers that did affect the normality distribution (for item no 84 and 58) were removed from the dataset and this reduced the number in the data set to 100. Before removing, the data was cross-checked back with the questionnaire to ensure the outliers were genuine and not a mistake while entering data.

5.3.2 Normality for constructs and factors

Normality is used to describe a symmetrical bell-shaped curve and important assumptions are required to carry out structural equation modelling analysis (Byrne, 2013). Examining the data normality is one of the critically important assumptions in the conduct of SEM analysis in general and in the use of AMOS in particular (Xiong et al., 2015). Tabachnick and Fidell (2013) mentioned that SEM analysis is required for the multivariate normality of a dataset. Violation of this assumption, especially with a small sample, will inflate GOF statistics and underestimate the standard errors. Thus, the data collected was then screened for the

normality distribution using SPSS. There are two ways of testing normality: the graphical and the numerical method. Numerical methods are used in this research, such as skewness and kurtosis, and the statistical test of normality is the Kolmogorov-Smirnov test.

SPSS (version 23) was used to describe the data by assessing the normality test. Normality can be assessed by obtaining skewness and kurtosis values of +1 to -1 (Pallant, 2013) considered a range of +3 to -3 for kurtosis. Skewness is the standardised moment of the data and measures the extent that a variable distribution is asymmetrical. Kurtosis is the standardised fourth moment of the data and measures a distribution's picks (Isik, Arditi, Dikmen, and Birgonul, 2009).

Table 5.3 indicates that all values of variables are within the suggested range by Pallant (2013), which concludes that the data were normally distributed. The outcome from the Kolmogorov-Smirnov statistic produced the score for normality distribution for the data. The outcome from the SPSS analysis showed results of more than 0.05 that indicates normality of the data.

Table 5.3 Result of normality test

Variables	**Skewness** *value of +1 to -1, (Pallant, 2013)*	**Kurtosis** *range of +3 to -3, (Hair et al., 2010)*
Policies and guidelines	-.147	-.043
Stakeholder values	-.370	1.036
Environmental evaluation	-.655	-.203
Product / Process	-.139	-.417
Green performance	-.441	.225

5.4 VALIDITY AND RELIABILITY ANALYSIS

To access both the content and construct validity, this research used the guidelines given by the commonly used, the Anderson and Gerbing (1988)'s guideline. Content validity was examined in this study by developing the questionnaire based on the literature review and by sending the questionnaire to a group of experts and actual respondents to check for

content validity and clarity as explained in Chapter 3. Based on the feedback, revisions made and the final questionnaire used in this study were assumed valid.

A reliability test was conducted to evaluate the reliability of factors. Cronbach's alpha is the most commonly used metric used to evaluation the reliability (Gliem and Gliem, 2003) used in this research. The Cronbach alpha formula incorporates the number of the item on the test, so the greater the number of items, the greater value of Cronbach alpha. Each variable and sub-variable consists of numbers of items and the reliability test is done for all items as one group for each variable. Table 5.4 shows the results of reliability analysis for variables in this study. The result shows that the reliability of the variables ranges between 0.733 and 0.897. For a standard Cronbach's alpha, the acceptable value is 0.7 and above (Nunnally and Bernstein, 1994). For the value of 0.800 and more, the reliability score shows a high degree of internal consistency (Pallant, 2001).

Table 5.4 Reliability of items measurement

Variables	**Sub-variables**	**Item**	**Cronbach's alpha value**	**Reliability**
Green orientation of building procurement	Policies and guidelines	14 items	0.798	Good
	Environmental evaluation	14 items	0.874	Very good
	Procurement related practices	11 items	0.897	Very good
Stakeholder's value		16 items	0.846	Very good
Environmental performance	Environmental aspects	8 items	0.777	Good
	Financial aspects	6 items	0.733	Good
	Social aspects	8 items	0.829	Very good

(n =100)

5.5 SUMMARY

The purpose of the analysis presented in this chapter was conducting a preliminary analysis to prepare and clean data for the next step of the statistical analysis. One hundred and twenty-one questionnaires were returned, and nineteen were set aside due to non-complete

response. Another two outliers with extreme values were also excluded from the analysis. The final hundred returned questionnaires were used for further analysis. The demographic of the respondents was also reported using descriptive analysis including respondent's profile and project's background. The normality test was also conducted on all variables and sub-variables and the data turned out to be normally distributed. The Cronbach's alpha test was applied to check the reliability of the variables and it was found that all variables and sub-variables indicated a good internal consistency, thus were considered reliable and able to consistently reflect upon the measuring construct.

The next chapter describes the use of SEM to study the impact of green procurement practices on the project's environmental performance. SEM was used to develop and propose a model to improve the situation in order to have a more positive outcome in the project delivery.

CHAPTER 6: MEASUREMENT MODEL AND STRUCTURAL MODEL

6.1 INTRODUCTION

Chapter 6 describes the steps to examine the relationships between the variables and their impacts on project cost, quality, and environmental performance and to develop and test a model that could guide an effective implementation of green building procurement in Malaysia.

6.2 MODEL DEVELOPMENT AND THE FIT INDICES IN STRUCTURAL EQUATION MODELLING

The relationship model presented in Figure 4.3 aims to answer the first research question (RQ1):

> *Which practices are important, associated with green-oriented procurement of a building project in Malaysia?*

Research question two (RQ2):

> *Do these practices have any significant relationship with the green performance of a building project in Malaysia?*

And research question three (RQ3):

> *How can project stakeholder use the identified key practices of green oriented procurement to improve project's green performance?*

6.2.1 Introduction Structure Equation Modelling

The use of structural equation modelling (SEM) has steadily increased in the construction management literature (Xiong et al., 2015). In particularly, SEM has been used by the researchers (Adham, 2014 and Bakir, 2013) to establish the framework pertaining to

green procurement in various sectors and localities. SEM is second-generation multivariate analysis applied to theoretical explorations and empirical evidence, which specifies, estimates and tests theoretical relationships. SEM produces regression weights, variances, covariance and correlations in its iterative procedures converged on a set of parameter estimates (Holmes-Smith, 2007). Taking Xiong et al. (2015)'s suggestion, this research took necessary steps in analysing and interpreting the result to ensure overall quality for SEM application in construction research. The SEM analysis used in this research is underpinned by the basic concept and the principle of SEM by established literature such as Anderson and Gerbing (1984), Byrne (2001) and Hair et al. (2010).

This research is adopting CB-SEM to analyse the measurement and structural model. The widespread application of CB-SEM has led to numerous advances that extend the method's capabilities. Several of these advances include approaches that enable more complex and comprehensive analysis than with first-generation methods (Hair, Gabriel and Patel, 2014). Furthermore, the CB-SEM method can be used to measure with second or even third order constructs that are applicable to this research. A second order construct of this research is the GPO, and GP is shown in Figure 4.3. GPO has three sub-constructs that are the POL, PP and EVA and for GP there are three sub-constructs as well: EVA, FIN and SOC.

6.2.2 Sample size

For SEM analysis, there is no correct rule for estimating sample size for SEM. Bagozzi and Yi (2012), and Xiong et al. (2015) advise sample size to be at least 100 for the results to be reasonably reliable. Bollen (1990) stated that if the model has variables that are reliable and effects are strong with the not overly complex model, smaller samples will suffice. Anderson and Gerbing (1991) found that the fit indices generally worsened as the number of factors in the model or number of variables per factor increased. In terms of bias reduction and even just getting the model to run, Anderson and Gerbing also highlighted "the rule of thumb of three or more indicators per factor with a sample size of 100 usually being sufficient for convergence" (1984, pp 170-171). Iacobucci (2010) thus highlighted that the SEM model could perform well even with small samples (e.g., 50 to 100). This study used 100 usable sample of questionnaire thus, it is considered within the acceptable range and the result is reasonably reliable.

6.2.3 Model specification

SEM is described as a test relationship between two kinds of variables, which are the latent variables and observed variables. Latent variables cannot be observed directly due to their abstract character, while observed variables contain objective facts and are easier to measure (Xiong et al., 2015). Several observed variables can reflect on latent variables. It is important to ensure the model has a strong theoretical basis.

6.2.4 Model development, evaluation and reporting of results

In dealing with SEM, this research involved a two-model analysis starting with the measurement model and the structural analysis. The measurement model is a model that demonstrates the relationship between measuring items and the latent construct. The measurement model will be further analysed for unidimensional, validity and reliability prior to modelling the structural model. Assessment of the measurement model includes standardised loading (SL) and modification indices (MI). Table 6.1 summarises the assessment of measurement.

Table 6.1 Assessment of measurement model

Standardised Loading (SL)	<0.4	Consider to delete
	0.40-0.50	Acceptable range (Lewis and Byrd, 2003 and Hair et al., 2010)
	0.50 – 1.00	Acceptable range (Hair et al., 2010)
	> 1.00	Out of range study (Hair et al., 2010)
Modification Indices (MI)	>10.00	Indicator model needs an improvement

Hair et al. (2010) mentioned that items with low factor loading could be dropped from the model as long as a construct retains a sufficient number of indicators. A few authors suggested that at least three indicators (Hair et al., 2010) should measure each construct. Also, Lewis and Byrd (2003) suggested that threshold value above 0.40 is still considerable.

The structural model demonstrates inter-relationships among constructs as theorised in the previous chapter.

Assessing the goodness of fit (GOF) of developed models is important for model improvement. However, Hooper, Coughlan, and Mullen (2008) and Kenny and McCoach (2003) argue that there is no consistent standard for evaluating an acceptable model. Based on Hair et al. (2010)'s recommendation, the fitness can be assessed using at least one index from each group. This research presents those criteria that are considered most important and are used in this research.

Table 6.2 Fit-indices for assessing the structural model fit

Indices used for this present study	Purpose	Threshold value	Level Fit
CDIM/DF *CDIM = Chi Square or X²* *DF= Degree of Freedom*	Evaluate overall model fit and assesses the magnitude of discrepancy between sample and fitted covariance matrices	CMIN/DF >1.0 and < 3.0 *(Hair et al., 2010)*	Excellent Fit
Goodness of Fit Index (GFI)	Evaluate the proportion of variance that is accounted for by the estimated population covariance matrices	>0.90 and < 0.95 *(Hair et al., 2010)*	Acceptable Fit
		At least >0.80 (Anderson andGerbing, 1984)	Acceptable Fit
Root Mean Square Residual (RMSEA)	Estimate how well the model fit	<0.08 *(Hair et al., 2010)*	Acceptable Fit
Comparative Fit Indices (CFI)	Estimate how well the model fit	>0.90 - <0.95 *(Hair et al., 2010)*	Acceptable Fit with CFI of 0.92 or higher *(Hair et al., 2010)*

The Chi-Square (X^2) test analyses the discrepancy between the sample and proposed model. A good model fit would provide an insignificant result at a 0.05 threshold (Barrett,

2007), thus is often referred to as a 'badness of fit' measure (Kline, 2005). Since this (X^2) statistic is prone to criticism due to being sensitive to sample size (Hooper et al., 2008; Xiong et al., 2015), this research decided to follow the recommendation to use (X^2) to the degree of freedom ratio to minimise the impact of sample size. A value ranging from one to three indicated a good fit (Hair et al., 2010). The absolute value also can be seen by observing the root mean square error of approximation (RMSEA). RMSEA measures how well the parameter estimates generated by the proposed model fit the population matrix (Byrne, 2013). The value below 0.80 and above 0.50 indicates an acceptable error of approximation and below 0.50 is an excellent fit.

The incremental fit indices (also known as relative fit indices or comparative fit indices) are a group of statistics obtained by comparison with a baseline model. This index was first introduced by Bentler (1990) and subsequently included as part of the fit indices in his EQS program (Kline, 2005). CFI takes into account sample size that performs well even when the sample size is small (Tabachnick and Fidell, 2013). The CFI takes the fit of one model to the data and compares it to the fit of another model to the same data (Iacobucci, 2010). This research uses comparative fit indices (CFI) with a threshold value of 0.90 to 0.95 as acceptable fit and more than 0.95 as an excellent fit.

6.3 MEASUREMENT MODEL AND CONFIRMATORY FACTOR ANALYSIS

This section will be revealed the findings of the measurement model that fits along with confirmatory factor analysis (CFA). CFA includes the testing for unidimensional, validity, reliability, and evaluates a data set by confirming the underlying structure based on theoretical background. The validating procedure used in this research refers to Confirmatory Factor Analysis (CFA). This research runs the CFA for pooled measurement models (PCFA) at once instead of CFA for each individual measurement model. The reason being, PCFA will provide a result that is more efficient. Using this approach, the correlations between constructs are computed simultaneously. The estimation method used is the method of maximum likelihood estimation (maximum likelihood estimation). Figure 6.1 shows the execution process of the CFA test using SEM-AMOS as suggested in the literature (Awang, 2015; Pallant, 2013).

Figure 5.2 shows the CFA result based on SEM AMOS output of the measurement model (standardized estimate) containing three latent constructs (GPO, SV and GP). The value of

"1" in the measurement model is the reference point on the model. The SEM-AMOS output for the CFA test shows the deletion of low loading items and one covariance for item fin2 and fin3. The correlation between exogenous constructs did not exceed 0.85. The final CFA revealed that this measurement model does fit well with RMSEA = 0.045 below the threshold value of 0.08, CFI with a value of 0.950 is regarded as an excellent fit. Figure 6.3 helps to explain the terminology used in this model e.g. factor loading, response items etc.

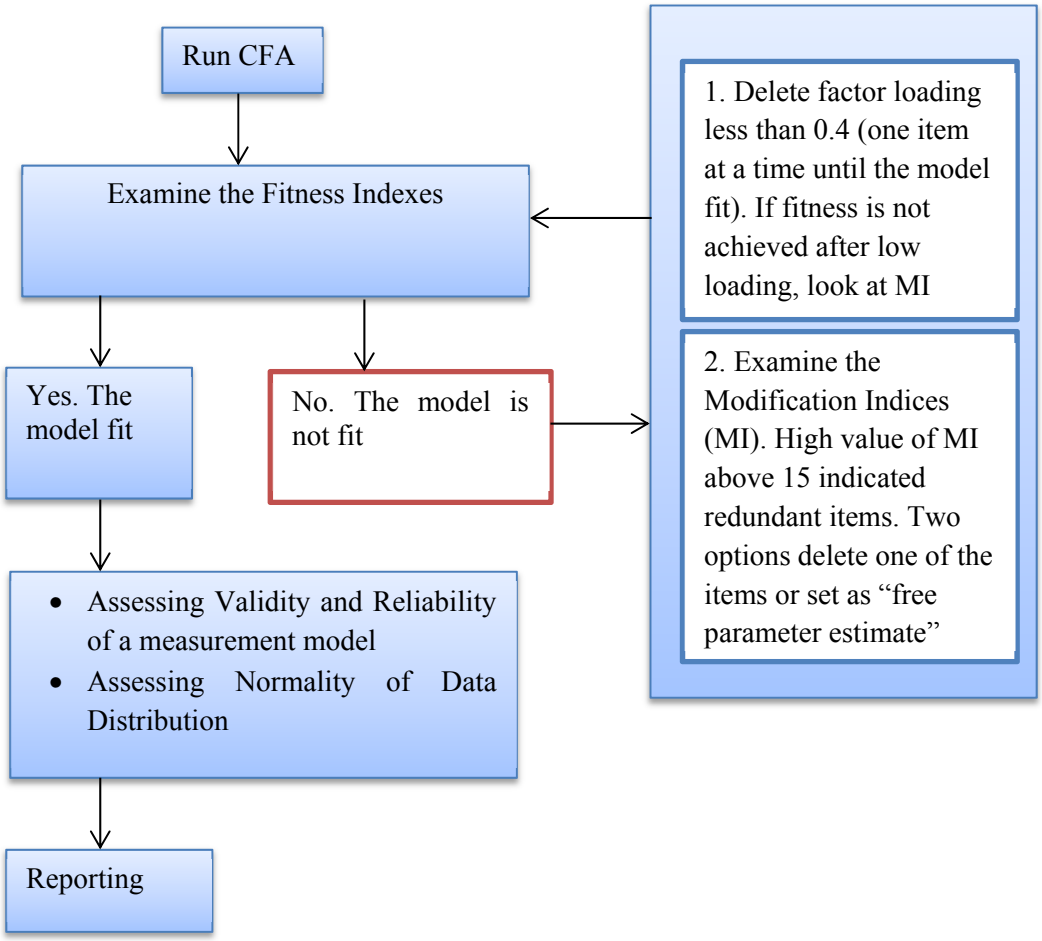

Figure 6.1 Execution of confirmatory factor analysis (CFA) test

Source: Adapted from Awang (2015); Pallant (2013)

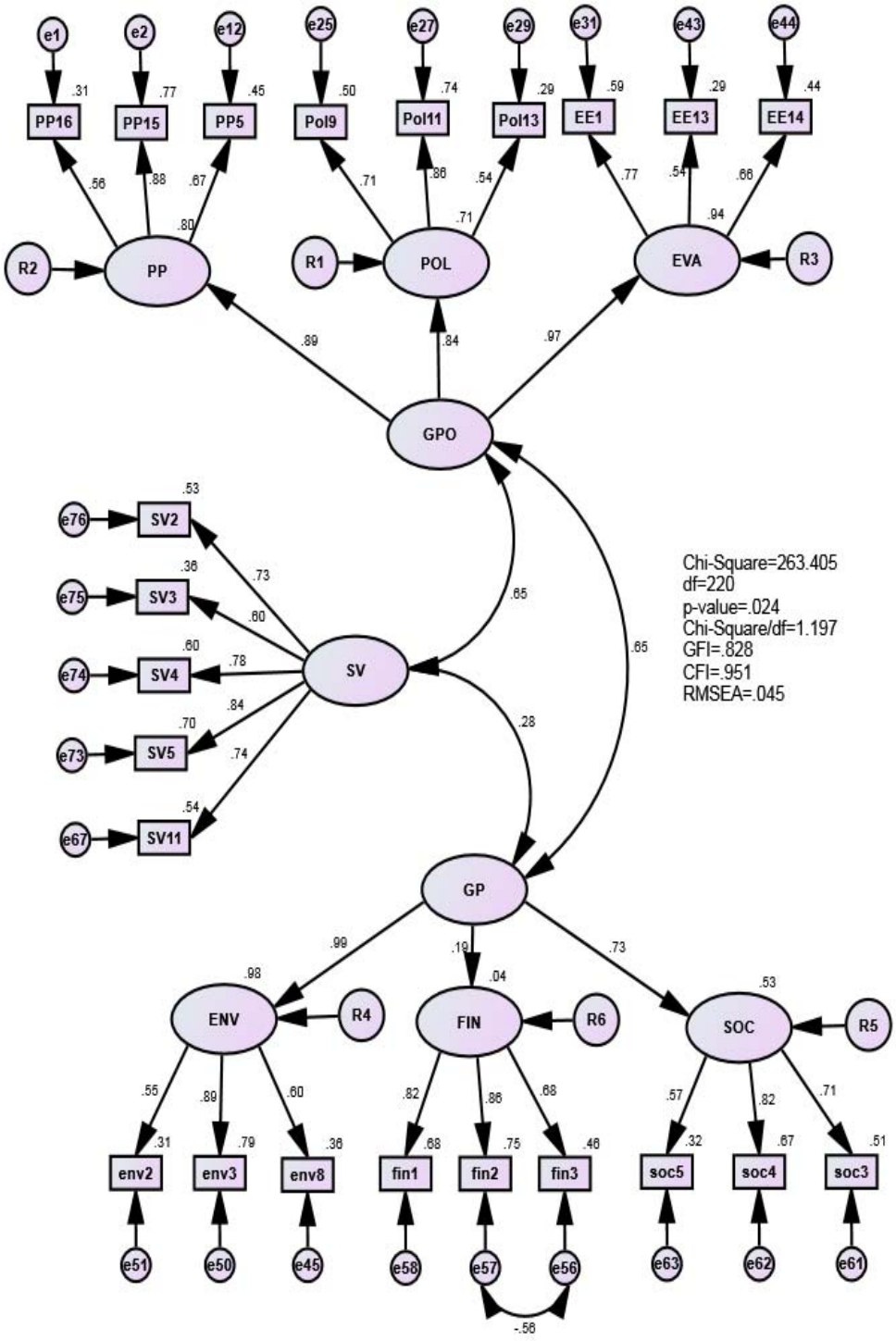

Figure 6.2 Confirmatory Factor Analysis Results from SEM-AMOS

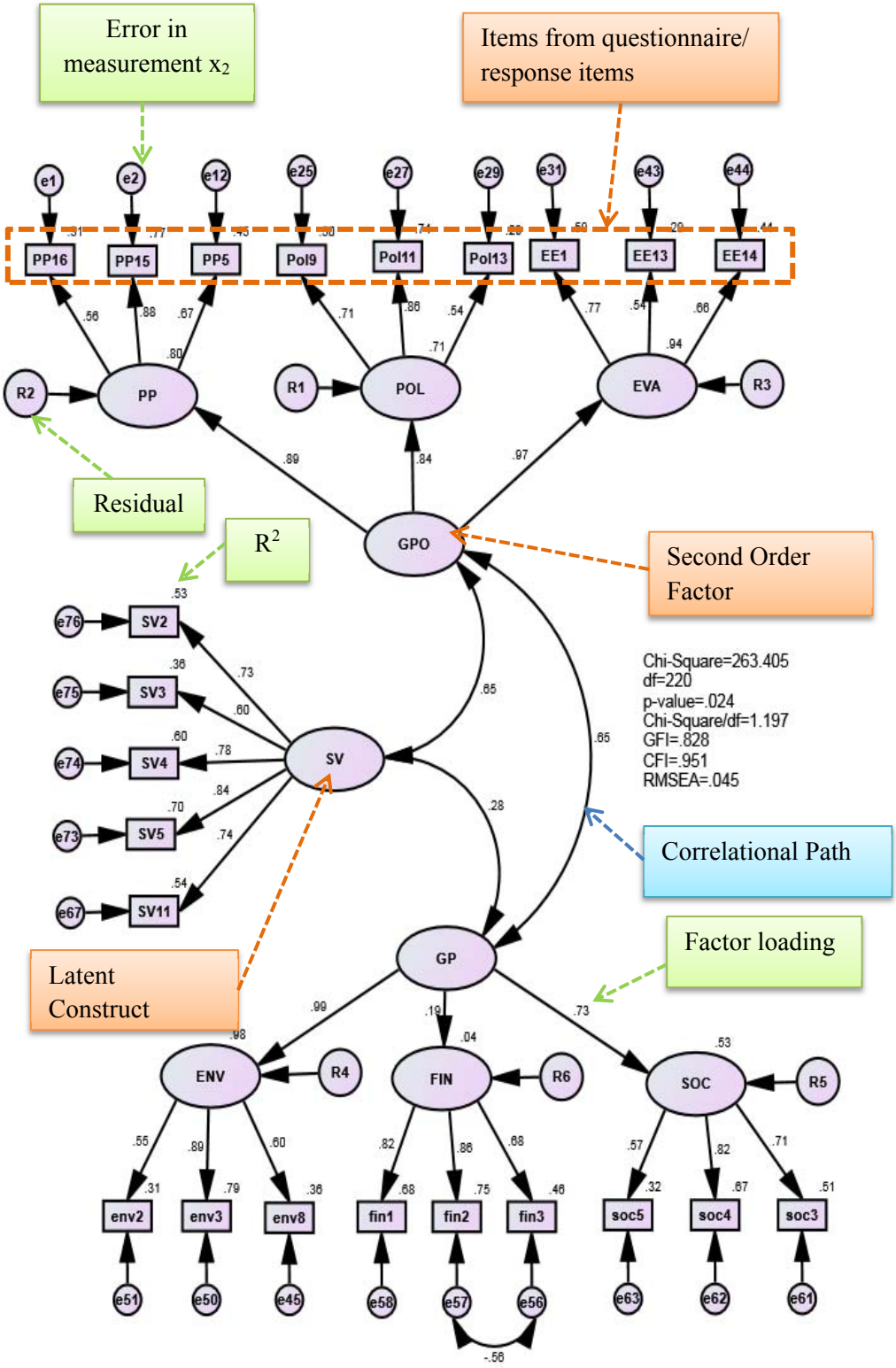

Figure 6.3 SEM-AMOS Output terminology used in this research

6.3.1 Evaluating validity and reliability of the measurement model

In the validation process of the research instrument, there are three basic validities, convergent validity, construct validity and discriminant validity. The construct validity is being achieved when the fitness indexes for a construct have achieved the required level as discussed in

Table 6.2. The fitness indexes indicate how fit the items are in measuring their respective latent constructs. The convergent validity refers to "the extent to which the scale correlates positively to its other measures of the same construct and discriminant validity is the extent to which a measure does not correlate with other constructs from which it is supposed to differ" (Hair, Gabriel and Patel, 2014).

PCFA is conducted to allow each measurement model tested in a similar situation and condition and permits the validity tests such as convergent and discriminant validity to be performed. Firstly, the unidimensional assessment was conducted and removed all meaningless indicators in this PCFA. The PCFA results as stipulated in Table 6.3 and Figure 6.2 show that all measuring items have acceptable factor loadings for the respective latent construct. All factor loadings are above the threshold of 0.40 as suggested by Lewis and Byrd (2003). All factor loadings are also positive numbers, which shows that this measurement model has achieved unidimensionality.

In order to achieve construct validity, the measurement model achieved the required fitness. Hair et al. (2010) suggested the use of at least three indices equivalence of absolute fit index, the incremental fit index and the Parsimonious fit index. Thus, all three indices used in this study had correspondence of RMSEA and GFI (absolute fit), CFI (incremental fit) and Chisq/df (Parsimonious fit). Table 6.3 shows the correspondence of RMSEA, CFI, TFI and Chisq/df study. The final PCFA revealed that this measurement model does fit well with RMSEA = 0.045 below the threshold value of 0.08; CFI with a value of 0.950 is regarded as an excellent fit. The GFI indicated the value of 0.842 that is within the acceptable fit. The measurement model achieved the required fitness required and strongly indicated that model achieved the construct validity.

To assess both convergent and discriminant validity, this study adopted tools by Gaskin (2012) for calculating average variance extracted (AVE, the mean of squared factor loadings) and maximum shared variance (MSV), the largest covariance with another variable). Gaskin's validity master tools can be used if the model has more than two latent variables and there are no "Heywood cases" in the model. Heywood cases is where the

AMOS outcome indicated that there is a standard regression weight loaded above the value of 1 (Gaskin, 2012).

For convergent validity, the Average Variance Extracted (AVE) value must be 0.50 or higher (Xiong et al., 2015). Assessing the AVE is necessary for making a reliable conclusion for this model. As indicated in Table 6.5, the AVE value for each construct is loading above 0.50. The AVE value also indicated the reliability of the measurement model in measuring the latent construct.

Table 6.3 Summary of CFA test Fit Indices for all measurement model

Index category	**Name of Index**	**Achieved Fit Indices**	**Comments**
Absolute fit	RMSEA	0.045	The required level is achieved
	GFI	0.828	The required level is achieved
Incremental fit	CFI	0.951	The required level is achieved
Parsimonious fit	CMIN/DF	1.197	The required level is achieved

This research indicated that the measurement model is free from the redundant items. The researcher deleted the items that highly correlated with other items based on the Modification Indices Report. Some of the redundant items have been set as 'free parameter estimate.' The final model also indicated the MI less than 10 that meets the requirement suggested by Hair et al. (2010) as stipulated in Table 6.4. The correlation between the exogenous constructs also did not exceed the value of 0.85 that indicated that the exogenous constructs are not having a serious multicollinearity problem. Table 6.4 indicated that the bold figure is the square root AVE. The square root AVE value should be higher than the values in its row and column and indicated that the measurement model is reliable and not having a serious multicollinearity problem (Fornell and Larcker, 1981).

Table 6.4 Discriminant validity

Construct	GP	GPO	SV
GP	**0.717**		
GPO	0.655	**0.904**	
SV	0.280	0.650	**0.740**

Table 6.5 Summary of CFA results for the measurement model for all main and sub-constructs

Construct	**Sub-construct**	**Item**	**Factor loading**	**Composite Reliability (CR) (>0.70)**	**Cronbach Alpha (>0.70)**	**Average Variance Extracted (AVE) (>0.50)**
Green orientation of building procurement	Product/ process	PP5	0.67	0.931	0.859	0.817
		PP15	0.88			
		PP16	0.56			
	Policies and guidelines	Pol9	0.71			
		Pol11	0.85			
		Pol13	0.55			
	Environmental evaluation	EE1	0.75			
		EE13	0.60			
		EE14	0.72			
Stakeholder values		SV2	0.71	0.854	0.857	0.548
		SV3	0.60			
		SV4	0.79			
		SV5	0.86			
		SV11	0.72			
Green Performance	Environment impact	Env2	0.55	0.714	0.752	0.515
		Env3	0.88			
		Env8	0.40			
	Economic	Fin1	0.88			
		Fin2	0.76			
		Fin3	0.71			
	Social	Soc3	0.71			
		Soc4	0.82			
		Soc5	0.59			

In addition, the composite reliability, or CR value more than 0.70, is required to show the reliability of this model. Table 6.5 revealed that all the constructs have CR value more than 0.70, which indicated the internal consistency of a construct and reliability of the model. The Cronbach's alpha coefficient, the measure of internal consistency of the questionnaire, was above 0.70 and indicating good consistency.

6.3.2 Green-oriented procurement (GPO)

The green-oriented procurement (GPO) construct is a second order construct with three sub-contracts: policies and guidelines (POL), environmental evaluation (EVA) and product and process (PP). The causal directions point out from GPO to the observed variable POL, EVA, and PP. Also, the sub-constructs POL, EVA, and PP are measured using items from the questionnaire (refer Appendix A, Question A, Section 4A, 4B and 4C).

The results in Figure 6.2 showed that green-oriented procurement as a lantern construct, loads well on its three sub-constructs. The factor loading of the critical practices of green procurement orientation on PP, POL and EVA are 0.89, 0.84 and 0.97 respectively. Furthermore, the R^2 for all sub-constructs are high (0.80, 0.71 and 0.94), which reflects the association between GPO on its three sub-constructs is good. The level of association between the GPO and its three sub-constructs is presented in the output of Regression Path Coefficient. Table 6.6 shows that the associations between the main construct on all sub-constructs are significant.

Table 6.6 The regression path coefficient and its significance for green-oriented procurement

			Estimate	**S.E.**	**C.R.**	**P**	**Results**
PP	<---	GPO	1.009	0.232	4.357	0.001	Significant
POL	<---	GPO	1.000	Reference Point			
EVA	<---	GPO	1.687	0.295	5.719	0.001	Significant

This shows that the theory suggested that the product and process, policies and guidelines, and environmental evaluation that are highly associated with green-oriented

procurement are well supported. This assessment has also attempted to answer research objective no 2;

"To determine the key factors and practices for green-oriented procurement of a building project in the Malaysian construction industry."

6.3.3 Green Performance (GP)

Green performance is also a second order construct with three sub-constructs: environmental aspects (ENV), economic aspects (FIN) and social aspects (SOC). The results also showed that the green performance loads on its three sub-constructs. The factor loading of green performance on environmental impacts, financial impacts, and social impacts are 0.99, 0.16 and 0.73 respectively. The environmental impacts and social impacts are highly associated with the main construct. The factor loading for a financial impact has somewhat of a low associated with green performance. The R^2 for ENV, FIN and SOC are 0.96, 0.03 and 0.54 respectively, which reflects that the association between GPO on its two sub-constructs (ENV and SOC) is good. Meanwhile, the association with another construct, FIN, is very weak. The level of association between the GPO and its three sub-constructs is also presented in the output of Regression Path Coefficient. Table 6.7 shows the associations between the main construct on all sub-constructs are significant.

Table 6.7 The regression path coefficient and its significance for green performance

			Estimate	**S.E.**	**C.R.**	**P**	**Results**
ENV	<---	GP	1.00	Reference Point			
SOC	<---	GP	0.751	0.209	3.593	0.001	Significant
FIN	<---	GP	0.278	0.198	1.402	0.161	Not Significant

Items loaded under financial impacts are;

- Fin 1 - Increase overall project cost due to environment –concerned activities
- Fin 2 - Increase operational costs to monitor environmental activities
- Fin 3 - Purchase to meet minimum environmental criteria

This research decided that this sub-construct (financial impacts) is retained in the model even though the result revealed the low association with the main construct, but there was a reliable association. It explained that there is an increasing of overall cost and operational cost due to environment –concerned activities, but it was indicated as a low. The point was to show there is a slight cost increase due to the incorporation of green practices. These three items are the items also strongly suggested by experts during the preliminary interview as mentioned in Chapter 4. This is also supported by a few studies conducted previously.

6.4 FINAL STRUCTURAL MODEL

The measurement model was CFA tested and reported in previous Section 6.3. The outcome from the measurement model and CFA test revealed that the measurement model is fit by assessing the model fit based on threshold value provided and meeting the requirement for the CF, AVE and Cronbach Alpha. By using the reliable and validated three constructs, the structure equation models were tested and assessed in this section.

6.4.1 Structure Model Fit

This research used a two-stage method to develop a structural model as suggested by (Xiong et al., 2014). As mentioned earlier, CFA demonstrates a satisfactory goodness of fit and is followed by the next stage where the correlation between the latent variables is replaced by hypothesising causal relationships. The result revealed that normed Chi-Square (CMIN/df) indicated a value of 1.227 that suggested threshold range between values of 1.0 and 3.0 by Hair et al. (2010). Anderson and Gerbing (1984), that the threshold value for GFI above 0.80 is considered an acceptable model fit with the condition that the CFI is above 0.920. The RMSEA shows a value of 0.048 that is considered very close to perfect fit. CFI is reported with acceptable range 0.944, which is above acceptable fit of 0.90. The conclusion is the structure model achieves the suggested goodness of fit.

The most important output of this stage is the value of R^2 for the model. Referring to Figure 6.4, the value of R^2 for the whole model is 0.43. By looking at this value, one could conclude that the model could capture at least more than 43 percent of the estimate on the endogenous construct by including certain exogenous constructs in the model. By this means, 43 percent of the performance in green performance could be estimated by using exogenous constructs, named critical practices of green orientation. The green procurement orientation variable is strongly

measured using sub-construct policies and guidelines, procurement-related practices and also environmental evaluation. At the same time, 40 percent of critical practices of green procurement could be measured by using stakeholder values.

Table 6.8 Final Structure Model Fit

		Final Structure Model Fit	**Result**
Parsimonious fit	CMIN/DF	**1.204**	***Excellent Fit***
Absolute Fit Indices	RMSEA	**0.045**	***Acceptable Fit***
	GFI	**0.826**	***Acceptable Fit, CFI above 0.920***
Incremental Fit Indices	CFI	**0.949**	***Acceptable Fit***

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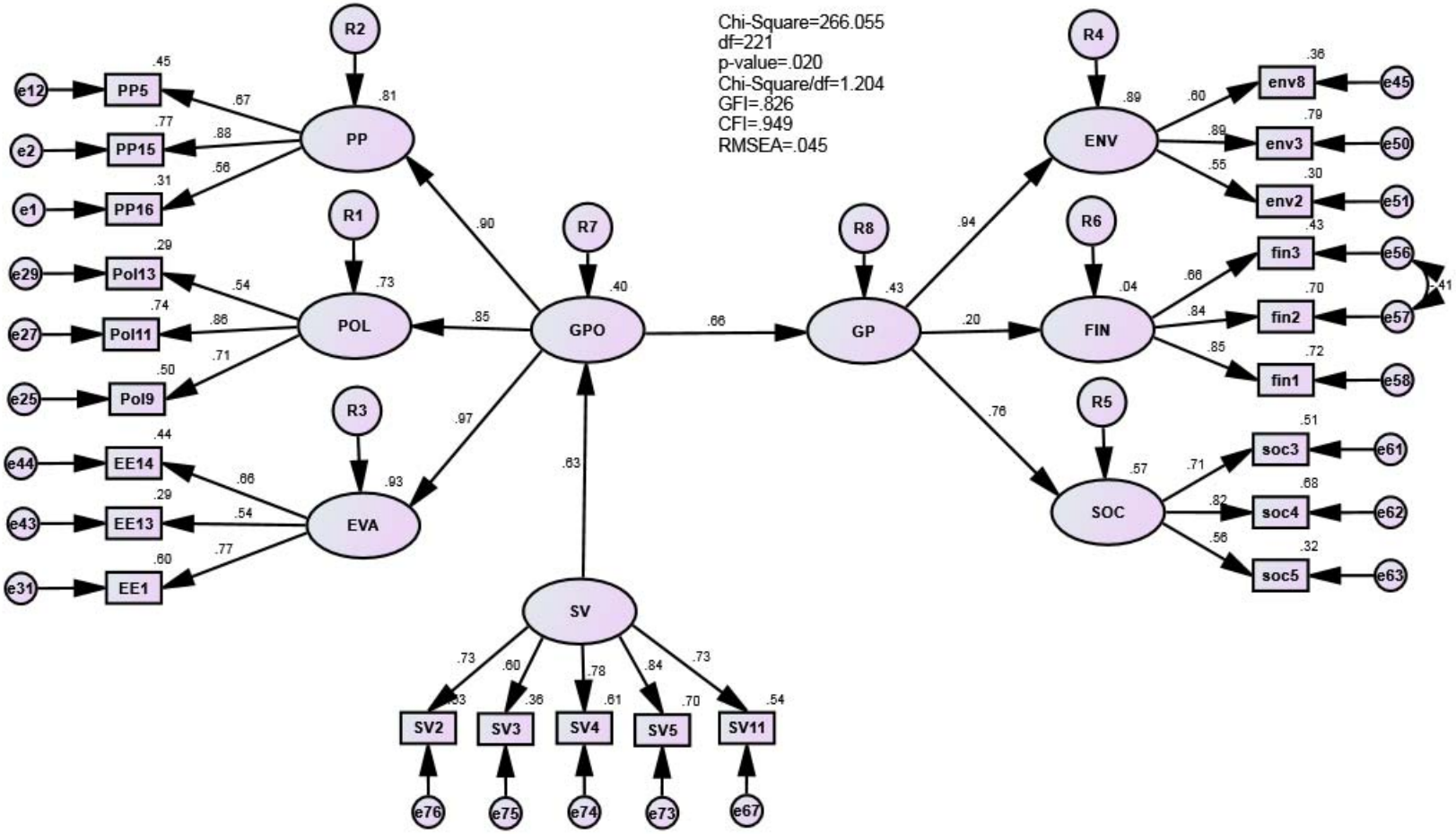

Figure 6.4 The standardised Path Coefficients between construct in the model

6.4.2 Impact of stakeholder values on green-oriented procurement

Based on AMOS output, the causal relations between stakeholder values on procurement's green orientation is hypothesised as H1 and provide an attempt to answer the second objective of this thesis;

> "*To examine these key factors and practices for green-oriented procurement of a building project in the Malaysian construction industry.*"

H1 is supported based on the H1 path coefficient that is 0.44 with CR value of 3.987. The $p < 0.001$ indicates a significant relationship. By looking at this value, 40 percent of critical practices of green procurement could be measured by using Stakeholder values.

This construct is measured using items namely project stakeholder commitment (sv2), project stakeholder technical competencies (sv4), Stakeholder ability to understand the bigger picture of green construction (sv5) and knowledge sharing among stakeholders in the project (sv11) is shown to positively and significantly impact the procurement's green orientation. The construct for critical practices of green procurement orientation is measured using three sub-constructs: policies and guidelines, procurement-related practices and environmental evaluation.

In the literature on temporary project organisation, a stakeholder is one of the important components of the temporary organisation and is a very important factor to ensure a project's success (Adham and Siwar, 2012; Bouwer et al., 2006; IISD., 2012; Li and Geiser, 2005; McCrudden, 2004; and Palmujoki et al., 2010). Each stakeholder is expected to work together towards the same goals and is required to have some values in term of technical skills, commitment and cooperation. These stakeholder's values create an effective organisation that has clear clarity of the project's goals.

In terms of level of importance, R^2 of each item are investigated. R-squared or represent using R^2 is the "percent of variance explained" by the model. It is called R-squared because in a simple regression model it is just the square of the correlation between the dependent and independent variables, which is commonly denoted by "r". In multiple regression models, R-squared is determined by pairwise correlations among all the variables, including correlations of the independent variables with each other as well as with the dependent variable. This will be further discussed in Section 6.5.

6.4.3 The impact of green procurement orientation on green performance.

Based on AMOS output, the causal relations between procurement's green orientation on green performance is hypothesised as H2 and is also an attempt to answer the third objective of this thesis;

"*To examine the impact of green-oriented procurement on the green performance of a building project.*"

The result revealed that the path coefficient of this causal relationship 0.66 and the CR value is 3.524. The value of $p < 0.001$ showed a significant relationship. Thus, H2 is supported. The construct for critical practices of green procurement orientation is measured using three sub-constructs: policies and guidelines, procurement-related practices and environmental evaluation. The green performance consists of three sub-constructs, which are environmental impacts, financial impacts and social impacts in terms of stakeholder's well-being. This discussion will be presented in detail in Chapter 7, Section 7.5 on the impact of environmental orientation on the green performance in Malaysia.

Table 6.9 The regression path coefficients and their significance

Construct			Estimate	S.E	C.R.	P	Result
GPO	<---	SV	0.552	0.125	4.411	0.001	Significant
PERF	<---	GPO	0.505	0.122	4.123	0.001	Significant

Table 6.10 The hypothesis statement for every path and its conclusion

Hypothesis statement		Result
H1	*Stakeholder values have a positive and significant impact on green-oriented procurement*	Supported
H2	*Green-oriented procurement has a positive and significant impact on project's green performance*	Supported

6.5 SUMMARY

This chapter focused on the empirical analysis focussing on the structure equation model (SEM) to examine the impact of the independent variables on the dependant variables using the path coefficient. Using Amos version 23, the research hypotheses were tested and the level of significance reported. The use of SEM-Amos as a methodology is suitable for this study because SEM as a multivariate technique uses analysis of covariance to explore relationships among a set of variables, as previously suggested by two researchers in the green procurement research (Adham, 2014; Bakir, 2013). The final model conforms to the threshold values of model fit statistics as shown in Table 6.2. The final model shows a normed Chi-Square of 1.204, GFI = 0.826, CFI =0.949 and RMSEA = 0.045 (refer Table 6.8). In general, the data is consistent with the hypothesised model.

CHAPTER 7: DISCUSSION

7.1 OVERVIEW

This chapter discussion explains the results and findings of the data analysis in previous chapters of this thesis. The final research findings were formulated and the data analysis results integrated with the findings from the literature review in Chapter 2 and preliminary interview in Chapter 4. Each key factor of green-oriented procurement for the building project was identified from the previous analysis and explained thoroughly. The synthesis was of all the data collection methods applied in this research; the questionnaire and analysis of structure equation modelling are discussed in detail. The final model of green procurement for the building project to support green construction practices is then presented. The developed guidelines help achieve the aims of this research.

7.2 REVISITING RESEARCH QUESTION

The following section addresses the research questions. Recently, sustainability has been a major concern and there has been discussion within the construction industry in addressing the adverse impact of development towards the natural environment. The principle of green concept and green construction has been introduced as a way to tackle this issue and improve current practices. Major conferences discussing the suitability issue have suggested that procurement is an effective tool to integrate the green concept into the organisation or system. Construction procurement is no exception. Green procurement for construction projects has a practice in construction in developed countries. This research began with reviewing a few fundamental concepts including building project organisation, procurement practices and environmental management. Based on extensive literature review, it is found that academic research discussing green-oriented procurement for the construction industry has been under-represented and this justifies the need for this research.

The research questions and research objectives provided a clear direction and strong basis upon which to achieve the overall aim of the research. The aim of the research was to model green-oriented procurement practices for a building project, in the context of the Malaysian construction industry, which potentially could be used by both government and

private stakeholders, to plan for procurement strategic planning for a green project. Subsequently, the research was facilitated by the adoption of an appropriate research methodology. Three interrelated but distinctive approaches to data collection were selected and adopted in this research:

1) Preliminary interviews among experienced practitioners
2) A questionnaire survey of industry professionals
3) SEM- AMOS analysis

The three research questions aligned with the two phases in this thesis, sources of data and the main method of analysis used, are presented in Table 7.1.

A range of factors that influence green-orientated procurement, as perceived by researchers and practitioners, is identified through the review of the literature at the beginning of the research. In fulfilling the first objective, the literature review identified sixty-four potential practices for supporting green-orientation procurement. The questionnaire survey was designed based on these identified factors. The survey was conducted to examine the importance of these factors in green project practices. These factors were validated by experts in the Malaysian construction industry. The interviews have resulted in the reduction of the list of green practices derived from the literature because of irrelevance and redundancy. Literature identified forty-four practices and another ten new lists of practices proposed by the interviewees. Consequently, the SEM-AMOS analysis conducted helped achieve the third objective, by providing a strong basis for the establishment of the structural model. The outcomes of this research can assist project stakeholders to improve their capabilities in order to support the implementation of sustainability measures. Figure 7.1 shows a final structural model where two hypotheses, H1 and H2, were posed and supported.

Table 7.1 Research questions, objectives and the phases of the thesis

Research question	**Research objective**	**Phase of the study**	**Source of data**	**Method for data analysis**
RQ1: Which practices, associated with green-oriented procurement of a building project in Malaysia, are important?	1. To identify the factors and practices that are associated with green-oriented procurement of a building project.	Stage 1 information gathering	Literature review, preliminary interview	Preliminary interview -Thematic analysis
	2. To determine the key factors and practices for green-oriented procurement of a building project in the Malaysian construction industry.	Stage 2 and tested at Stage 3 of this research	Questionnaire	SPSS and SEM-AMOS analysis
RQ2: Do these practices have any significant relationship with the green performance of a building project in Malaysia?	3. To examine the impact of green-oriented procurement on the green performance of a building project.	Stage 2 and tested at Stage 3 of this research	Questionnaire	SPSS and SEM-AMOS analysis
RQ3: How can project stakeholder use the identified key practices of green oriented procurement to improve project's green performance?	4. To model the key practices of green-oriented procurement and the impact of green-oriented procurement on the green performance of a building project	Stage 1 preliminary model, Stage 3 finalising model	Literature review, preliminary interview & Questionnaire	

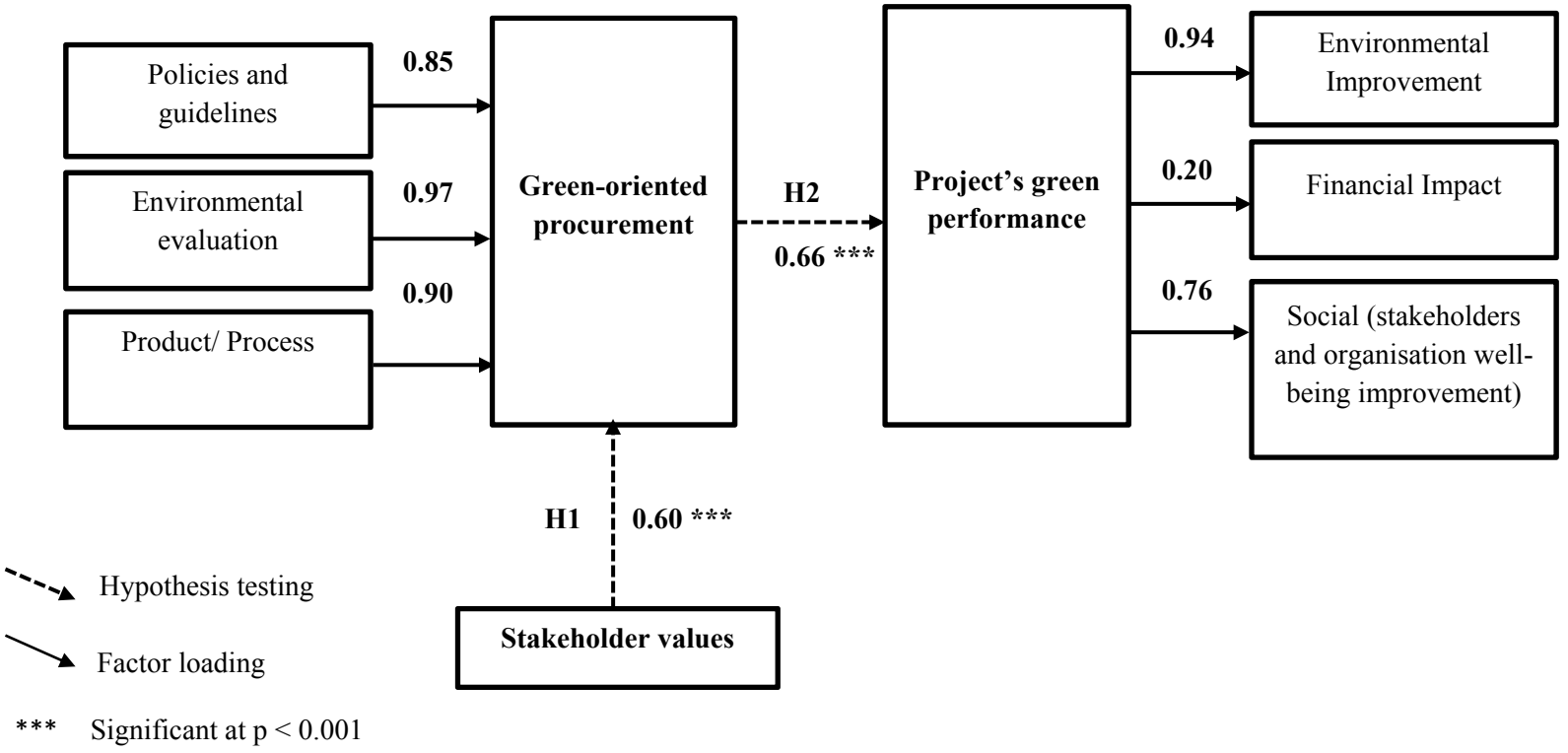

Figure 7.1 The structural paths of the final model

7.3 WHICH ARE THE FACTORS AND PRACTICES THAT ARE IMPORTANT FOR GREEN-ORIENTED PROCUREMENT FOR BUILDING PROJECTS IN MALAYSIA?

In addressing the research questions, three key factors and practices for green-oriented procurement for building projects in Malaysia were derived from literature and supported by experts through the preliminary interview. The items of measurement were designed to measure the green orientation of building procurement constructs. Both the literature and preliminary interview outcome were used to formulate the survey instrument, the questionnaire, to provide internal consistency.

Three factors referred to as policies and guidelines, product and process and environmental evaluation are found to be the important aspects to determine green-oriented building procurement in Malaysia. As methodically measured and validated, policies and guidelines, product and process, and environmental evaluation, are the important factors that determine the green orientation of a building project from the perspective of experienced practitioners from the Malaysian construction industry. The result of the study, as validated by SEM-AMOS analysis, also suggests that the three factors of the green orientation of building procurement are equally strong factors.

A preliminary conceptual model is developed for a building project in Malaysia, as a general guide to understanding the key aspects that are regarded as being highly associated with green-oriented procurement practices. The combination of these factors will provide the right approach to the path that will provide the way to form a green-oriented culture and move forward sustainability in the construction industry. Each of the three important factors is discussed in more detail, as follows:

Table 7.2 Summary of final items on sub-construct and constructs

Sub-construct	Item coding		Standardised loading	Ranked based on factors
Product/process	PP5	Selecting materials based on project's basic environmental requirement (technical)	0.67	2
	PP15	Using On-site systematic waste management	0.88	1
	PP16	Giving priority to suppliers with long term policy, which promotes efficient waste management	0.56	3
Policies and guidelines	Pol9	Definition of "green" by project team	0.71	2
	Pol11	Availability of policy at project level urging environmental awareness	0.85	1
	Pol13	Availability of eco-labelling program	0.55	3
Environmental evaluation	EE1	Government approval at early stage to incorporate green practices	0.75	1
	EE13	Considering public feedback	0.60	3
	EE14	Mandatory legislative report submission e.g. Environmental Monitoring Report (EMP)	0.72	2

7.3.1 Policies and guidelines

Policies and guidelines in this research refer to the policies or guidelines that are urging the integration of green practices formulated as environmental standards, regulatory frameworks, and industry standards, and include policies and guidelines formulated at the project level. This research confirmed that policies and guidelines could send a signal to the whole project life cycle to adopt green practices. The policies and guidelines that were enforced efficiently through the provision of environmental standards, regulatory frameworks, and incentives, act as the control tools to ensure compliance (Ruparathna and Hewage, 2015b). Roos (2012) also pointed out that sustainability considerations can be addressed at various points across the procurement stages and are defined by the relevant laws and regulations.

SEM-AMOS analysis from this study highly supported the association of policies and guidelines in determining green-oriented procurement. The result revealed that the policies and guidelines in understanding the concept of "green" at the project or at organisational level are ranked as top practices and are followed by the availability of policy at project level urging environmental awareness. This shows the importance of interpreting the policies and guidelines given by government and industry and customised based on the needs of specific projects. This outcome is alligned with Ofori (2000) and Zhang et al. (2016), in that setting up a clear objective at project level helps to pave their way towards green building development. Availability of guidelines at project level helps the project to signal to the stakeholders the need to be on a greener route. This finding aligned with Zhu and Sarkis (2006), in that policies and guidelines are the coercive pressure that demand a green culture throughout project delivery. Policies and guidelines can shape project-buying behaviour in terms of what to procure and what processes are involved. It will help the project team that has a decisive power to develop the procurement strategic plan that incorporates green practices. Sourani (2008)'s finding enhances the importance of policies and guidelines in formulating green adoption strategy into procurement practices. Policies and guidelines have a strong push factor to drive changes within the industry.

Furthermore, the current challenges that they face, as mentioned by one of the interviewees during the preliminary interview, are to persuade the whole team to integrate green practices. Various studies also have suggested the importance of defining the term "green" within the project's context to ensure that all project stakeholders are working on the same interest (Hes, 2005; Marcelino-Sádaba et al., 2015). 'Green' needs to be defined

carefully within the project context and client expectation. Various considerations need to be put in place: for instance, the priority on the fundamental project objectives, that are the cost, time and quality with the need to integrate green practices.

Construction stakeholders coming from different backgrounds with difference expertise will have different expectations and interests for the project. A clear direction on project goals will help each party to realign their expectation and interests based on the project goals. The availability in understanding "green" at project level signals to the team the priority for green concepts in the project. Basic understanding posed by Lundin and Soderholm (1995), where it is expected that the individual with different background and experience will interact within the team environment, which has been brought together by a common interest (1995). The agreed common interest helps the project team to make a better decision pertaining to procurement delivery and helps to minimise or mitigate the risk of purchasing.

The use of industry standards, such as eco-labelling, has gained global attention and been identified as environmentally effective (Grolleau et al., 2007) in helping the project team to decide on the extent of green practice adoption in the project. Malaysia has initiated the eco-labelling program under *myHijau* program and *myHijau* Directory and it is still emerging. Apart from promoting sustainability in the built environment and raising environmental awareness among developers, designers, and builders, eco-labelling can help to provide a benchmark to evaluate building materials for its environmental impact and performance. Eco-labelling is an effective way of informing project stakeholders of the green impact of products based on achieved prescribed environmental standards. The information helps project stakeholders to make informed purchasing decisions (Bratt, 2011; Li and Geiser, 2005). During the interviews with experienced practitioners, and empirically validated using SEM-AMOS, industry standard eco-labelling emerged as crucially important to help project stakeholders to benchmark the level of green products and services and identify the sets of green procurement indicators that will be part of the project's requirement.

To summarise,

- Policies and guidelines are validated as key aspects of green-oriented procurement of building projects in Malaysia. There are three practices related to policies and guidelines that are validated as crucial: the availability of policy at project level

urging environmental awareness, the definition of "green" by the project team and availability of the eco-labelling program.

- This research provides an insight into the policies and guidelines that can be a contributing factor to integrating the green building procurement process, and to the notion that project stakeholders require an established set of policies and guidelines in their decision-making process.

- Policies and guidelines must be formulated at the project level to guide the stakeholder in a decision-making process, including the decision about the extent of green practice adoption as well as the project's green direction.

7.3.2 Product and process

The second key aspect identified from the literature review and validated from the preliminary interview is the integration of the green principle into a procurement process of products and services. Sterner (2002) mentioned that a green procurement must integrate the principle of green throughout the process; this includes the procurement planning and selection of products and services. Green procurement practices were identified from the literature and exploration to suit local context was carried out by conducting face-to-face preliminary interviews among the experienced practitioners of green building within the Malaysian construction industry. Findings from the literature review revealed that there is no collaborative guideline on the current green procurement practices in the Malaysian construction industry. However, there are a few practices that have been incorporated into procurement such as purchasing green building materials.

The items under this construct that incorporate two main practices are i. green products and services and ii. green practices related to the procurement process. Based on past research, green products and services has referred to the effect of the product on the natural environment: the carbon impact, recycling, and association with waste management. Meanwhile, green practices refer to the procurement process that considers the green practices such as value management, life cycle analysis, usage of information technology such as e-tendering and building information management (BIM). There are three practices that are ranked as important;

- Consideration of waste management principle

- Pre-qualification of building material supplier that promotes a waste management principle
- Availability of project environmental criteria

The empirical findings suggested that the purchasing of materials and services related to waste minimisation throughout project stages ranked in the top important practices under the product and process construct. There have been some criticisms that the building project throughout the project life-cycle has poor waste management and low awareness on waste reduction. The outcome of this research, which is supported by Peng, Scorpio, and Kibert (1997), revealed that reduction of construction waste is one of the efficient methods used in combatting waste disposal problems. Also, previous research has identified a number of benefits derived from recycling, such as the use of less energy and fewer resources in the manufacturing of products (Björklund and Finnveden, 2005). During the face-to-face interview with an experienced practitioner, one of the interviewees mentioned the concept of reverse logistics and the recycling campaign as one of the most common, yet effective, efforts in reducing waste. Quoted from R2;

"We asked one of the suppliers, Lafarge, to provide 500kg in one bag instead of 50kg. We are indirectly helping to save the environment by reducing usage of paper and plastic to pack the cement. We also encouraged them to recycle the used cement bag." (R2)

The impact of reverse logistics is described: "the resources recovered are used to make new products, thereby mitigating the need to extract new resources, thus reducing the environmental impact" (Miller and Sarder, 2011). Implementing reverse logistics has proven to be an effective strategy to make organisations more competitive in the manufacturing sector (Krikke et al., 2004; Lau and Wang, 2009). The Malaysian construction sector reported five percent productivity growth (Malaysia Productivity Corporation, 2009), supporting the prediction that the construction waste generation rate will continue to increase, highlighting the need to incorporate this practice into the project.

Stakeholder involvement is an important enabler of building procurement and integration of green principles as a new approach in procurement delivery. This research revealed that the selection of building materials' suppliers and sub-contractors that support the green initiative in their organisational policy, helps to improve a project's green compliance and delivery. The infamous issue of waste has been long discussed in

construction projects, thus, selection of building materials' supplier and sub-contractors who promote and support effective waste management is very relevant.

One of the ways forward is to do pre-qualification of the supplier and sub-contractors who are green certified, based on their credentials in green initiatives. It is good if a supplier or sub-contractor can come out with their proposal on waste management throughout the product life cycle as well as when the work is done on site. In a report by the United Nations Environmental Program (2014), it is important for a building material supplier to provide a necessary waste management plan and waste management reporting to ensure compliance. As highlighted by Ofori (2000), the demand for a green certified supplier and sub-contractor will be a signal throughout the building supply chain, urging them to shift towards a greener approach by formulating waste management policy and obtaining environmental certification.

This research also recognises the importance for a project to produce a project's environmental criteria at project brief to help the stakeholders in making a purchasing decision. The environmental criteria refers to the criteria sets through legislative and industry requirement and are tailored based on project suitability. These environmental criteria also send a signal to the project team on how and to what extent the project greenness is required. This finding is similar to that of Sourani and Sohail (2005), in that incorporating the environmental criteria in a project brief enables the green issue as a focus at any stage of the project.

This research revealed that material selection should consider meeting at least the minimum requirement of environmental criteria that has been formulated at project brief, thus highlighting the need to include the environmental criteria to be part of contract specification and condition. Souri (2008) emphasised that integration of this requirement is the top priority for a project to be green. Consideration must be given to the available policies and guidelines produced by government and industry to ensure compliance (Grob and Mcgregor, 2005). In the Malaysian construction industry, the government demand is for greener project delivery for building construction. As explained in Chapter 2, a few policies and guidelines have been identified including the Code of Practice on Energy Efficiency and Use of Renewable Energy for Non-Residential Buildings MS1525:2007. This code is used as the minimum baseline in designing energy efficient buildings that demand the usage of green materials and services.

To summarise,

- A project's environmental criteria are very important practices that will lead to a project being green. They have to be formulated based on the project's suitability at project brief
- To incorporate the green criteria is part of the contract requirement and condition
- Select building materials from suppliers and sub-contractors where environmental management policy in their organisations focuses on waste management.

7.3.3 Environmental Evaluation

The third key aspect refers to environmental evaluation and is regarded as one of the important aspects of green-oriented procurement. The importance of environmental evaluation for successful environmental performance in an organisation is proven in previous studies including Adham (2014). Environmental evaluation provides a proper evaluation of a project's compliance with the environmental requirement, serves as a basis for the re-evaluation and adjustment of the requirement and supports the possibly needed development of new environmental requirements. A proper auditing base on the performance indicators should be identified as a measurement system and also a suggestion on the non-compliance procedure (Green, Morton, and New, 1998). Sourani (2008) suggested that environmental evaluation should be conducted periodically to monitor performance. The evaluation plan needs to be decided on, as early as in the planning stage. There are three environmental evaluation practices identified as important:

- Environmental evaluation by government during planning stage
- Continuous mentoring by government during project delivery
- Public feedback.

The empirical finding of this research revealed that environmental evaluation by external stakeholders, such as government and the public, could help to monitor a project's compliance. The government in its normal setting has a coercive power to ensure compliance and the public, on the other hand, is normally the end user of the building that is affected by the project. Early involvement of the government during the planning stage is seen as giving the pressure to urge for green compliance in project delivery. This research suggested that submission of a green compliance plan is a prerequisite document for project plan approval. A green compliance plan should be a holistic approach throughout all procurement stages in terms of site selection impact, building design based on green principles, selection of green building materials etc. However, a green compliance indicator must be formulated to set a

basic standard requirement to provide a guideline to the industry practitioner. In Malaysia for instance, Code of Practice MS1525:2007 (Introduction of energy-efficiency and the use of renewable energy for non-residential buildings) was introduced as a guideline to the industry. This code urged for a new non-residential building to be designed based on energy efficiency principles.

Continuous monitoring is one of the environmental evaluation strategies to ensure compliance by project stakeholders. The project needs to plan an evaluation strategy throughout the procurement stages. For instance, submission of a green compliance plan to the government during the planning stage, incorporation of the environmental requirement in the tender selection and submission of an energy usage report to the relevant organisation (Renukappa et al., 2013). Kahlenborn et al. (2013) pointed out that environmental evaluation and reporting is a challenging task. Environmental evaluation in this context does not mean to decide on the extent of success or failure; instead, it means to track progress by identifying the current performance, identifying any related issue that arises and additional plans to improve current delivery.

This research also acknowledges that public monitoring is an efficient way to ensure green compliance. In the literature of environmental management, public feedback is an important practice. The public are regarded as the external stakeholders but are affected by the projects, thus, their opinion matters. The research conducted by Zhang et al. (2008) shows those pressures from the community play significantly positive roles in engaging firms in improving environmental management performance.

To summarise,

- There should be a performance indicator to check environmental performance and track the non-compliance practices throughout the procurement stages.

- The study found evaluation practices by a third party, such as government or the public, are important practices to ensure compliance. This finding suggested that strong enforcement and monitoring is needed to create awareness and compliance at this stage of implementation.

- Involvement of the evaluator during project planning and the designing stage are important practices, but continuous monitoring must be done throughout the project life-cycle.

7.4 IMPACT OF STAKEHOLDER VALUES ON THE BUILDING PROCUREMENT GREEN ORIENTATION

Kibert (2012) suggests that the construction industry must shift to a greener approach in order to address the problem of environmental degradation. Such a shift requires the support of the various stakeholders of construction projects, and guidance from higher-level management (Adham et al., 2013). Findings from the literature review suggested that stakeholders are the most important aspect of project success. In construction management literature, project stakeholders are the enabler that helps to materialise the project's goals. Thus, the stakeholders are expected to hold values that drive them towards those goals. Deal and Kennedy (1983) defined organisational values as the guiding principles of actions. As revealed by Berry and McCarthy (2011), stakeholders' commitment and competencies are the top factors that are important in implementing the green concept in an organisation and these values create an effective organisation that has a clear focus on results and clarity of goal (Moynihan and Pandey, 2004).

There are key five items identified under stakeholder values (Refer Figure 7.2).

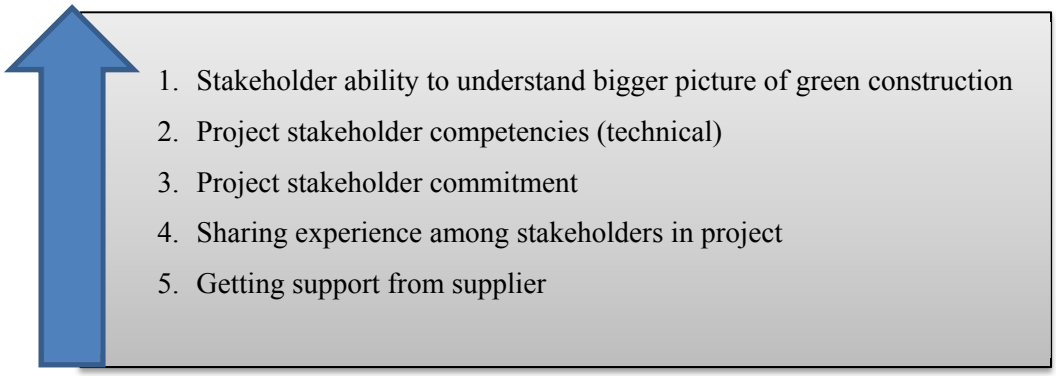

Figure 7.2 Ranking of stakeholder values based on SEM analysis

The SEM-AMOS analysis of this research has revealed that a stakeholder's ability to understand the bigger picture of green construction is of the utmost importance. Sarpin and Yang (2013) categorised this practice as the anticipatory capability that related directly to the concept of sustainability. The ability to think on the short- and long-term consequences, including the risk of any decision, is crucial for a better future. Thus, it is important to create awareness and educate the project stakeholders before projects commence, as well as throughout the project life-cycle. During the preliminary interview, one of the interviewees (R5) highlighted that the team that consists of those parties that are aware of environmental issues, will help the success rate of incorporating green practices in the project. Sufficient guidance and education in adopting and

implementing green practices in a project will be important determinants for green-oriented operation in an organisation.

Technical competencies were ranked as of second importance in practices under the stakeholder's values construct. Competencies may be referred to as the expected behaviour that an individual must demonstrate, and some might refer to it as the minimum standard of expected performance (Hoffmann, 1999). In this research, the competencies refer to the specific technical ability to perform the activities within an occupation's scope, to the standard expected by the client (Dada and Musa, 2016). Within project organisation literature, project stakeholders came from various backgrounds of technical skill and were expected to have competencies to perform in order to meet project objectives. Thus, for a green project, these stakeholders are also expected to have a certain level of knowledge on green practices. Specifically, the technical competencies are the skills required to drive green project delivery, such as green products, environmental criteria, determining criteria for evaluation, verifying bidders to bid on the adherence to environmental criteria and monitoring the implementation of green procurement. Continuous training and learning throughout the project is necessary to deepen their competencies. Furthermore, their credentials on green construction, such as green certification and experience in a green project, are indicators that they have sufficient knowledge on green implementation.

The third important practice under this stakeholder value construct is the stakeholder's commitment. Commitment refers to "the identification of individuals in an organisation characterised by a strong belief in the organisation goal and values" (Porter et al., 1974). As discussed in the literature of project organisation, commitment from stakeholders is crucial. The authors, Adham and Siwar (2012), Bouwer et al. (2006), IISD (2012), Li and Geiser (2005), McCrudden (2004), and Palmujoki et al. (2010), suggested that every procurement policy must encourage greater involvement and commitment of the stakeholders. These stakeholders coming from various permanent organisations are required to work together to meet project goals. Thus, each of the individuals is expected to have a mutual understanding and give their commitment to accomplishing project goals. Although there is different interest for each of the stakeholders, it can be shaped into heading towards the same goal, by formulating common interest.

The commitment will start with creating awareness and nurturing understanding among the stakeholders. The organisation's sustainability strategy must also include the vision, mission and value statement to summarise the organisation's desired approach to sustainability. This is then followed by the settings of the goals, objectives, and processes to promote sustainability. Once the sustainability strategy plan has been finalised, it can then be made available to all the

stakeholders. At this point, this research suggests that all stakeholders must have the ability to deeply understand the strategy to articulate it to the other stakeholders involved, both internal and external to the organisation. When explaining the strategy to other stakeholders, it is important to establish a clear line of communication, to review and document work and to conduct spot checks (Putnam and Price, 2005). The stakeholder commitment will drive the whole team to cooperate in determining the extent of green adoption in the project and implementing it into actual practice.

Knowledge sharing ranked as the fourth important practice under this stakeholder values' construct. Knowledge sharing refers to the knowledge dissemination and training within the organisation. Earlier literature has affirmed that failure to disseminate knowledge and create awareness among stakeholders is one of the most common barriers to implementing the green concept in a project (Abidin et al., 2013). Souran (2008) supported this finding and revealed that knowledge-sharing practices in procurement delivery are very important to establish a link between project teams in that particular project. One of the interviews in the preliminary interview conducted earlier in this research mentioned that, an experienced stakeholder could help to guide project teams through formal and informal knowledge sharing. R4 quoted that;

> *"Actually, this is the first time the consultant has been involved in green building. Fortunately, the contractor is knowledgeable and very proactive in the green part." (R4)*

Souran (2008) also highlighted that knowledge-sharing practices help the project team to develop the technical knowledge needed to deliver a green project. Knowledge sharing can be in the form of formal and informal training, project meetings and benchmarking. This knowledge sharing can be done through continual training throughout project delivery to ensure the green project goals' accomplishment (Robichaud and Anantatmula, 2011). Continual training can be a common training routine in the construction project such as the project briefing, monthly progress meeting and relevant educational session, all helping to create awareness and capabilities of stakeholders (Robichaud and Anantatmula, 2011).

This research recognised the top-down approach as the effective way to signal the industry gearing towards a green approach. There is strong evidence from the literature that legislative requirements and guidelines have the ability to motivate the industry to a new direction (Abidin et al., 2013; Adham and Siwar, 2012; Bakir, 2013; Bohari et al., 2015;

Ruparathna and Hewage, 2015b). Literature also suggests that the support throughout the supply chain helps to strengthen the effort to integrate the green concept into procurement practices. Based on the empirical evidence, this research revealed that support from suppliers ranked as the fifth-most-important practice under the stakeholder values' construct. As Seuring and Miller (2008) explain, the decision by project clients to incorporate green practices applies pressure to the supply chain. This pressure starts from a focal company being appointed and then passes to the multi-tier suppliers and sub-contractors. Thus, getting support from suppliers throughout the supply chain will help to ease the process. In research by Eltayeb and Zailani (2009) and Wooi and Zailani (2010) on green supply-chain management for the manufacturing industry in Malaysia, the level of involvement of Malaysian companies as well as adaptation to green supply chain management was low, which makes the momentum towards implementing a green procurement slower.

To summarise,

- This research empirically validated that project stakeholder values are a crucial factor for green-oriented procurement. Stakeholder ability to understand a bigger picture ranked as the top priority, followed by stakeholder technical competencies, commitment, the knowledge sharing and also support from supplier, which are the five important values

- Creating a common value can help project stakeholders who came from different permanent organisations and professional expertise can help the project to meet its project goals.

7.5 IMPACT OF GREEN-ORIENTED PROCUREMENT ON THE PROJECT'S GREEN PERFORMANCE

The second research question of this research is to examine which green procurement practices influence the performance of a green building project. Hypothesis 2 postulates that there is a significant positive relationship between green-oriented procurement and a project's green performance. Green performance as mentioned by Ofori (1992) is in addition to the triangle of common project goals; these are the cost, quality and time dimension. In the theory of environment management, environment, social and economic aspects are the most commonly used sustainability indicators in infrastructure

projects. However, the environmental aspects dominated the field of construction. While it is important to address the environmental concerns, the social and economic issues also need to be considered. Green performance in this research context was measured based on the perception of the research respondents.

The finding of this research has conceptually and empirically examined the aspects of green-oriented procurement and green performance. Empirical results of this research validated the idea on the importance of greening the building procurement in the project's green performance. Three key aspects of green performance are environment, economic and social impact, as explained below.

7.5.1 Environmental aspect

This research revealed that an environmental aspect is the major focus of a non-residential building project. The SEM-AMOS analysis provided the empirical evidence of this strong association. The integration of green principles into the procurement process will help to improve the overall building's green performance, including environmental aspects. The empirical evidence derived from this study revealed that there are three environmental improvements as the outcome of incorporating green practices in the procurement delivery. These environmental improvements are the indoor air quality, energy efficiency and reducing the contribution to pollution. Throughout its life cycle, building makes a significant contribution to global greenhouse gas (GHG) emissions and is a major consumer of energy (Robichaud and Anantatmula, 2011).

The empirical finding shows that a government has a coercive power in ensuring green compliance through the formulation of policies and guidelines and shaping the green mindset of the stakeholders in the project organisation These practices will also lead to an environmentally conscious buying habit or culture, as revealed in the empirical finding. The continuous evaluation throughout the process of procuring the project also helps projects to benchmark and improve their performance. Thus, it is concluded that determinants for green-oriented procurement have a positive impact in improving a project's green performance. The greater the degree of acceptance, the higher the impact will be on improving the environmental aspect of green performance.

This research context, which is that of Malaysian construction, requires new building construction specifically to be on a greener path by introducing efforts towards green construction, including the application of green procurement. The government has started

this effort by educating the industry through a series of training and workshops and introducing policies and guidelines on the green concept. Since the 1980s, policies on Environment Impact Assessment have been enforced. The EIA required any new proposed project to submit risk assessment and is a way to mitigate the impact; currently the building standard of MS1525 serves as a baseline for energy efficiency design for non-residential buildings.

7.5.2 Economic aspect

Green star (2010) and Varnas et al. (2009) strongly suggested that financial impact should be considered in evaluating a project's green performance. Literature has proposed the concept of value for money by adopting life-cycle-costing (LCC) in the selection of products or services (Hochschorner, 2008). The cost of going green must be internalised and does not increase long-term costs (Sterner, 2002). However, Williams and Dair (2007) argued that the cost of providing green features and developments is significantly higher than for standard schemes. Similarly, Kato and Murugon (2010) revealed that some of the green start certified buildings cost more, with an average of 10 percent addition. Although some clients are willing to pay for the extra costs involved, this could be a de-motivation factor for future projects and for other clients wishing to venture into green projects. Bandy et al. (2007) and Brammer and Walker (2011) asserted that higher upfront costs (new designs, technology, and construction methods) were the main barrier to green building development. Sourani (2008) mentioned that the cost increase in the long term would reduce the interest of construction stakeholders to purchase green materials and services.

Empirical findings of this research (sub-section 6.3.3) validated the later opinion by Williams and Dair (2007), in that there is an increased cost to the overall operating costs and the costs of the monitoring green practices. This finding is also similar to a study conducted by Yang & Zhang (2012), where they found the negative correlation between green cost and the green purchasing. However, this research proposes that this cost increase also must be discussed in a broader view that considers the effects over a long time during the lifespan of the building and in a broad perspective, the future generation. It also suggests that there is a need to further investigate the actual reason of the cost increase.

The logic may well be that there is limited availability of the materials and services offered in the market and less competition among between the green building material suppliers and green building contractors (Evidence R1, R3 during the preliminary interview).

As revealed by the interviewees in the section of this research, the current knowledge on LCC is very limited. It takes much effort to educate and convince every stakeholder on the benefit of LCC. As quoted by one of the interviewees (R4);

> *"It is very difficult; the market is still very small, with a lack of suppliers. The total cost is slightly high, with an increment of 8 percent, but fair enough." (R4)*

Another possible logic posed is based on Hall et al. (2011) and Olubunmi et al. (2016). According to Hall et al. (2010) and Olubunmi et al. (2016) there has been criticism that the outcome of green building certification did not bring the three aspects of sustainability, especially social and economics, together. Similarly, the current rating tools that have been a primary guideline for a project in Malaysia to procure a green project, are criticised due to the absence of cost-impacts on their checklist (GBI). Sourani (2008) revealed that the separation of green specification with the project's specification would lead to separation of green cost from project's capital cost and would increase overall project cost. He argued that the green cost should be internalised. The preliminary interview also revealed that there is a lack of green-cost data available in the industry, which also leads to a poor cost analysis for green building, which is similar to a suggestion by Yang (2012). This research is highlighting the importance of the green cost data so that the practitioners can track and benchmark previous project green-cost data, for better and effective costs for future projects. These two factors causing financial impact become of less priority in delivering the green project.

However, while the empirical evidence explained that there is an increasing of overall cost and operational costs due to environment-concerned activities, these were indicated as being of low impact. This outcome is similar to Adham et al. (2013) and Kahlenborn et al. (2013)'s statement relating to Malaysia, where focus on green performance is an environmental aspect that aims to reduce the adverse impact on the natural environment and improve the current situation towards a better environmental protection. Thus, this research suggests that to motivate reductions in energy and operating costs, it is strongly recommended that a project team conduct a life-cycle analysis and evaluate tenders based on life-cycle costing (Sterner, 2002). This research also suggests that the financial aspect must be placed on par with another two aspects of environmental performance: the environmental aspect and the social aspect to achieve a cost-effective performance as suggested by Hall et al. (2011).

7.5.3 Impact on social well-being

This research contends that social performance relates to generating social benefits that impact on the social well-being of stakeholders in the organisation. The empirical results indicated that green-oriented procurement would impact positively on the well-being of the stakeholders and project organisation. There are three important impacts highlighted:

- Green-oriented procurement adoption helps to cultivate green culture
- The adoption of green practices in project delivery will produce educated stakeholders in green construction
- The outcome of the green project delivery will give satisfaction to the client.

Procurement will engage stakeholders throughout the process and stages. When procurement is designed to be green-oriented, it helps to spread the word and signal throughout the supply chain that there will be change in the way procurement is delivered. This change demands stakeholder's commitment and competencies. It also requires continuous training and learning within the project teams, as well as the help of experts. These values could create awareness and push stakeholders to shift the way they think and deliver a project.

In the Malaysian construction industry context, being an early adopter gives the company involved an advantage as an industry trendsetter and this has become one of the important factors encouraging participation, particularly for private developers. Their involvement provides an opportunity for the company to establish its name, be a market leader and explore the market. The interview outcome revealed that they were keen to be part of a green project to gain a good image and reputation. Quoted by the interviewees,

> *"They believe to be part of green is good for their organisation's image and as a life model for other people." (R4)*

> *"We do have a main objective to help the client to achieve platinum certification and support government policy to reduce environmental problems." (R2)*

This finding is related to what has been revealed by Zhang, Shen, and Wu (2011). Zhang et al. (2011) mentioned that adopting green strategy is part of social responsibility, where in turn it can contribute positively to the organisation's reputation and image. Also,

they mentioned that by establishing their organisation as the market leader, an organisation indirectly improves its relationships with the government and the market consumers.

7.6 PROPOSED GREEN-ORIENTED PROCUREMENT MODEL FOR A BUILDING PROJECT

The main aim of this research is to develop a procurement strategy to procure a green project. The green-oriented procurement for building projects' model proposed in this research will help them to plan a strategy to procure a building project that aims to incorporate green-oriented practices in the project delivery. Thus, the model highlights the key practices for green-oriented procurement and proposes the important strategies together with the proposed action plans to improve current procurement delivery. The model was built initially based on information gathered during the literature review stage. Then, preliminary interview was conducted to ensure the suitability of the initial model within the Malaysian construction industry context. The survey was conducted using questionnaire and SEM-AMOS used to finalise the model. The final model is shown in Figure 7.3.

7.6.1 Potential benefit of the proposed green-oriented procurement model for building projects in the Malaysian construction industry

Introducing procurement approaches that support green construction

Green-oriented procurement is an emerging approach for the construction industry specifically in the Malaysian construction industry. Green-oriented procurement is built based on traditional procurement practices but integrating the green practices throughout the project, which means, green-oriented procurement is supporting the concept of 'build green' that will help to nurture and urge for adoption of green culture throughout the project delivery at all stages. As previously mentioned under Section 1.2, there is an implementation gap that has been identified in current procurement delivery of a green construction and has slowed down the promotion of green agenda in the construction industry. The current procurement delivery is not supporting the initiative to support green construction. In the 10MP report, the government is urging development of an initiative model that is enforcing green practices for building projects (Adham, Merle and Weihs, 2013). Thus, the model proposed will help to signal the industry on the needs to shift towards the greener procurement approach. Although this research revealed that

there have been some green practices used in the current procurement delivery, the model proposed will help to disseminate thorough information on the actual green-oriented practices.

Basis for green procurement strategic planning

Green practices must be planned during procurement planning to ensure their effectiveness. As has been highlighted in this research, there is an absence of guidelines on green procurement for a construction project. This model aims to be a basis for planning tools for the stakeholder to procure a construction project. The model provided the overview on the important determinants for green-oriented procurement that they need to consider during a project's planning stage. It helps to set a vision of the project for the stakeholders to achieve and provides a map on the important factors and practices for how to get there. After all, there have been issues highlighted by previous researchers on the difficulty of kick-starting the green project (Refer to section 1.2).

This strategic plan is headway in ensuring all the ideas will be turned into actions. When the client has decided to be on a greener approach, which should be their mission statement, then a detailed description of this project goal needs to be provided. This model provides three important aspects of a green-oriented procurement that needs to be considered as early as the planning stage. Three important aspects are policies and guidelines, purchasing of green material, and process and environmental evaluation. This model also incorporates the stakeholder values, such as commitment and knowledge, as the important enablers of green-oriented procurement. For example, in term of policies and guidelines, this model has suggested that the project stakeholders must consider policies and guidelines at the macro level and most importantly, to translate the policy and guidelines to suit the project procurement context in terms of suitability and limitation.

Improve organisation purchasing behavior

There is a call for project stakeholders in the construction industry to shift their purchasing preferences towards green purchasing. Green purchasing refers to a purchasing preference that considers green products and services, as well as integrates the concepts of value for money and purchasing that give benefits in term of social contribution. Hoejmose and Adrien-Kirby (2012) revealed that green purchasing became an important consideration when more pressure was given to the organisation to consider the environmental aspects.

This model indicated that the policies and guidelines both at national and project level act as a pressure to the project to change their purchasing preference. For instance, the Malaysian government is urging more demand for green buildings in the future by formulating policy at a national level as stipulated in the CITP 2016-2020 report (CIDB, 2015). Thus, giving a signal to the industry that government is the major client of the construction industry is demanding that the industry change the way they deliver the project.

The goals and objectives of an organisation are major determinants as to how and what the organization will purchase. In an organizational buying context, there are always re-defined rules as to who can participate in the purchasing decision and who the ultimate deciding authority is. This model has highlighted that it is important that the project plan a strategy to achieve the green performance goals. The decision to go for green purchasing needs to be supported by the client and have decisive stakeholders' commitment. It is undeniable that interpersonal conflicts and conflicts of interest will occur but establishing a project's common interest with a clear guidance among the stakeholders will be the major role in overcoming this problem. This model is also highlighting the need to have stakeholders that have interest and knowledge in green project delivery, because their educational background and level of awareness have a major bearing on what type of purchases they will make.

Cultivate green culture within construction industry

To move towards a greener path is not about simply producing green products, but cultivating green culture throughout the construction industry. The proposed model indicated the importance of green practices throughout the procurement stages that will affect the project stakeholders. The green-oriented procurement model will provide a sign to the project stakeholder throughout the supply chain on the demand to fulfil the green practices and thus, demands their commitment to achieve better results for the project. The proposed model will help to create awareness and improve their level of knowledge on green construction as an individual and as a collective. This benefit was validated empirically by this research, in that the green-oriented organisation would produce knowledgeable stakeholders in the green construction discipline.

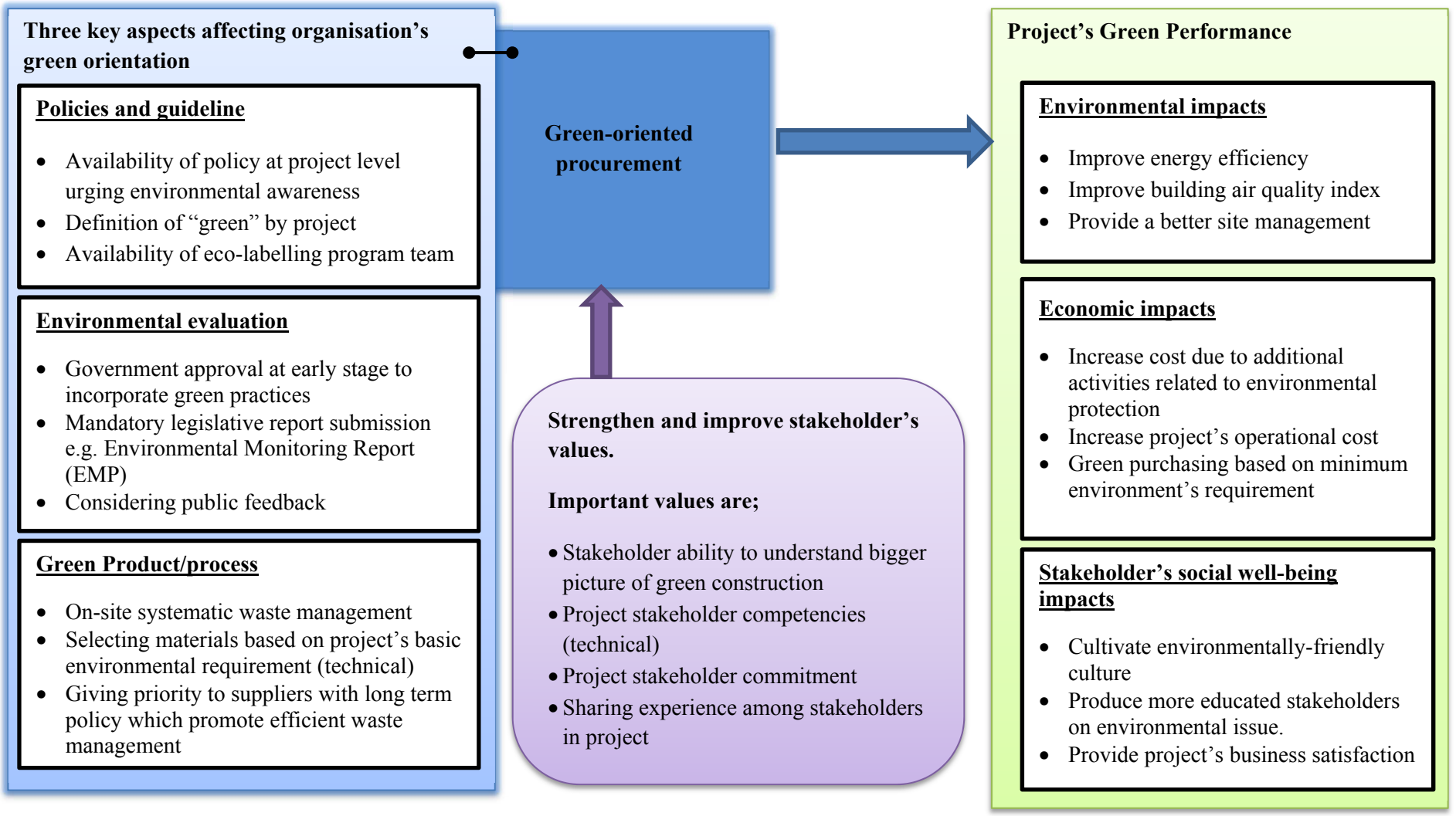

Figure 7.3 Green-oriented Procurement model

7.6.2 Proposed strategy to improve current procurement delivery based on proposed model

The aim of this model is to improve current procurement practices by introducing an improved process for the application of environmental requirements in building procurement. The model can assist construction project to:

- Align the integration of environmental management with project missions and objectives;
- Establish a procurement platform for integrating environment management strategies, plans and actions;
- Control and monitor the processes of green procurement delivery; and
- Secure green performance goals and foster continuous improvement

In order to enhance the implementation of environmental management in the procurement process, an improved process of procurement delivery is explained in Figure 7.4 and further demonstrates the actions and potential effects of each important aspect of green-oriented procurement factor as recommended in Table 7.3. This proposed guideline was developed from the findings of the literature review, preliminary interview and findings of the questionnaire.

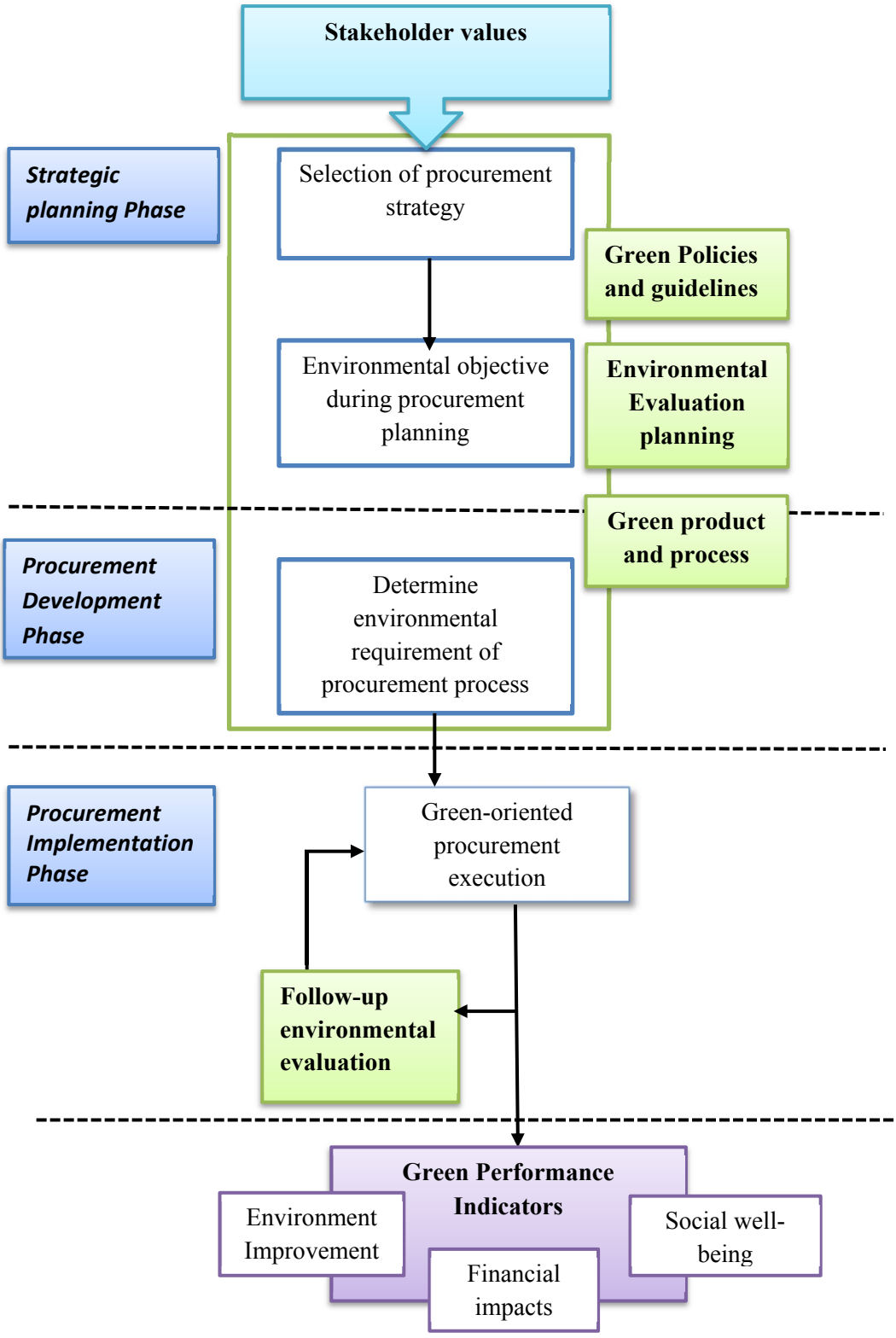

Figure 7.4 Suggestion of improved process for the application of environmental requirements in building procurement

Table 7.3 Suggestion of improved process for the green-oriented procurement (the action and intended outcomes)

	Proposed actions	**Intended outcomes**
Green policies and guidelines	• Determine common goals in term of green performance • Establish the scope and interpretation of green policies that encourage green adoption • Formulating guidelines at project level based on project needs in term of suitability and capability • Developing project green requirements and indicators	• Stimulate improvement of the procurement strategy • Develop awareness of green principles in procurement delivery • Understanding of the importance of sustainable practice considerations • A pre-requisite for the formulation of the right sustainability goals, strategies and action plans • Enhance the agreement among the stakeholders to support sustainability efforts • Share the sustainability goals, strategies and action plan with other stakeholders both inside and outside of the organisation
Green products and process	• Selecting materials based on project's green indicators (incorporate into contract) • Promote waste management	• Reduce the purchasing risk of an environmental issue face by future generations • Shifting purchasing preference towards greener option • Trigger awareness throughout the supply chain • Improve building design in terms of energy efficiency, water efficiency and waste reduction

Environmental evaluation	• Develop evaluation plan; • Perform regular monitoring; • Integrating monitoring and reporting throughout	• Able to monitor the progress • Benchmarking the progress and improve the weakness • Getting feedback from government, public, as well as the end user of the project
Stakeholder values, development capacity and competence	• Project briefing, training, Implement and inculcate environmental values, knowledge sharing	• Enhance knowledge through sharing of ideas, expertise, experiences, etc. • Facilitate the discussion and negotiation process regarding the organisation's sustainability strategy • Drive the project stakeholder interest toward sustainability efforts • Enhance the ability of all the project stakeholders to work together to achieve sustainability goals

7.7 SUMMARY

This chapter discussed the synthesised findings of this study that adopted the quantitative technique of questionnaire and the structure equation modelling using AMOS. Based on literature and preliminary interviews with the experts, the questionnaire was developed and distributed. The SPPS software used to analyse the preliminary analysis and SEM-AMOS was used to validate the proposed model. The findings of the analysis supported the literature and preliminary interview findings but show reduction of items of each factor. This outcome nevertheless is essential in providing the direction for project

stakeholders to identify the important practices that influence building procurement orientation. On a practical level, these factors need to be incorporated in order to support building green implementation. The final section of this chapter presented the findings in relation to the extant literature in order to reconcile the findings with the existing literature. The next chapter provides a summary of the thesis, identify the limitations of the study and suggests promising directions for future research.

CHAPTER 8: CONCLUSION AND RECOMMENDATION

8.1 OVERVIEW

The awareness of the need to improve green performance of a building project has evolved, aiming to reduce the adverse impact on the natural environment. In Malaysia, the government has urged for a project to be built on a greener path as one of the initiatives to move forward in sustainable development. Procurement of a building project has been identified as an important tool to help the industry towards a greener approach. This research developed a model of green procurement for building project, highlighting the important aspect contributing to green-oriented procurement, and also demonstrates the impacts on the project's green performance. The main aim of this research is to produce a model of green procurement for a building project in Malaysia to guide the stakeholder in making decisions during the planning phase. Three research questions were posed to help this research fulfil its research aim. The questions are;

1. Which practices, associated with green-oriented procurement of a building project in Malaysia, are important?

2. Do these practices have any significant relationship with the green performance of a building project in Malaysia?

3. How can project stakeholder use the identified key practices of green oriented procurement to improve project's green performance?

To achieve the research aims, this research undertook three phases starting from data gathering until the final model was validated and this thesis was structured in eight chapters. Preliminary data gathering was conducted through a review of the interdisciplinary literature and expert interviews with the practitioners in Malaysia. The significant factors and practices to determine green procurement orientation were established through a combination of both the literature and interview. Questionnaires formed the main survey instrument, and these were distributed to the stakeholders that were involved in green-certified projects in

Malaysia. This method is to generalise the findings that derived from phase 1 of this research. Empirical models were validated in order to validate the model. Data derived from the survey was first cleaned and preliminary analysis conducted. Descriptive analysis was conducted to determine the demographic background of the respondents. SEM-AMOS analysis was used to measure each individual measurement model and overall structure analysis also was conducted to confirm the model. The validity and reliability of the model were assessed.

8.2 KEY FINDINGS

The clear establishment of all research objectives has led to the achievement of the main aim of this study. Hence, the conclusions for the establishment of the research objectives are described according to the sequence of study objectives. The green procurement of building project model developed in this research provides a strategic planning tool to guide project stakeholders to procurement of a building project. Green procurement is also identified as a tool that helps green project delivery and supports the concept of build green. Building construction projects are complex and have their own unique objectives, team members and requirements. Therefore, each project must be dealt with in its own unique way to suit project capabilities and needs. Findings in Chapters 2, 4, 5, 6 and the discussion in Chapter 7 revealed the results of the following research questions.

8.2.1 Finding related to the extant literature

Green procurement for the construction industry in Malaysia is something new and an innovative approach to tackling environmental problems because of the adverse impact of project development activities. This study has made exploration through literature from Malaysia and other countries to establish factors that determine green procurement orientation. The interview with the experienced practitioners was conducted to explore the current practices within the Malaysian construction industry and validate the findings from the literature (refer to Chapter 4). This research affirms that there is no specific framework to guide in relation to such practices; many practitioners in the construction industry believe there is a gap that exists between the policy formulation and the actual delivery in Malaysian construction industry. This study provides an additional impact on literature in the field of green procurement in the context of the construction industry in Malaysia.

The research acknowledges the need to adopt green procurement as a project delivery to achieve better results of a project's green performance. Previous studies on green procurement conducted in Malaysia, focusing on other industries such as domestic purchasing and manufacturing industry (ElTayeb et al., 2010; Eltayeb and Zailani, 2010; Zailani et al., 2015). Adham (2014) worked on doctoral research that provides the first empirical study on the factors that are influencing green procurement direction in Malaysia but only focuses on government procurement in general. A few journal and conference papers (Buniamin et al., 2016; Musa et al., 2013) discuss adoption strategy on green procurement focusing on Malaysian public enterprise. These findings have contributed importantly to the knowledge gap by not only focusing the research on green procurement for the construction industry but also providing a green procurement adoption strategy.

This project's research also adds new information to the existing body of knowledge. This study is the first attempt to provide an empirical study on green-oriented procurement for a construction project. This model can provide a direction for procurement personnel or project stakeholders generally in deciding the factors that should be prioritised for green practices among all the factors in terms of their impact on the project's green performance. This study was built with several theories including procurement related theories and environmental management theory. The environmental response in terms of management is necessary to understand how environmental challenges are embedded into decisions, management practices, and organisational structure. This theory suggests that the focus should be given to a process of acquiring green building rather than focusing on the product. This study supports this notion because building procurement is seen as the tool that can incorporate green practice processes to produce green buildings.

In the view of a construction management concept, the construction project is a temporary organisation formed by stakeholders that came from a different permanent organisation with different skills. This stakeholder is crucial, as they are the key to lead the process. Empirical data obtained in this study reinforces the findings of the previous opinion. Stakeholder's values such as commitment, competencies, and learning culture are important in shaping the orientation of building green procurement. Commitment and competencies of a stakeholder in green construction should be cultivated as early as the beginning of the project with a view to achieving a more satisfactory outcome of the green performance. There should be continuous training to ensure consistency and persistence in terms of commitment and increasing knowledge and skills to form a project team that is more competent.

8.2.2 Findings in relation to first research question

RQ1: Which practices, associated with green-oriented procurement of a building project in Malaysia, are important?

Results from literature suggested that three important aspects of green-oriented procurement are the policies and guidelines, the green products and process and the environmental evaluation. It was also found that the stakeholder, as the project enabler, is perceived to be a significant factor contributing to the achievement of green-oriented procurement.

Policies and guidelines have a coercive pressure that sends a signal to the project teams on the green performance objective. The most important are the determinants of the concept of green within the project context that have become of common interest to every stakeholder throughout the project stages. The policy at project level revealed help to make a way forward for a successful project implementation. The policies and guidelines at project level also help to create an understanding among the stakeholders on the project's green orientation, which is also revealed by this research as an important practice. The green procurement requires more push factors from the government, as it is very difficult to persuade a conventionalist to change their current practices of procuring building projects.

The incorporation of green practices needs to be clearly mentioned in the project's green requirement and be articulated clearly to each of the stakeholders. This research suggested that there must be a set of green indicators, also known as the green specification, to create a common direction for the project. To enforce the implementation, the project needs to consider incorporation of the green practices as part of the tender and also contract terms. This will create the signal that the projects are considering green in their practices. In addition, the stakeholder's level of awareness and knowledge help to determine to what extent the project has decided to be on the greener path.

This research also revealed that evaluation is an important practice in determining a project's green orientation. Evaluation should be continuous practice since the planning stage towards the life cycle. The evaluation aims to be a cross-checking procedure to ensure the green compliance. This research confirmed that environmental evaluation or assessment by government and the public are the effective tools as the third party to the project to ensure the model is valid and reliable.

Project stakeholders are perceived as a very important factor for green-orientated procurement of building project. This stakeholder expected to have capabilities in terms of knowledge and experience in green construction and was committed towards project green goals. Knowledge sharing among project stakeholders is perceived as an important value in order to successfully deliver green-oriented procurement. This research also acknowledges the importance of building material suppliers and contractors for successful green-oriented procurement.

8.2.3 Findings in relation to second research question

RQ2: Do these practices have any significant relationship with the green performance of a building project in Malaysia?

Findings of this research revealed there is a significant positive relationship between green-oriented procurement and green performance. Three key aspects of green performance are environment, economic and social impact, as explained below;

- Environmental aspect

Green-oriented procurement has a significant impact on environmental aspects. As hypothesised, this research confirms that green-oriented procurement helps to reduce the adverse impact of building project development on the natural environment. The empirical evidence derived from this study revealed that green-oriented procurement adoption could help to improve indoor air quality, energy efficiency and reduce the contribution to pollution.

- Financial impact

This research revealed that adopting green-oriented procurement will have a financial impact where it will increase overall project cost and cost of going green. Also, to minimise the cost increase impact, the purchasing is based on the basic environmental purchasing where purchasing is made to meet the minimum requirement of green indicators. There have been a few reasons identified, including the small market of green materials that leads to a less competitive market and using imported materials due to the unavailability of green materials in the local market.

- Social

In term of social impact, the green-oriented procurement will positively affect the social well-being of the stakeholder and organisation. The adoption of green-oriented procurement will help the project as whole in cultivating green culture and produce more educated stakeholders in green construction. The most important of the outcomes of green project delivery are those that will give satisfaction to the client.

8.2.4 Findings in relation to third research question

RQ3: How can project stakeholder use the identified key practices of green oriented procurement to improve project's green performance?

In order to assist project stakeholder in applying the identified important factors and practices of green-oriented procurement, this research identified the green-oriented procurement model for a building project (refer Figure 7.3) and proposed the improved practices as discussed in Section 7.6. The developed green-oriented procurement of a building project model will help the project stakeholder to plan a procurement strategy that will improve the project's green performance by not just identifying the list of green-oriented procurement practices, but also helps to prioritise the green-oriented practices. This research proposed a check-list of possible actions to integrate green practices into a building procurement as well as the intended outcome derived from the actions taken (refer Figure 7.4 and Table 7.3).

8.3 RESEARCH CONTRIBUTIONS

This section justifies the contribution of the research in view of two different perspectives, the theoretical contribution and practical contribution.

8.3.1 Theoretical contribution

This thesis identifies the specific factors and practices that determine the green orientation of building procurement to determine the direction of a project's procurement.

Framed with a building procurement context, the contribution of this thesis is significant due to the importance of a project to be on a greener path and the importance of procurement in charting this greener way. The current trend of academic literature is addressing the importance of procurement in greening the project delivery.

Firstly, this research contributes to environmental management knowledge by focusing on the procurement of tools in greening the project. It supports the concept of building green rather than focusing on the product. Second, this research contributes to the empirical research that is associating the factors and practices in determining the green orientation of project procurement. In addition are the impacts of the green procurement orientation with the overall project green performance. A discussion made from a conceptual standpoint is also provided. Third, it identifies the green procurement model that consists of the importance practices, the causal path between the stakeholders and the green orientation and the causal path between green procurement orientation and the project performance.

Each of these contributions is discussed in more detail as follows:

i. The introduction of the concept of green procurement as a tool in greening the project

The academic interest in producing a greener project in order to support the sustainable development agenda is emerging, while the discussion on the procurement as tools to greener the project is still new. Research factors associating green procurement are still lacking empirical evidence. As such, a core contribution of this research lies in its ability to provide a holistic idea on the application of green procurement within a construction project. Within the Malaysian construction industry, the term green procurement is still very new. There is no specific definition of the term “green procurement” and there is no guideline or framework so far. This research will help to shed some light to pave the way for future investigation on this subject matter. This research has established the definition of green procurement based on green procurement practices in various fields and organisations and fits it with the building project context.

ii. *Empirical research that is associating the factors and practices in determining the green orientation of project procurement. Also the impacts of the green procurement orientation with the overall project green performance.*

Environmental management knowledge has been adopted in research relating to sustainability issue in the construction industry and other industries as well. This research has to highlight the need to green the procurement delivery through the phases and process to ensure the projects are on a greener path. In addition, this research also revealed that the stakeholder's values are important to ensure the effectiveness of green procurement.

This research enriches the literature in this area by making a theoretical breakthrough on the utilisation of responsible environmental operation within the construction procurement. Note, there has been no research that has been conducted to investigate this association empirically. In addition, this research has also empirically proven that there is a significant impact of project stakeholder values on the effectiveness of the construction procurement's green orientation. Lastly, this research provided evidence that responsible environmental operation within the construction procurement would lead to a better project performance in terms of green performance.

iii. *Identification of the green procurement model to promote the implementation of a responsible environmental operation within the procurement process.*

This thesis derives its theoretical contribution through a comprehensive literature review, empirical data from the questionnaire and the structural equation model. This combination has led to the main contribution of this research, namely, the development of an empirically derived green procurement model to promote the implementation of environmentally responsible operations within the procurement process.

The developed model is unique for several reasons. This study provides the empirical study that shed light on the environmentally responsible operation within the procurement process in order to deliver a green project. It has empirically

validated the important factors that influence the green orientation of the procurement. This research also validated the importance of stakeholder's values in determining the green orientation of the procurement.

This research identified the factors and practices based on the literature and preliminary interview and used them to developed the questionnaire. The data was analysed using the SPSS software and SEM-AMOS software to provide a clear and well-defined structural model. The model was validated and provides an overview of the important practices of procurement's green orientation that need to be considered when designing a project's green orientation. This model also shows the importance of the stakeholder's values in determining the green orientation.

In summary, from the theoretical perspective, this research is one of the first to explore and provide empirical evidence on the factors that determine the procurement's green orientation, impact of the stakeholder's values in determining the procurement's green orientation and finally, the impacts of green procurement on the project's green performance. This thesis provides a new path and approach to green the project delivery.

8.3.2 Practical contribution

This research offers two contributions to the industry practices in term of i) the identification of practical tools to create environmentally responsible operation within the construction procurement, ii) and raise awareness among industry practitioners regarding the potential of green procurement to pave the way towards sustainability.

i. The identification of practical tools to create environmentally responsible operation within the construction procurement,

The structural model provides industry stakeholders with a practical tool that facilitates the understanding of the implementation of the critical factors and practices. This research offers the stakeholders the general strategy to adopt green orientated procurement into their project delivery strategy, making it more integrated and holistic. Furthermore, the established list of factors and practices and its

importance for green-oriented procurement as well as the impact on green performance will help to guide project stakeholders to foresee the upcoming opportunities and challenges in implementing green-oriented procurement. This model could be implemented across the types of construction procurement such as traditional procurement or design and build procurement. The study is unique in the context of the Malaysian construction industry. Overall, the outcome of this study will be of use to plan their project delivery and incorporate green management to achieve a more satisfactory outcome in their project.

ii) Raise awareness among industry practitioners regarding the potential of green procurement.

There has been little discussion about a unified definition of the whole concept and the interpretations of greening the project delivery. The study has addressed the need for increasing knowledge of the concept of green procurement. The findings of this research will help raise awareness among the industry stakeholders regarding the potential of green procurement as a tool in greening the project delivery. By studying and utilising the present research findings such as the developed framework, industry practitioners may identify the relevant knowledge gaps to assist then in planning education and training as well as encouraging the paradigm shift towards new mind-sets and attitude.

iii) Provide an overview of the current state of procurement delivery for green building project in Malaysia.

This research is among the first that has attempted to explore the green procurement practices of a building project in Malaysia. During the first phase of this research, the exploration is made on the available policies of green procurement, any related guidelines on green procurement, incentives and green practices in Malaysia from the literature and face-to-face preliminary interview. The outcome of this finding has been reported in this thesis (refer to Chapter 2 and Chapter 4) and a few journal and conference publications. The preliminary interview conducted among the early adopters of the green project in Malaysia and their points of view is

essential for other practitioners in Malaysia and beyond as a future guideline and improvement.

8.4 LIMITATIONS

Despite the contributions, the limitations of this research are pointed out to improve the outcome of this research. Table 8 summarises some of the limitations of this study.

Table 8.1 Addressing the limitations in the study

Limitation		Discussion
Semi-structure interview	Limited scope	The face-to-face semi-structured interview scope in this study was limited to the scope of the study as well as the fact that current green building is a new practice in Malaysia and hence there are few experienced practitioners yet. Although the sample size is small and limited, the in-depth nature and the detailed explanations of the issues provided by experienced interviewees is in line with Romney et al. (1986), Becker (2012), Charmaz (2012) and Bonde (2013) (Refer Section 4.2.2).
Survey	Sample	This study also relies on the sample that is listed in the publicly available database from the Green Building Index (GBI) website and identified the green-certified projects as listed. Using internet search and snowball technique, the actual respondents were identified. Due to the limitation of time and resources, the identified respondents were identified and contacted through email and phone call to seek their agreement to participate in the survey. The researcher also faced a problem where the key person involved in the project may have left the organisation, and the information was

		not properly retained within the organisation.
	Performance indicators	The green performance construct as the dependant variable for the produced green procurement model of a building project in Malaysian construction industry used the subjective measurements (González-Benito and González-Benito, 2005). The research used the self-reported perception by the stakeholders that were involved in the green certified project, which implies that there could be some possibility of a bias in the results of this study and thus, does not claim to be comprehensive.
	Mediator effect	This study did not address the mediator effect that may affect the green purchasing practice, such as project size, because of the limited information available, however, this limitation has been addressed under the Section 8.5 the recommendation of future research.
	Data analysis	This research used quantitative analysis the use of SEM-Amos. Other techniques such as PLS and the content analysis might lead to different outcomes. However, justification has been given in this thesis for the selected approach.
Results	Model produced	Given that most of the participants were from Malaysia, the findings are specifically applicable to the practices in Malaysia. However, the learning from this study can provide a good source of references for research and practice in other countries.

8.5 RECOMMENDATIONS FOR FUTURE RESEARCH

This research highlights more opportunities for exploring sustainability endeavours by focusing on the green procurement approach. Therefore, the following recommendations are made for future research:

- The topic of "green-oriented procurement" in this study was specifically focused on building project. Future researchers could expand the green-oriented procurement on other types of the project such as the infrastructure works within the context of Malaysian construction industry or beyond

- The research compiled, analysed and validated the important aspects that are associated with green-oriented procurement within the Malaysian construction industry. It is suggested that, for future research, further investigation and customisation of a more specific practical guide tool for stakeholders should be conducted. It is also suggested that the model need to be tested in the context of project size etc. as the moderator variables.

- A study on the level of readiness of all the professions involved in a project to adopt each of the factors and practices that are associated with green-oriented procurement needs to be conducted to understand the level of awareness and readiness among the industry players in the Malaysian construction industry.

- The impacts of green-oriented procurement on the project's green performance in this research is based on subjective indicators of respondent's opinion based on their experience in green projects showing the level of acceptance, satisfaction and improvement. It is suggested that this model can be further enhanced by using objective or quantitative measurements to measure the impact of green-oriented procurement on green performance.

- This research focused on the building sectors in Malaysia. The outcomes from this research could also be tested and verified in other regions of the world. Having said that, some modification of the developed model may be necessary to accommodate local differences. It is also suggested that a comparative study be undertaken about green procurement of a building project in Malaysia and other developing countries within the southeast Asian region and also developed countries, to benchmark the practices.

8.6 CONCLUDING REMARKS

As a concluding note, this study revealed that procurement recognised important tools to green project delivery. This research shed some light for green-oriented procurement of a building project application in the Malaysian construction industry. Although the green-oriented procurement is still a new concept in Malaysia, the current policy stipulated in government planning such as 11th MP and CITP 2016-2020 is fully supporting the effort in greening project delivery and promoting project efficiency. The findings of this study should be used, as it is appropriate in the context of Malaysia. As quoted from CITP 2016-2020,

> *"Malaysia has set a target to become an advanced economy by 2020. This will be achieved in a resilient, low carbon, resource efficient and socially inclusive manner." (CIDB, 2015)*

With careful planning, green-oriented procurement can help to conserve the environment and move Malaysia towards a low carbon economy, and achieving sustainable development for the benefits of future generation.

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Appendices

Appendix A: Sample of Questionnaire

Queensland University of Technology
Faculty of Science and Engineering

RESEARCH ON GREEN PROCUREMENT FRAMEWORK FOR CONSTRUCTION PROJECT IN MALAYSIA

You are invited to participate in this survey that will help to develop a green procurement framework for the Malaysian construction Industry. Green procurement in this survey refers to the recognition, integration and implementation of environment practices, initiatives or systems into a procurement practices.

The survey seeks to identify important practices that give impact to the project being green. Once these important practices are identified, they will be used to develop a framework for green procurement that can guide the stakeholders in Malaysian construction industry to procure green projects. Your organisation has been identified from the green building list available the public Green Building Index website. Please note that this study has been approved by the Economic Planning Unit, Prime Minister's Department of Malaysia (*Reference no UPE 40/200/19/3227*) and approved by the QUT Human Research Ethics Committee (*Approval number 1500000214*).

All responses will be **kept strictly confidential** and will only be used for research purposes. The result of this study will be made available in the PhD thesis, papers for publication or presentation for academic purpose. The survey has been designed to avoid the identification of any individuals, projects or naming of organisations. Completion of the questionnaire and returning the completed questionnaire will be considered as your consent to participate in the survey.

The questionnaire will take approximately 20-30 minutes to complete. It is important to answer all questions to the best of your knowledge, even if some may appear to be similar. You can choose to return this questionnaire either using the stamped addressed envelope provided, or through email asmahalia.mohamadbohari@hdr.qut.edu.au. Your early reply is highly appreciated.

Thank you for taking time to participate in this research.

Yours sincerely,
Asmah Alia Mohamad Bohari
PhD Student
Science and Engineering Faculty
Queensland University of Technology, Australia

If you have any questions, please contact Asmah Alia at asmahalia.mohamadbohari@hdr.qut.edu.au.

INFORMATION SHEET AND CONSENT STATEMENT

PARTICIPATION

The questionnaire will take approximately 20-30 minutes to complete. It is important to answer all questions to the best of your knowledge, even if some may appear to be similar. This questionnaire divided into four main sections:

Section 1: Demographics background
Section 2: Project background
Section 3: Green project performance
Section 4: Green practices
Section 5: Optional Sections

You can choose to return this questionnaire either using the stamped addressed envelope provided, or through email asmahalia.mohamadbohari@hdr.qut.edu.au. Your participation in this project is entirely voluntary. If you do agree to participate you can withdraw from the project without comment or penalty and you do not have to complete any question(s) that you are uncomfortable answering. If you withdraw, on request any identifiable information already obtained from you will be destroyed. Your decision to participate or not participate will in no way impact upon your current or future relationship with QUT or with any associated external organisation.

EXPECTED BENEFITS

It is expected that this project will not directly benefit you. However, it may benefit the collective knowledge of green procurement and creating awareness among construction players in Malaysia.

RISKS

There are no risks beyond normal day-to-day living associated with your participation in this project.

PRIVACY AND CONFIDENTIALITY

All comments and responses are anonymous and will be treated confidentially unless required by law. Any data collected as part of this project will be stored securely as per QUT's Management of research data policy. Please note that non-identifiable data collected in this project may be used as comparative data in future projects or stored on an open access database for secondary analysis.

CONSENT TO PARTICIPATE

Returning the completed questionnaire using post or email and submitting the completed online questionnaire is accepted as an indication of your consent to participate in this project.

CONCERNS / COMPLAINTS REGARDING THE CONDUCT OF THE PROJECT

QUT is committed to research integrity and the ethical conduct of research projects. However, if you do have any concerns or complaints about the ethical conduct of the project you may contact the QUT Research Ethics Unit on [+61 7] 3138 5123 or email ethicscontact@qut.edu.au. The QUT Research Ethics Unit is not connected with the research project and can facilitate a resolution to your concern in an impartial manner.

SECTION 1 : DEMOGRAPHIC INFORMATION

This section (Questions 1-5) seeks information about your background and your organisation information about your most recently completed project as a "case study". Please tick [✓] the most appropriate answer where shown.

1. Your position in the project

Project Procurement officer	☐	Quantity Surveyor	☐
Architect	☐	Other, please specify	☐
Engineer	☐	_____	

2. Organisation

Public client	☐	Other, please specify	☐
Client private organisation	☐	_____	
Consultant	☐		

3. Years of experience in construction industry

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

4. Significant Involvement in green projects

First project	☐	More than one project	☐

5. Professional training for green construction

During Tertiary	☐	Self-training	☐
Project/ organisation in-house training	☐	None	☐
Green expert training	☐	Other, please specify	☐
Peer training	☐	_____	

1

SECTION 2 : PROJECT DETAILS

This section (Question 6-11) requires information about your most recently completed project as previously described in Section 1. Please tick [✓] the most appropriate answer where shown.

6. Project location

- ☐ Peninsular Malaysia
- ☐ Sarawak
- ☐ Sabah
- ☐ Others, please specify _____

7. Project size

- ☐ Less than RM1 million
- ☐ RM1 million to RM5 million
- ☐ RM5 million to RM10 million
- ☐ More than RM10 million

8. Procurement type

- ☐ Traditional procurement
- ☐ Design and build
- ☐ Construction Management
- ☐ Private Finance Initiative (PFI)
- ☐ Other, please specify _____

9. Client for the project

- ☐ Federal government
- ☐ State government
- ☐ Local authorities
- ☐ Private sector
- ☐ Other, please specify _____

10. Green Recognition : Project status

Green Building Index (GBI);

- ☐ Platinum
- ☐ Gold
- ☐ Silver
- ☐ Application stage
- ☐ Don't know
- ☐ Awarded by others, Please specify _____

11. Types of building

- ☐ Residential
- ☐ Non-residential *(Please choose one)*
  - ☐ Industrial
  - ☐ Health
  - ☐ Commercial
  - ☐ Educational
  - ☐ Other, please specify _____

SECTION 3: GREEN PERFORMANCE

This section particularly covers the green performance of your project. The green performance also relates to the degree to which firms' green effectiveness, responsiveness, conscientiousness and investment strategy are better for the environment.

Please use the most recently completed project as described in section 1 to answer this section. Please circle the appropriate scale to rate the following statement relate to the overall green performance of the project.

	Very Low				Very high	Don't know
ENVIRONMENTAL ASPECT						
Reduce **waste production** on site	1	2	3	4	5	0
Improve building design in term of **energy efficiency**	1	2	3	4	5	0
Improve building design in term of **Air Quality Index**	1	2	3	4	5	0
Extensive use of **water recycling**	1	2	3	4	5	0
Manage **resources efficiently**	1	2	3	4	5	0
Better **site management**	1	2	3	4	5	0
Better compliance in accordance to litigation	1	2	3	4	5	0
Minimise **potential environmental pollution risks**	1	2	3	4	5	0
FINANCIAL ASPECT						
Increase overall project cost due to environment –concerned activities	1	2	3	4	5	0
Increase operational costs to monitor environmental activities	1	2	3	4	5	0
Purchase to meet **minimum environmental criteria**	1	2	3	4	5	0
Purchase value for money	1	2	3	4	5	0
Tender award based on **most economically advantageous tender**	1	2	3	4	5	0
Avoid fines for environment destruction	1	2	3	4	5	0
SOCIAL ASPECT						
Creating **awareness among project team** of environmentally-friendly culture	1	2	3	4	5	0
Receiving **positive feedback** from community	1	2	3	4	5	0
Enhancing **environmentally friendly culture**	1	2	3	4	5	0
Producing **educated** stakeholders in green project	1	2	3	4	5	0
Gaining business satisfaction in terms of **good image/reputation**	1	2	3	4	5	0
Be recognised as industry **leading example**	1	2	3	4	5	0
Gain **satisfaction in terms of cost performance**	1	2	3	4	5	0
Gain **satisfaction in terms of design performance**	1	2	3	4	5	0

SECTION 4: GREEN PRACTICES OF CONSTRUCTION PROJECT IN MALAYSIAN CONSTRUCTION INDUSTRY

This section covers your opinion the importance of green practices for the construction project and extends of the practices in your project. "Green" in this research referred as environmental orientation. It is understood as the recognition, integration and implementation of environmental practices, initiatives, and systems in the project to address environmental issues.
Please use the most recently completed project as described in section 1 to answer this section.

Based on the project you were involved in, please circle the appropriate scale, to show the importance of these practices that contribute to the project being green

	Based on your experience from most recently completed project, please circle the appropriate scale, to show the importance of these practices that contribute to the project being green.					
	Very low				Very high	Don't know
A. POLICIES AND GUIDELINES						
Government **legislative requirements**	1	2	3	4	5	0
Government **green incentives** e.g. tax exemption.	1	2	3	4	5	0
Enforcement of Environmental Impact Assessment **(EIA)**	1	2	3	4	5	0
Enforcement of Uniform Building By-Laws Code of Practice **MS1525:2014** (2nd revision)	1	2	3	4	5	0
Obtaining a **Green Building Index** rating	1	2	3	4	5	0
Policy that encourages participation certified **ISO 14001:2004** organisation	1	2	3	4	5	0
Policy that encourages participation certified **Environmental Management Systems (EMS)** organisation	1	2	3	4	5	0
National Strategic Plan for Solid Waste Management policy	1	2	3	4	5	0
Having an **agreed definition of "green"** by project team	1	2	3	4	5	0
Availability of a green project **needs statement**	1	2	3	4	5	0
Availability of **policy at project level urging environmental awareness**	1	2	3	4	5	0
Availability of appropriate **reward/incentives** at project level on green achievement	1	2	3	4	5	0
Availability of **eco-labelling** program	1	2	3	4	5	0
Adopting other completed green project mechanisms	1	2	3	4	5	0

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	Based on your experience from most recently completed project, please circle the appropriate scale, to show the importance of these practices that contribute to the project being green.					
	Very low				Very high	Don't know
B. GREEN PRACTICES						
Compliance to **MS1525** guideline	1	2	3	4	5	0
Designing building based on project's **green specification**	1	2	3	4	5	0
Designing building based on **GBI** guidelines	1	2	3	4	5	0
Selecting materials based on **eco-labelling guideline**	1	2	3	4	5	0
Selecting materials based on project's **basic environmental requirement (technical)**	1	2	3	4	5	0
Conducting **preliminary study** on environmental impact	1	2	3	4	5	0
Conducting a **value management**	1	2	3	4	5	0
Adopting the **Industrialised Building system (IBS)**	1	2	3	4	5	0
Information Technology e.g., managing project	1	2	3	4	5	0
Using **Building Integrated Management (BIM)**	1	2	3	4	5	0
Using **E-tendering**	1	2	3	4	5	0
Providing **waste management plan**	1	2	3	4	5	0
Recycling waste	1	2	3	4	5	0
Using alternative for material **packaging**	1	2	3	4	5	0
Using **On-site systematic waste management** e.g. separate hazardous waste with general waste	1	2	3	4	5	0
Giving priority to suppliers with long term policy which promote efficient waste management	1	2	3	4	5	0

	Based on your experience from most recently completed project, please circle the appropriate scale, to show the importance of these practices that contribute to the project being green.					
	Very low				Very High	Don't know
C. ENVIRONMENTAL EVALUATION						
Government approval at early stage to incorporate green practices	1	2	3	4	5	0
Conducting **Life cycle Analysis (LCA)**	1	2	3	4	5	0
Providing **Life cycle Report**	1	2	3	4	5	0
Product benchmarking using eco-labelling	1	2	3	4	5	0
Using **external environmental rating tools**	1	2	3	4	5	0
Environmental requirements in technical specifications	1	2	3	4	5	0
Mandatory environmental requirement criteria for tender assessment	1	2	3	4	5	0
Project's green compliance mechanisms	1	2	3	4	5	0
Tender evaluation based on **price preference** e.g. willing to pay extra for green products	1	2	3	4	5	0
Tender evaluation based on **set-asides** e.g. specific minimum targets for green purchasing	1	2	3	4	5	0
Benchmarking with previous projects	1	2	3	4	5	0
Public reporting on green performance	1	2	3	4	5	0
Considering **public feedback**	1	2	3	4	5	0
Mandatory legislative report submission e.g. Environmental Monitoring Report (EMP)	1	2	3	4	5	0

	Based on your experience from most recently completed project, please circle the appropriate scale, to show the importance of these practices that contribute to the project being green.					
	Very low				Very high	Don't know
D. STAKEHOLDERS VALUES						
Project client commitment	1	2	3	4	5	0
Project stakeholder commitment	1	2	3	4	5	0
Getting **support** from supplier	1	2	3	4	5	0
Project stakeholder competencies (technical)	1	2	3	4	5	0
Stakeholder **ability to understand bigger picture of green construction**	1	2	3	4	5	0
Pre-qualification based on **knowledge** in green construction	1	2	3	4	5	0
Pre-qualification based on **past experience** in green construction	1	2	3	4	5	0
Conducting **In-house training/briefing**	1	2	3	4	5	0
Acquiring **external collaboration** or **training**	1	2	3	4	5	0
Appointing green **specialised consultant/trainer**	1	2	3	4	5	0
Sharing experience among stakeholders in project	1	2	3	4	5	0

FURTHER COMMENTS

Please state any other points which you may think important practices of a green procurement for construction project that have not already been examined in this questionnaire.

7

SECTION 5 OPTIONAL SECTIONS

Would you like to receive a copy of the major findings of this study?

☐ Yes ☐ No

(Please provide your contact details, preferably an e-mail address)

Personal details

Name:

Designation:

Contact details

Phone no:

Fax:

Email:

These contact details can be submitted separately from the questionnaire to protect your confidentiality. Please email this page to **asmahalia.mohamadbohari@hdr.qut.edu.au** or **alyiaboh@gmail.com**

Your time in sharing information about your experience in the green project is highly appreciated and will be **treated confidentially**. Your contribution is extremely valuable to this research.

Yours sincerely,

Asmah Alia Mohamad Bohari
PhD Student
Science and Engineering Faculty
School of Civil Engineering and Built Environment
Queensland University of Technology
Australia

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Appendix B: Preliminary Data Analysis

Missing values

		S1.1	S1.2	S1.3	S1.4	S1.5	S2.6	S2.7	S2.8	S2.9	S2.10	S2.11
N	Valid	100	100	100	100	100	100	100	100	100	100	100
	Missing	0	0	0	0	0	0	0	0	0	0	0
Mean		3.59	2.47	2.05	1.42	2.52	1.08	3.28	1.69	2.72	2.48	3.04
Median		4.00	3.00	2.00	1.00	2.00	1.00	4.00	2.00	3.00	3.00	4.00
Std. Deviation		1.016	.937	.869	.496	1.467	.307	1.129	.849	1.364	1.749	1.752

Mean and standard deviation

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
S1.1 Position in the project	100	1	5	3.59	1.016
S1.2 Organisation	100	1	4	2.47	.937
S1.3 Experience in construction industry	100	1	3	2.05	.869
S1.4 Involvement in green project	100	1	2	1.42	.496
S1.5 Training	100	0	5	2.52	1.467
S2.6 Project location	100	1	3	1.08	.307
S2.7 Project size	100	1	4	3.28	1.129
S2.8 Procurement type	100	1	5	1.69	.849
S2.9 Client of the project	100	1	5	2.72	1.364
S2.10 Green recognition	100	0	5	2.48	1.749
S2.11 Types of building	100	0	5	3.04	1.752
Valid N (listwise)	100				

Frequencies

S1.1 Position in the project

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Project Procurement Officer	1	1.0	1.0	1.0
	Architect	15	15.0	15.0	16.0
	Engineer	29	29.0	29.0	45.0
	Quantity surveyor	34	34.0	34.0	79.0
	Other	21	21.0	21.0	100.0
	Total	100	100.0	100.0	

S1.2 Organisation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Public client	22	22.0	22.0	22.0
	Private client	18	18.0	18.0	40.0
	Consultant	51	51.0	51.0	91.0
	Other	9	9.0	9.0	100.0
	Total	100	100.0	100.0	

S1.3 Experience in construction industry

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 5 years	35	35.0	35.0	35.0
	5 to 10 years	25	25.0	25.0	60.0
	More than 10 years	40	40.0	40.0	100.0
	Total	100	100.0	100.0	

S1.4 Involvement in green project

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	First project	58	58.0	58.0	58.0
	More than one project	42	42.0	42.0	100.0
	Total	100	100.0	100.0	

S1.5 Training

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	9	9.0	9.0	9.0
	During tertiary	7	7.0	7.0	16.0
	Project inhouse training	48	48.0	48.0	64.0
	Green expert training	14	14.0	14.0	78.0
	Peer training	3	3.0	3.0	81.0
	Self-training	19	19.0	19.0	100.0
	Total	100	100.0	100.0	

S2.6 Project location

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Peninsular Malaysia	93	93.0	93.0	93.0
	Sarawak	6	6.0	6.0	99.0
	Sabah	1	1.0	1.0	100.0
	Total	100	100.0	100.0	

S2.7 Project size

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than RM 1 million	15	15.0	15.0	15.0
	RM 1 million to RM5 million	8	8.0	8.0	23.0
	RM 5 million to RM10 million	11	11.0	11.0	34.0
	More than RM10 million	66	66.0	66.0	100.0
	Total	100	100.0	100.0	

S2.8 Procurement type

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Traditional procurement	49	49.0	49.0	49.0
	Design and build	39	39.0	39.0	88.0
	Construction management	7	7.0	7.0	95.0
	Private finance Initiative (PFI)	4	4.0	4.0	99.0
	Other	1	1.0	1.0	100.0
	Total	100	100.0	100.0	

S2.9 Client of the project

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Federal government	32	32.0	32.0	32.0
	State government	13	13.0	13.0	45.0
	Local authorities	7	7.0	7.0	52.0
	Private sector	47	47.0	47.0	99.0
	Other	1	1.0	1.0	100.0
	Total	100	100.0	100.0	

S2.10 Green recognition

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Others	18	18.0	18.0	18.0
	GBI Platinum	19	19.0	19.0	37.0
	GBI Gold	12	12.0	12.0	49.0
	GBI Silver	13	13.0	13.0	62.0
	GBI application	24	24.0	24.0	86.0
	Don't know	14	14.0	14.0	100.0
	Total	100	100.0	100.0	

S2.11 Types of building

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Others	17	17.0	17.0	17.0
	Residential	4	4.0	4.0	21.0
	Non-residential Industrial	15	15.0	15.0	36.0
	Non-residential Health	7	7.0	7.0	43.0
	Non-residential Commercial	36	36.0	36.0	79.0
	Non-residential Education	21	21.0	21.0	100.0
	Total	100	100.0	100.0	

Appendix C: AMOS output

C-2 CFA Test

Overall Model Fit Measure

Chi-square = 263.405	GFI=.828
Degrees of freedom = 220	CFI=.951
Probability level = 0.024	RMSEA=.045

Standardized Regression Weights: (Group number 1 - Default model)

			Estimate
PP	<---	GPO	.893
POL	<---	GPO	.845
EVA	<---	GPO	.970
ENV	<---	GP	.990
SOC	<---	GP	.726
FIN	<---	GP	.192
GreenpracticeB16	<---	PP	.555
Policy9B	<---	POL	.708
Policy11B	<---	POL	.861
Policy13B	<---	POL	.537
EvaluationB1	<---	EVA	.770
EvaluationB13	<---	EVA	.540
EvaluationB14	<---	EVA	.663
Environ8	<---	ENV	.599
Environ3	<---	ENV	.891
Environ2	<---	ENV	.553
Finance3	<---	FIN	.679
Finance2	<---	FIN	.864
Finance1	<---	FIN	.823
Social3	<---	SOC	.714
Social4	<---	SOC	.818
Social5	<---	SOC	.568
StakeholderB11	<---	SV	.737
StakeholderB4	<---	SV	.777
StakeholderB2	<---	SV	.727
GreenpracticeB5	<---	PP	.667
StakeholderB3	<---	SV	.602
StakeholderB5	<---	SV	.838
GreenpracticeB15	<---	PP	.

Regression Weights: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	P	Label
PP	<---	GPO	1.009	.232	4.357	***	
POL	<---	GPO	1.000				
EVA	<---	GPO	1.687	.295	5.719	***	
ENV	<---	GP	1.000				
SOC	<---	GP	.751	.209	3.593	***	
FIN	<---	GP	.278	.198	1.402	.161	
GreenpracticeB16	<---	PP	1.000				
Policy9B	<---	POL	1.000				
Policy11B	<---	POL	1.149	.163	7.037	***	
Policy13B	<---	POL	.821	.169	4.846	***	
EvaluationB1	<---	EVA	1.000				
EvaluationB13	<---	EVA	.647	.127	5.111	***	
EvaluationB14	<---	EVA	.868	.137	6.344	***	
Environ8	<---	ENV	1.000				
Environ3	<---	ENV	1.705	.298	5.717	***	
Environ2	<---	ENV	.831	.184	4.516	***	
Finance3	<---	FIN	.878	.402	2.186	.029	
Finance2	<---	FIN	1.200	.533	2.253	.024	
Finance1	<---	FIN	1.000				
Social3	<---	SOC	1.000				
Social4	<---	SOC	1.524	.246	6.198	***	
Social5	<---	SOC	.746	.152	4.913	***	
StakeholderB11	<---	SV	1.000				
StakeholderB4	<---	SV	.969	.131	7.377	***	
StakeholderB2	<---	SV	.820	.119	6.902	***	
GreenpracticeB5	<---	PP	1.002	.205	4.897	***	
StakeholderB3	<---	SV	.685	.120	5.692	***	
StakeholderB5	<---	SV	1.173	.149	7.901	***	
GreenpracticeB15	<---	PP	1.658	.300	5.533	***	

C-2 Validity and Reliability Assessment (CFA)

Stats tools (validity master) by James Gaskin at Gaskin, J., (2012), "Validity master ," Stats Tools Package. http://statwiki.kolobkreations.com

Results derived from the validity master tools;

	CR	AVE	MSV	MaxR(H)	GP	GPO	SV
GP	0.714	0.515	0.429	0.981	**0.717**		
GPO	0.931	0.817	0.429	0.986	0.655	**0.904**	
SV	0.857	0.548	0.423	0.988	0.280	0.650	**0.740**

Caveats and Assumptions:
1. Your **latent** variable names **do not** end in numbers (bad: F1, Factor12). It is okay to have **observed** variables named whatever you want.
2. Your error/residual names **do** end with numbers (good: e1, res12)
3. Your variable names are not any of the following: AVE, Max, CR, MSV
4. You have more than 2 latent variables.
5. You have no heywood cases (standardized regression weights > 1.00)

$$CR = \frac{\left(\sum_{i=1}^{i} \lambda_i\right)^2}{\left(\sum_{i=1}^{i} \lambda_i\right)^2 + \left(\sum_{i=1}^{i} 1 - \lambda_i^2\right)}$$

$$AVE = \frac{\sum_{i=1}^{n} L_i^2}{n}$$

$$H = \frac{1}{1 + \frac{1}{\sum_{i=1}^{p} \frac{\lambda_i^2}{1-\lambda_i^2}}}$$

C-3 – Structure model

Overall Model Fit

Chi-square = 266.055 GFI=.0.826
Degrees of freedom = 221 CFI=0.949
Probability level = 0.02 RMSEA=.045

Standardized Regression Weights: (Group number 1 - Default model)

			Estimate
GPO	<---	SV	.631
GP	<---	GPO	.658
PP	<---	GPO	.900
POL	<---	GPO	.854
EVA	<---	GPO	.966
ENV	<---	GP	.944
FIN	<---	GP	.204
SOC	<---	GP	.757
GreenpracticeB16	<---	PP	.557
Policy9B	<---	POL	.709
Policy11B	<---	POL	.858
Policy13B	<---	POL	.540
EvaluationB1	<---	EVA	.774
EvaluationB13	<---	EVA	.538
EvaluationB14	<---	EVA	.662
Environ8	<---	ENV	.601
Environ3	<---	ENV	.890
Environ2	<---	ENV	.552
Finance3	<---	FIN	.657
Finance2	<---	FIN	.836
Finance1	<---	FIN	.850
Social3	<---	SOC	.712
Social4	<---	SOC	.825
Social5	<---	SOC	.563
StakeholderB11	<---	SV	.732
StakeholderB4	<---	SV	.780
StakeholderB2	<---	SV	.731
GreenpracticeB5	<---	PP	.668
StakeholderB3	<---	SV	.599
StakeholderB5	<---	SV	.839
GreenpracticeB15	<---	PP	.878

Regression Weights: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	P	Label
GPO	<---	SV	.440	.110	3.987	***	
GP	<---	GPO	.620	.176	3.524	***	
PP	<---	GPO	1.000				
POL	<---	GPO	.991	.226	4.389	***	
EVA	<---	GPO	1.651	.341	4.835	***	
ENV	<---	GP	1.000				
FIN	<---	GP	.320	.213	1.500	.134	
SOC	<---	GP	.817	.225	3.629	***	
GreenpracticeB16	<---	PP	1.000				
Policy9B	<---	POL	1.000				
Policy11B	<---	POL	1.144	.162	7.055	***	
Policy13B	<---	POL	.824	.169	4.871	***	
EvaluationB1	<---	EVA	1.000				
EvaluationB13	<---	EVA	.641	.126	5.074	***	
EvaluationB14	<---	EVA	.862	.137	6.312	***	
Environ8	<---	ENV	1.000				
Environ3	<---	ENV	1.698	.301	5.645	***	
Environ2	<---	ENV	.827	.184	4.507	***	
Finance3	<---	FIN	.822	.359	2.292	.022	
Finance2	<---	FIN	1.124	.474	2.370	.018	
Finance1	<---	FIN	1.000				
Social3	<---	SOC	1.000				
Social4	<---	SOC	1.541	.247	6.233	***	
Social5	<---	SOC	.741	.152	4.880	***	
StakeholderB11	<---	SV	1.000				
StakeholderB4	<---	SV	.978	.133	7.338	***	
StakeholderB2	<---	SV	.830	.120	6.890	***	
GreenpracticeB5	<---	PP	.999	.203	4.913	***	
StakeholderB3	<---	SV	.686	.122	5.633	***	
StakeholderB5	<---	SV	1.182	.151	7.827	***	
GreenpracticeB15	<---	PP	1.648	.297	5.553	***	

Appendix D: List of publications

Journal Publication

P1: Bohari, A. A. M., Skitmore, M., Xia, B., Teo, M., Zhang, X., and Adham, K. N. (2015). The path towards greening the Malaysian construction industry. *Renewable and Sustainable Energy Reviews*, *52*, 1742-1748**.- Published (ISI -Tier 1)**

P2: Bohari, A. A. M., Skitmore, M., Xia, B., & Teo, M. (2017). Green oriented procurement for building projects: Preliminary findings from Malaysia. Journal of Cleaner Production, 148, 690-700. **Published (SCOPUS and Scimago- Tier 1)**

P3: Bohari, A. A. M., Skitmore, M., Xia, B., and Zhang, X. (2016). Insights into the adoption of green construction in Malaysia: The drivers and challenges. *Environment-Behaviour Proceedings Journal*, *1*(4), 45-53. **Published**

Conference proceeding

P4: Bohari, M., Alia, A., and Xia, B. (2015). Green procurement framework for the Malaysian construction industry. In *Proceedings of the 7th International Conference on Sustainable Development in Building and Environment*. SuDBE.

P5: Bohari, A. A. M., and Xia, B. (2015). Developing green procurement framework for construction projects in Malaysia. In *The Proceedings of the 6th International Conference on Engineering, Project, and Production Management (EPPM2015)* (pp. 282-290). Association of Engineering, Project, and Production Management (EPPM).

In progress

Bohari, A. A. M., Skitmore, M., Xia, B., Zhang, X (2016). Determinant for Green orientation of a building procurement. **Prepared for publication** in *Renewable and Sustainable Energy Reviews*

(P1) THE PATH TOWARDS GREENING THE MALAYSIAN CONSTRUCTION INDUSTRY

Paper published in the Renewable and Sustainable Energy Reviews journal
(Tier1, Impact factor 6.798)

/10.1016/j.rser.2015.07.148

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Abstract

Construction industry contributes significantly to environmental degradation and governments in many countries which are endeavouring to address the situation. Malaysia is no exception. This paper examines the path towards green construction project delivery in Malaysia, focusing on current green policies and initiatives by governments. The historical waves in Malaysian approaches to tackling environmental issues are described, starting from the early 20th century, through the 1990s to the present, and the influence of these approaches on construction practices is analysed. Based on the findings of policy review, essential green construction practices aimed at mitigating the adverse effects of construction activities on the environment in Malaysia were identified. This paper paves the way for future studies in construction and sustainability in Malaysia, especially for the Southeast Asian region where sustainability practices are urgently needed.

Keywords: Malaysia; construction industry; environmental protection; policy; green practices.

(P2) GREEN ORIENTED PROCUREMENT FOR BUILDING PROJECTS: PRELIMINARY FINDINGS FROM MALAYSIA

Paper published in the Journal of Cleaner Production
(Tier 1, Impact factor 4.959)

10.1016/j.jclepro.2017.01.141

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Abstract

As Malaysia is planning an increasing number of construction projects in the near future, a major imperative is to embark on a 'greener path' to ensure a more sustainable future. One of the efforts currently being undertaken is the introduction of green procurement, which is part of the government's *MyHijau* initiative and highlighted in the Malaysian economic planning program. Previous studies have found that the concept of green procurement is still very new to the Malaysian construction industry and accordingly have sought to address the low levels of knowledge in this area. This paper presents preliminary findings of green procurement practices in Malaysia based on a review of the existing literature as well as a pilot study utilising semi-structured interviews of experienced practitioners. Our findings indicate that, although the term 'green procurement' is not being used broadly across construction stakeholders, some green practices related to procurement are developing in the industry. These include the availability of green procurement guidelines, the inclusion of green criteria in the tender process, with due consideration given to green purchasing. The findings are encouraging and point to a growing awareness, practices and implementation of green procurement by practitioners in Malaysia. It is envisaged that the paper will provide the basis for future research into green procurement practices for construction projects in Malaysia and beyond.

Keywords: green construction, green procurement, green practices, Malaysian Construction Industry

(P3) INSIGHTS INTO THE ADOPTION OF GREEN CONSTRUCTION IN MALAYSIA: THE DRIVERS AND CHALLENGES

7th Asia-Pacific International Conference on Environment-Behaviour Studies,
St Leonard Hall, Edinburgh University, United Kingdom, 27-30 July 2016

http://ebpj.e-iph.co.uk/index.php/EBProceedings/article/view/165/pdf

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Abstract

The construction sector is an essential in providing physical development for nations to cater to the demand for infrastructures such as education, housing, and manufacturing. However, the adverse impact of the building sector on the environment has triggered a growing awareness of the sustainable approach. Green construction is becoming expected in every construction project, and Malaysia is developing a national pathway to sustainable construction. After a comprehensive literature review, this research used semi-structured face-to-face interviews with industry experts to explore the current practices. In the Malaysian context, the compliance with government policy and industry guidelines has been the primary push factors to deliver green projects. The most common barrier faced was the low level of knowledge and awareness of project stakeholders. This paper helps provide a basis for future research and increase stakeholder awareness of green construction in the Malaysian construction industry and beyond.

Keywords: Green Building; Green construction, Drivers, Barriers.

(P4) GREEN PROCUREMENT FRAMEWORK FOR THE MALAYSIAN CONSTRUCTION INDUSTRY

The 7th International Conference of SuDBE2015, Reading, UK; 27-29 July 2015

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Abstract

Construction projects have a negative impact on the environment. As Malaysia is planning more construction projects to cater for its current and future development needs, practitioners are urged to undertake greener approaches to construction. One of the efforts is the introduction of green procurement, which is promoted under the Malaysian Government's *MyHijau* initiative. Construction procurement is recognised as a tool to shift the construction business into a greener industry. However, the implementation of green procurement in Malaysia is still in its infancy and faces a number of challenges, such as the lack of knowledge. A significant gap has been found between policy formulation and actual project delivery as there are no practical guidelines for stakeholders to procure environmental-friendly construction projects. To address this problem, the present research (as part of an ongoing PhD project) aims to develop a green procurement framework that guides stakeholders in procuring green projects in Malaysia. This article highlights the concept of green procurement in Malaysia; the work carried out to date to achieve the research objectives and the preliminary framework that has been established. It is hoped that this research will help academics and practitioners to further explore the potential of green procurement to improve sustainability in the current construction industry practices.

Keywords: green procurement, green practices, green project, Malaysian construction industry

(P5) DEVELOPING GREEN PROCUREMENT FRAMEWORK FOR CONSTRUCTION PROJECTS IN MALAYSIA

International Conference on Engineering Project and Production Management, Gold Coast, Australia. 2nd September 2015.

http://www.ppml.url.tw/EPPM/conferences/2015/download/Developing%20Green%20Procurement%20Framework%20for%20Construction%20Projects%20in%20Malaysia.pdf

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Abstract

With the current emerging development pattern in Malaysia, the Malaysian government has enthusiastically promoted green procurement approach that will help the construction project being green. Previous studies highlighted that the concept of green procurement is still very new to the Malaysian construction industry, and this increases the needs for further research in this area. This paper addresses the needs of guidelines for stakeholders to procure environmentally-friendly construction. Currently, there is a limited practical guideline for stakeholders to procure green projects. This paper discusses the progress to date of a research project aimed at developing a green procurement framework for construction projects in the Malaysian construction industry. This framework will guide the stakeholders to plan the green procurement implementation to procure construction projects. Through literature and expert opinion, this paper explores the list of green practices within procurement practices which becomes the basis to develop a survey instrument that will be used in the later part of this study. The paper will shed useful information for construction researchers and practitioners in exploring the green procurement concept for the construction industry in Malaysia.

Keywords: green procurement, green practices, Malaysia construction Industry, preliminary framewor