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Managing Project Sustainability: A Study of the Construction Industry in Hong Kong

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Abstract

Despite the vast research on project success and sustainability, little is known about managing project sustainability, particularly Hong Kong's construction industry. Previous empirical studies on construction project implementation success lack the ingredients of sustainability. This sequential mixed methods research explores such a relationship from both project maturity and process perspectives. The quantitative study on local construction project managers identifies the status quo of project sustainability maturity. In addition, it identifies sustainability success criteria and factors attributable to project implementation success. The quantitative study results generate question for a subsequent qualitative e-Delphi study. The follow-up e-Delphi study distinguishes the degree of impact related to economic sustainability, environmental sustainability, and social sustainability on construction projects. This study surveyed 55 local construction project managers and received consensus from 12 international experts in the field. First, the mixed methods study found that a discernible construction project sustainability maturity level does not appear in the Hong Kong construction industry. However, organisations generally value project sustainability. Second, the study found four traditional success criteria to explain a majority of local construction project implementation success. Third, two significant sustainability impact criteria (economic and environmental constructs) contributed to local construction project implementation success. However, criterion representing social sustainability impact was not identified. Fourth, the traditional constituent success criterion for construction project implementation success linked to certain sustainability impact elements. Fifth, the study categorised important sustainability impact-related factors (economic: 3; environmental: 4; and social: 3). Finally, e-Delphi experts believed that environmental sustainability was more important than economic and/or social sustainability. This study contributes knowledge to

researchers in the field. It also provides local construction project managers with management practices in structuring sustainability-related success criteria and factors contributing to project implementation success. Limitations of this study include not able to conduct longitudinal study, limited judgmental sample size in the survey, clients and stakeholders' view not being considered in the quantitative study, and that majority of the e-Delphi experts in the qualitative study are not base in Hong Kong, etc. Such limitations may reduce the reliability of the research findings.

Acknowledgements

I started practicing project management 30 years ago as a project engineer of a coal-fired power station. I went on to earn a Master of Science in energy at the Heriot-Watt University in the United Kingdom. Upon graduation, I moved to France to learn project management theory at the ESC Lille (now SKEMA) where I met a group of prominent project management academics, researchers, and practitioners. At that time, I obtained PMP and PRINCE2 professional qualifications. Researching project sustainability evolved as my academic and professional knowledge accumulated in the field of project management and sustainability. In 2013, I began a Doctor of Business Administration at the London South Bank University. As a foreign student based in Hong Kong, I would like to thank the International Academy of Management (IAM) for their support, especially to William Chow and Karen Keung. I would also like to thank those individuals who have inspired my research in project sustainability. I would like to express my gratitude to those professors, lecturers, colleagues, and friends who shared their knowledge and experience with me. I would like to thank Professor Shushma Patel and Dr. Paul Sin who guided me through the writing process and shared valuable advice. Thanks also to the Project Management Institute Hong Kong Chapter for supporting my research on this subject. Without the help of survey respondents and e-Delphi experts, this research study would not be possible. Thanks to all internal and external examiners who provided feedback and opinions for improvement. A special thanks to my wife, Shirley, on her patience and tolerance during this academic study project. She can cook, keeps my life happy, and helps me stay healthy. Thanks, Shirley!

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Chapter 1 Overview

Apart from the threat of hostilities and terrorism, it seems certain that climate change and the exhaustion of natural fossil fuel resources will provide the biggest challenges in the future. We shall need effective project managers to deal with these challenges if humankind is to survive. (Lock, 2013: 6)

1.1 Introduction

Lock (2013) raised concerns about the sustainability of humankind as he predicted that project managers would face challenges related to climate change and lack of fossil fuels. Project management is becoming a common way to manage businesses (Bredillet, 2000; Turner, 2009). Therefore, project managers and their teams must be mindful of how sustainability challenges in project delivery can impact modern times. They would become a part of the solution to human survival and/or sustainable development. The fourth edition of the PMBoK Guide, published by the Project Management Institute (PMI, 2008: 5), recognised that "… projects can also have social, economic, and environmental impacts that far outlast the projects themselves."

Hong Kong, which is 1,104 km^2 of land on the southern coast of China, is home to 7.3 million people with approximately 425,000 registered construction workers in December 2015 (HKSAR, 2016). In according to a report prepared by China Insights Consultancy (CIC Report) (CIC, 2018), the construction industry contributed 4% (HK$ 211.1b) to Hong Kong's Gross Domestic Product (GDP) in 2013. In 2017, this GDP share increased to 5.2% (HK$ 304.1b) and that it is expected to further increase the GDP share up to 6.1%

(HK$ 429.1b) by 2022. Table 1.1 below shows the construction industry share of GDP in Hong Kong.

Table 1.1. *Construction industry share of GDP in Hong Kong*

	% GDP	Investment (HK$ billion)
2013	4.0	211.1
2014	4.3	244.0
2015	4.6	262.8
2016	4.9	278.6
2017	5.2	304.1
2018E	5.5	323.2
2019E	5.6	345.5
2020E	5.8	370.1
2021E	6.0	397.7
2022E	6.1	429.1

Wong, Ng and Chan (2010), in their study on strategic planning for the sustainable development of Hong Kong's construction industry, revealed that local experts anticipated a period of stable growth surrounding the local construction industry. An aging and expanding population, which is estimated to reach 8.6 million by 2036, has increased demands on local property markets and public housing (C&SD, 2007; Wong *et al.*, 2010). Demands for housing, community facilities and urban regeneration projects inevitably create substantial work for the construction industry. Increasing inter-economic activities between Hong Kong and mainland China have also added opportunities for professional, skilled and general workers in the sector. For example, the building of the Hong Kong-Zhuhai-Macao Bridge created many jobs. The bridge will significantly reduce commuting times and transportation costs between Hong Kong and the western Pearl River Delta region. Another example is construction of the Hong Kong section of Guangzhou-Shenzhen-Hong Kong Express Rail Link, which is part of mainland China's 16,000 km high-speed railway network linking major cities (HKSAR, 2016). Increasing infrastructure investments in Hong Kong create local job opportunities in the construction industry. They also result in negative sustainability impacts if improperly handled.

As a project professional and researcher in Hong Kong, researching sustainability attributes in project management will help the local construction project management community to advance management practices. This study aims to learn how local construction project managers can promote positive sustainability impacts while minimising negative sustainability impacts during project implementation. The knowledge from this study will also benefit other regions' efforts in sustainable construction project development and implementation. This chapter will discuss the research theme, problem areas, knowledge gap and research goals/objectives. The research questions, hypotheses and research framework in the following chapters will be briefly restated.

1.2 Research Theme

Projects are temporary in nature (PMI, 2017). **Project management** is the process by which projects are defined, planned, monitored, controlled and delivered to realize agreed benefits (The APM Body of Knowledge 5th Edition - Definitions, APM, 2006). The **sustainability** process aims to attain a goal embedded in a supporting system. It is not a methodology. Instead, it is linked to a will to change behaviours, attitudes, consumption patterns, spending and purchasing habits, and perceived values related to the environment. Sustainability concerns inter-generational equity and intra-generational development (Brundtland, 1987). Project management and sustainability are recognised as two disciplines and professional practices in the academic circle. However, they are inter-related in the business world.

Projects focused on sustainability dimensions are increasingly observed in the construction industry, especially in the new millennium. Traditional assessments of project implementation success did not consider such impacts. For example, Pinto's (1986) project implementation profile (PIP), which is well-received in the field of project management for assessing success, does not address sustainability-related elements. The project management community needs this knowledge to help project managers accomplish successful sustainability activities.

Projects seeking financial support from the Equator Principles financial institutions (EPFIs) must follow stipulated requirements to assess relevant sustainability risks. EPFIs include banks and other financial institutions that adopted principle benchmarks to determine, assess and manage social and environmental risk in project financing. These principles ensure that financed projects are socially responsible and reflect sound environmental management practices. Such requirements only link to project financing compliance. However, it reflects a growing importance to understand sustainability requirements through project execution.

The building research establishment environmental assessment method (BREEAM), published in 1990 by the UK Building Research Establishment (BRE), has driven environmental sustainability quality and value. However, BREEAM sets standards and benchmarks across similar projects. This focuses on the environmental footprint of a project's post-completion performance. It does not concentrate on sustainability-related criteria and factors (economic, environmental and social) leading to project implementation success. Therefore, BREEAM's framework is not applicable to this study.

The research theme on managing project sustainability is established from the above discussion, as well as the following literature review. This study focuses on determination of sustainability criteria and success factors for project implementation applicable to Hong Kong's construction industry. Other non-sustainability-related areas of study linked to project implementation success are excluded from the scope of this research.

1.3 Problem Area for Research

Sustainability (or sustainable development) is an important topic recognized by the United Nations during the 1992 Earth Summit and other conferences spanning the last two decades. The United Nations recognises that activities during projects or operations can both positively and negatively impact sustainability. Construction project professionals are among the first individuals supporting a project's environmental and social assessments because they understand the significance and impacts of sustainability on project processes and outcomes. For example, Abidin (2005) suggested that sustainability be treated as part of a vision during the construction project. A commitment to sustainability must be established during the project's first stage to ensure smooth processes and participant adoption (Abidin, 2005).

The project manager oversees the development process to ensure project success. Project managers are increasingly required to handle sustainability activities (e.g., Equator Principles for project financing). These activities may impact the project owner, user and the stakeholder community at large. Project managers need theoretical and empirical support to define project success under the emerging sustainability impacts. Project management communities find it imperative to understand and echo these impacts on/from projects under development. Project manager awareness to sustainability challenges can contribute to society. Therefore, a thorough understanding of construction project sustainability impacts will help project managers develop tools and processes to meet the needs of sustainability for construction projects, infrastructure projects, etc.

Traditionally, project success criteria heavily relied on the “iron triangle” of cost, time and quality. This efficiency measurement is entirely within the boundary of the project itself. Until Brundtland (1987) presented the concept of sustainable development in her report “Our Common Future,” it was uncommon to consider sustainability’s external impacts other than in some infrastructure projects. Brundtland (1987: 43) defined sustainable development as the “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” Her definition pointed out intra-generational development and inter-generational equity, as well as the “three pillars” of sound environment, just society and healthy economy. However, project based on the iron triangle has become insufficient in the new millennium.

Project sustainability has grown in the last two decades. Yet project managers lack the support of a project management body of knowledge. For example, a sustainability-related knowledge area is not included in the most current edition of the PMBoK Guide, which provides guidelines to more than 500,000 project managers worldwide, including Hong Kong (PMI, 2017). Silvius, Schipper and Nedeski (2013), in their European case studies, found that organisations remain conservative in managing project sustainability. Maldonado-Fortunet (2002: xiv), in his review on the literature, and revealed that:

… a lack of both (1) specific sustainability criteria that can assist planners of infrastructure projects in defining project objectives to guide the delivery process, as well as the ultimate outcome of the project; and (2) a practical methodology that can be applied to implement sustainable development normative and operational principles.

Project works, infrastructure project activities in particular, have shown substantial impacts on society. For example, consumption of resources in projects may have economic impact on local community. Release of carbon dioxide (CO_2) leading to climate change and other gas emissions during project execution may have impact on global and local environment. To a further extent, project activities may have positive (e.g. employment which is beneficial to society) or negative (e.g. child labour employment which is detrimental to society) impact to local community. In Hong Kong, no previous research conducted integrating the consideration of economic impact, environmental impact and societal impact in managing project sustainability. Understanding of such limitations in project execution may help to improve the chance of project success and reduce negative impact(s) to society as a whole.

Lack of sustainability knowledge for project managers is a key barrier to building a sustainable society.

1.4 Knowledge Gap

Project management and sustainability are separate disciplines of knowledge. There are many researchers and academics developing a respective body of knowledge. Project development in the new millennium is subject to sustainability impact screening on economic, environmental and social risks. However, the potentials and challenges of sustainable development in project management have not been carefully researched (Gareis, Huemann and Martinuzzi, 2009; 2010). Therefore, research into sustainability attributes for the benefits of the project management community is an untapped area.

Project management, which is an evolving academic discipline and professional practice, develops in response to the needs of society (Bredillet, 2006; Bredillet, 2007a, 2007b, 2007c, 2008; Kloppenborg and Opfer, 2002; Shenhar and Dvir, 2004; and Kwak and Anbari, 2008). The definition of project success has also changed. In the early stage of modern project management, success focused on efficient measurements of time, cost and quality (Barne, 1969). More recently, it focuses on a framework to assess efficiency, impacts on customers and teams, business and direct success, and preparation for the future (Shenhar and Dvir, 2007). It now considers stakeholders' views and external influences.

Until the 1990s, sustainability as project externality had little influence on the historical development of modern project management. Daniel (1961), as a pioneer researcher working on success factors for business, described the necessity to collect environmental information to satisfy a management information gap, including the social, political, and economic aspects of the climate in which a business currently or potentially operates. About 40 years after

Daniel (1961), Belassi and Tukel (1996) and Atkinson (1999) brought project externality considerations into their frameworks for systematically assessing the success and/or failure of a project. Belassi *et al*. (1996) considered political environment, economic environment, social environment and technological environment as part of the external factor group. These external environmental factors lead to success and/or failure as they impact the implementation of the project.

Unlike Belassi *et al*., Atkinson's (1999) square route model recognised the importance of social and environmental impacts. The model also recognised economic impacts on the surrounding stakeholder community as criteria for project management success. These developments make Belassi *et al*. (1996) and Atkinson (1999) supporters to the consideration of project externality toward project and project management success at the conceptual level.

Empirical research in the field emerged following Atkinson. International projects by Maldonado-Fortunet (2002) and Silvius *et al*. (2013) are good examples. Maldonado-Fortunet (2002), in his international construction projects study, identified several contributing factors satisfying project sustainability under the process perspective (see Chapter 3, Literature Review). From the maturity perspective, Silvius *et al*. (2013) conducted an empirical study on 56 European projects integrating the concept of sustainability (economic, environmental and social) into projects and project management (see Chapter 3, Literature Review).

The European study by Silvius *et al*. (2013) did not focus on a construction environment. Therefore, its results may not reflect the situation in Hong Kong's construction industry. In the past 20 years, the Hong Kong government has promoted sustainability at the policy level.

Although the construction industry in Hong Kong responded to the change, it focused on an environmental sustainability perspective (Shen and Tam, 2002). Hong Kong construction project managers do not have access to empirical research on managing project sustainability. Therefore, it is difficult for them to understand the various dimensions of sustainability in project development.

International project management researchers are working empirically in inter-disciplinary studies on project management and sustainability. Some researchers are working on project sustainability maturity. Other researchers are conducting studies from a process perspective. However, there are limited tools and knowledge to help local project managers develop sustainability competence in a dynamic project environment. Sustainability knowledge (economic, environmental and social) as part of the project manager competence requirement is not clearly established. There is a necessity to empirically test the elements identified from the literature review within each of the sustainability constructs. The lack of research and discussion on sustainability criterion for project implementation success in the local project management community has caused a gap in knowledge creation and dissemination. This study will fill the void in the knowledge gap.

1.5 Research Goals and Objectives

Project development (e.g., infrastructure project development) aims to avoid damaging the ecosystem with minimal use of resources. These constraints have placed project managers under enormous pressure. This research study intends to provide Hong Kong construction project managers guidance on integrating sustainable development principles into projects leading to project implementation success. To be more specific, the goal of this research is to learn the perception of Hong Kong construction project managers in respect of sustainability attributes for project implementation success. To help project managers in facing these challenges, this research study set the following goals:

- **Goal 1:** Through exploratory study, project managers will better understand sustainability attributes in the realm of project management.
- **Goal 2:** This study will promote project success through the organisation and management of project sustainability by the project management community.
- **Goal 3:** Further research on this subject will be possible with knowledge obtained from this study.

To achieve these goals, objectives include:

- **Objective 1:** The reader will learn the perception of project managers in respect to project sustainability maturity levels for projects in Hong Kong's construction industry.
- **Objective 2:** The reader will identify project sustainability success criteria for judging project implementation success in Hong Kong's construction industry.
- **Objective 3:** The reader will understand the significance of literature-identified factors toward various constructs of project sustainability.
- **Objective 4:** The reader will consider the future of project management by raising and integrating sustainability issues into their project management processes.

1.6 Research Questions

Research questions are concerned with identifying and satisfying specific needs through the study (Maxwell, 1996). Bouchard (1976) suggested that good research asks the right questions and selects the most powerful method to answer the questions. This research adopts sequential mixed methods. It is a quantitative study with follow up qualitative study in answering questions.

Part 1 – Quantitative Study

In reference to the aforementioned problem statement, knowledge gap, and research goals and objectives, the research questions in Section 3.2 (Sustainability in Project Management) study project sustainability maturity and success criteria (economic, environmental and social) leading to project implementation success. This study focused on construction project managers in Hong Kong. Three research questions in the quantitative study were developed by making key references to Silvius *et al*. (2013) and Maldonado-Fortunet (2002) with Pinto's (1986: 219) performance measurement targets on project implementation success. Details on developing the research questions are described in the literature review chapters. To re-state:

#1) What is the level of sustainability consideration for projects in Hong Kong's construction industry?

#2) To what extent does project sustainability (economic, environmental and social) impact project implementation success of Hong Kong's construction industry?

If such criteria exist, then:

#3) What is the degree of significance of identified sustainability-related factors contributing to project implementation success?

The research question Q1 intends to highlight the view of project managers on project sustainability maturity that the project positioned. It is for future study and that Chi-square test for goodness-of-fit is used to test project maturity in terms of business resources, business processes, business model, and products and services. Framing of hypothesis is not required.

For research question Q2, it seeks to understand how the impact of respective sustainability dimension influences on project implementation success in the local construction industry. To formulate research hypothesis, it is required to identify impact relationship between economic sustainability and project implementation success. In a similar vein, hypotheses for respective environmental sustainability and social sustainability impact relationship on project implementation success are framed.

The purpose of research question Q3 is to ask project managers to rank the relative importance of identified factors contributing to project implementation success. The ranking is carried out in respect sustainability dimensions (economic, environmental, and social). Framing of hypothesis is not required.

Research question Q1 on project sustainability maturity refers to performance of project organisation, and questions Q2 and Q3 study the process perspective of a project. Project organization should normally drive the performance of their sponsored projects. In this sense, project sustainability maturity performance and process achievement are inter-related.

Part 2 – Qualitative Study

Findings from Part 1 indicate that there is no social sustainability-related criterion identified significant to construction project implementation success. To complement the quantitative study, a Delphi panel study is proposed. The purpose of this subsequent qualitative study is to better understand the differences between respective sustainability impacts. Expert views from the Delphi panel can be contrasted to Part 1 survey results of construction project managers.

The Question (Q) asks: *Is there any difference in terms of degree of importance on respective economic sustainability impact, environmental sustainability impact and social sustainability impact on project implementation success of construction projects?*

1.7 Research Hypotheses and Framework

Part 1 – Quantitative study

Under the three-pillar approach, this study identifies respective sustainability impacts on project implementation success (or the success criteria in process perspective). It also focuses on researching the perspective of project sustainability maturity. Sustainability maturity is considered a whole (rather than a respective dimension) at each level of the project sustainability maturity model (e.g., business resources at the lowest level).

The development of three sustainability constructs (economic, environmental and social) encompasses several criteria from the literature review. In turn, these may be applicable to the construction industry in Hong Kong. Abidin and Pasquire (2007), Silvius *et al*. (2013), and Maldonado-Fortunet (2002) demonstrated the factors in each construct. Linkages between respective sustainability impacts (independent variables) and project implementation success (dependent variable) develop where relationships are tested in the framework (see Figure 1.1). The three hypotheses in the research framework are as follow:

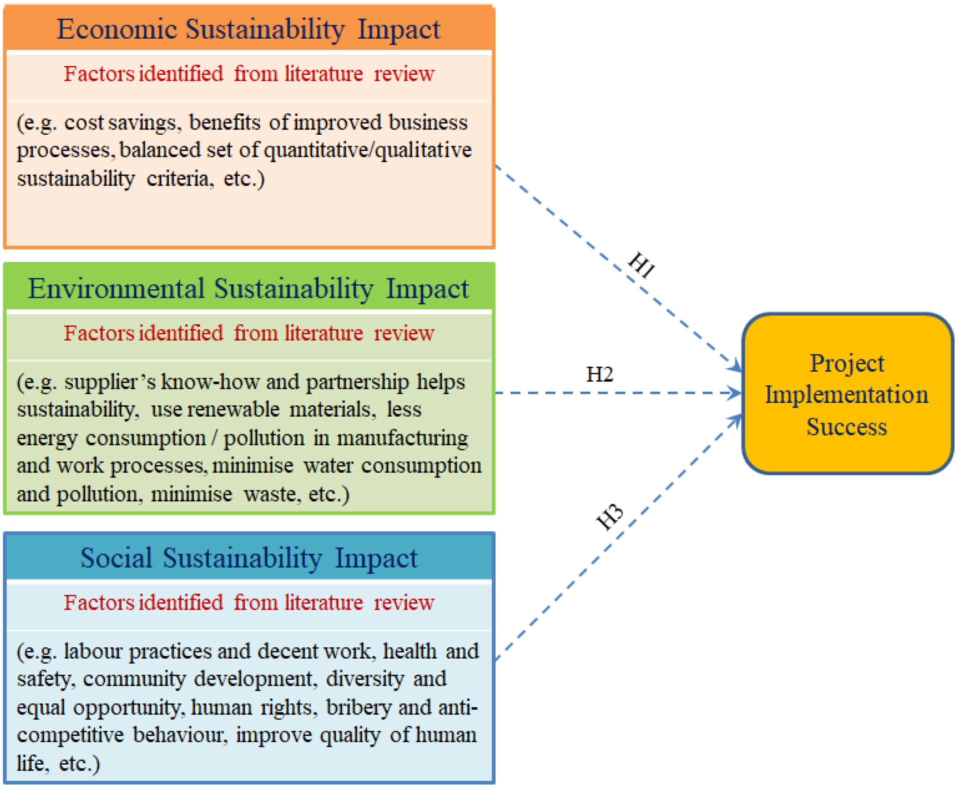

Figure 1.1. Quantitative research framework

1. Economic sustainability impact:

   H_{10}: There is no impact relationship between economic sustainability and project implementation success.

   H_{11}: There is an impact relationship between economic sustainability and project implementation success.

2. Environmental sustainability impact:

   H_{20}: There is no impact relationship between environmental sustainability and project implementation success.

H_{21}: There is an impact relationship between environmental sustainability and project implementation success.

3. Social sustainability impact:

   H_{30}: There is no impact relationship between social sustainability and project implementation success.

   H_{31}: There is an impact relationship between social sustainability and project implementation success.

The linkages between research goals, research objectives, quantitative research questions and research hypotheses are shown in Table 1.2.

Table 1.2. *Linkages between research goals, research objectives, quantitative research questions and research hypotheses*

Research Goals	Research Objectives	Quantitative Research Questions	Hypotheses
Goal 1: Through exploratory study, helps project managers gain better understanding of sustainability attributes within the realm of project management	Objective 1: Learn the perception of project managers in respect of project sustainability maturity level for projects in the Hong Kong construction industry	Question 1: What is the level of sustainability consideration for projects in the construction industry of Hong Kong?	Chi-square test for goodness-of-fit used to test project maturity in terms of business resources, business processes, business model, and products and services Remark: This simple question highlights the view of project managers on project sustainability maturity that the project positioned (for future study).

	Objective 2: Identify project sustainability success criteria for judging project implementation success in Hong Kong's construction industry.	Question 2: To what extent does project sustainability (economic, environmental and social) have an impact on the project implementation success of the construction industry in Hong Kong?	H_{10}: There is no impact relationship between economic sustainability and project implementation success. H_{11}: There is an impact relationship between economic sustainability and project implementation success.
			H_{20}: There is no impact relationship between environmental sustainability and project implementation success. H_{21}: There is an impact relationship between environmental sustainability and project implementation success.
			H_{30}: There is no impact relationship between social sustainability and project implementation success. H_{31}: There is an impact relationship between social sustainability and project implementation success.

Goal 2: Promote success in project considering organisation and management of project sustainability undertaken by the project management community	Objective 3: Understand the significance of literature-identified factors toward various constructs of project sustainability	Question 3: What is the degree of significance of identified sustainability-related factors contributing to project implementation success?	N.A. Remark: This simple question asks project managers to rank the relative importance of identified factors for project sustainability. Hence, a hypothesis is not framed.
Goal 3: Instigate further research on this subject with knowledge obtained in this study	Objective 4: Shed light on the future of project management in raising and integrating sustainability issues into project management process	N.A. Remark: The project management community will benefit from the results of this study. The outcomes of this research project may generate another set of research questions (for example, questions in Part 1 for Part 2) and research hypotheses for future study.	

Part 2 – Qualitative study

Part 1 results point out the lack of significant success criterion under social sustainability dimension from process perspective. A follow-up qualitative Delphi research study helps to understand whether a social sustainability pillar carries the same level of importance or attention to economic and environmental sustainability pillars. A Delphi research process is established, as shown in Figure 1.2, to form a consensus among invited experts in Part 2. The following sub-section outlines the flow of the study.

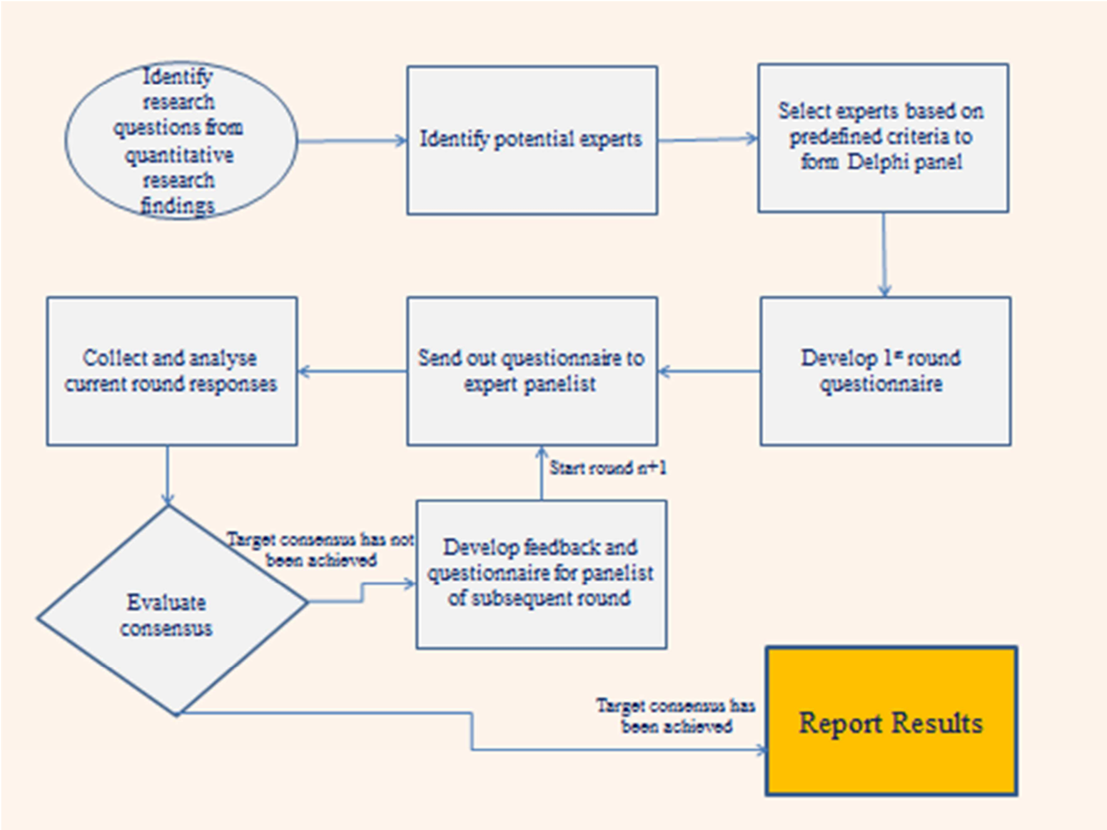

Figure 1.2. *Qualitative Delphi research framework*

1.8 Thesis Outline

The outline of the thesis is shown in Figure 1.3.

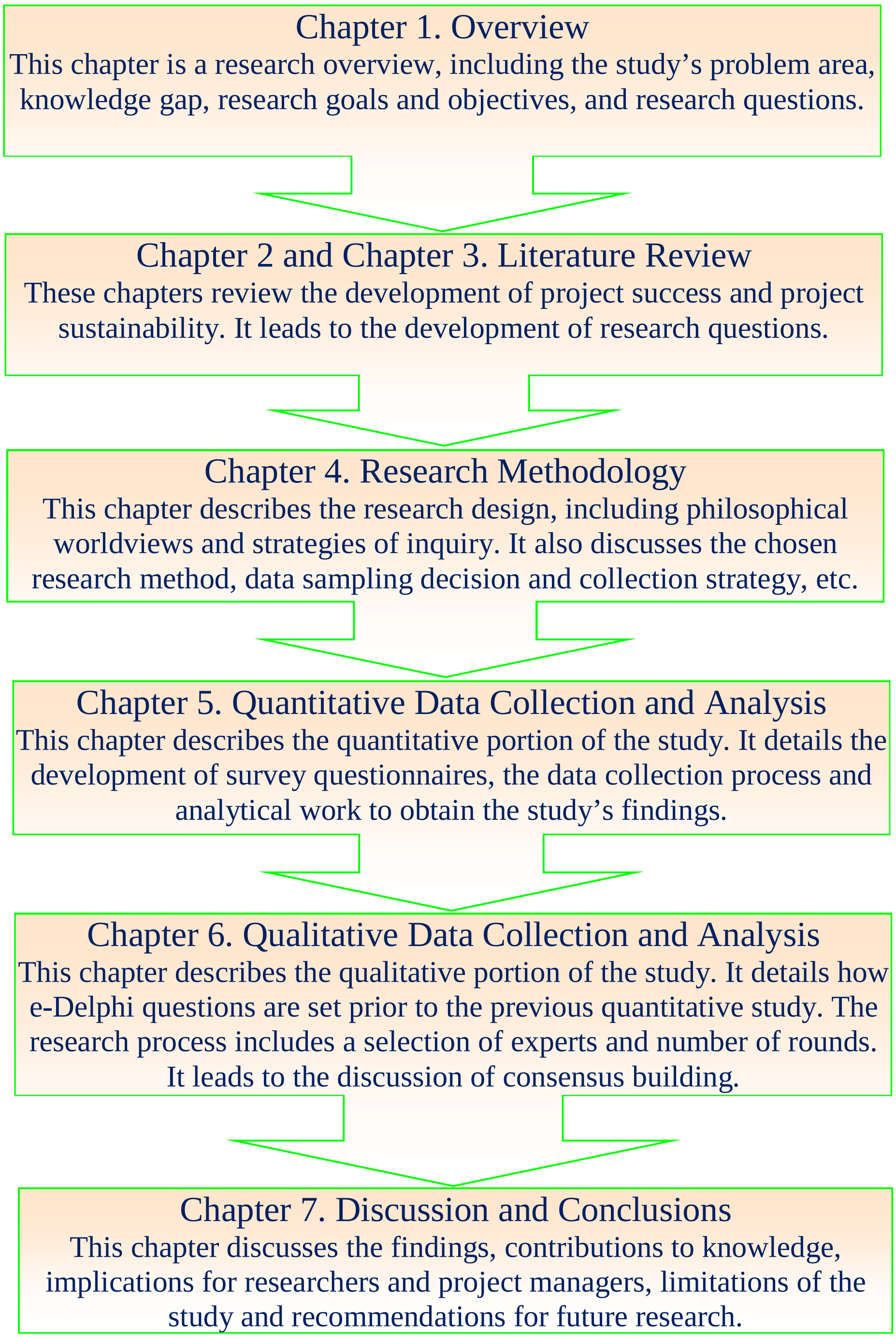

Figure 1.3. *Thesis outline*

Chapter 2 Project Success

2.1 Introduction

Project management is an evolving academic discipline and professional practice developed in response to societal needs. It focuses on the efficient use of resources and effective implementation of corporate strategy. Project management aims to successfully complete a temporary task (Dinsmore and Cooke-Davies, 2006; PMI, 2008). The Association for Project Management (APM) (2006) defines **project success** as the satisfaction of stakeholder needs measured by the success criteria as identified and agreed at the start of the project (The APM Body of Knowledge 5th Edition - Definitions). Pinto (1986) studied project implementation success and defined its success by four measures, including on time (time criterion), within budget (budget criterion), achieves basically all the goals originally set for it (effectiveness criterion), and accepted and used by clients for whom the project is intended (client satisfaction criterion). Sustainability on the other hand addresses long-term existence concerning both intra-generational development and inter-generational equity (Brundtland, 1987). Project management and sustainability are inherently inter-related.

Effective and efficient use of resources will achieve the realisation of sustainability on the environment (planet), society (people) and economy (prosperity) (Gibb, 2004). Elkington (2004) referred to this as the "triple bottom line" (TBL). Toole (2006: 300) defined construction as "the application by people of technology developed by people to achieve goals established by people involving the erection or retrofitting of infrastructure and buildings."

Adopting a sustainable approach to construction leads to significant business benefits, including a better understanding of client needs, identification of opportunities for innovation, increased shareholder value, reduced costs and risks, enhanced public relations and community liaison, and increased employee motivation. It can create efficient, profit-oriented practices while helping society and protecting the environment (Holton, 2009).

The construction industry recognises sustainability impacts as a key consideration in project success. Following an exploratory pilot study by Opoku and Fortune (2010), sustainability became a criterion for public sector procurements and public funded housing projects in the UK (Opoku and Fortune, 2010). Academicians and practitioners in Hong Kong share this vision. The “Hong Kong’s Construction Industry Vision 2020,” jointly published by the Hong Kong Construction Association and the Construction Industry Group of the British Chamber of Commerce, identified five strategic areas to the growth and prosperity of Hong Kong’s construction industry (HKCA, 2012):

1. Safety, health and quality of life
2. Environmental awareness and efficient energy
3. Business ethics and procurement processes
4. Continuous improvements to productivity
5. Development of a viable and sustainable construction industry

This focus aligns with the concept of sustainability in relation to economic, environmental and social perspectives.

According to the final research report of the Construction Industry Institute in Hong Kong, “Reinventing the Hong Kong Construction Industry for its Sustainable Development,” sustainability is an important focus of the construction industry. It includes improvements to energy, waste management, construction methods, etc. (CII, 2008). However, as demonstrated by Shen and Tam (2002), the industry has benefitted from barriers and measures to implement environmental management rather than economic, environmental and social sustainability impacts. This differs from neighbouring mainland China’s construction industry in which more economic factors are considered than social and environmental attributes in project feasibility (Shen, Tam, Tam and Ji, 2010).

In 2001, the Hong Kong government established a sustainable development unit (SDU) to initiate studies and activities for sustainability (Yip and Poon, 2009). Stakeholders in the construction industry play a key role in achieving a sustainable society. Yip and Poon (2009) categorised five groups of stakeholders in accordance to their functional roles and professional disciplines: (1) government; (2) developers; (3) architects, structural engineers, electrical and mechanical engineers and surveyors (collectively the “consultants”); (4) main contractors, sub-contractors and suppliers (collectively the “contractors”); and (5) site agents, site supervisors and foremen (collectively the “non-professionally-recognised participants”). In their study, government and developer groups in Hong Kong did not aggressive promote sustainable development in construction from 2000 to 2004. However, consultants, contractors and non-professionally-recognised participants exhibited significant awareness, concern, motivation and implementation throughout that same research period (Yip and Poon, 2009).

Although some studies related to sustainability have focused on the construction industry in Hong Kong, most studies focused on reduction, reuse and recycling of construction and demolition waste (Jaillon, Poon and Yu, 2004; Poon, 1997), green building (Fong, Lam, and Chan, 2004), and implementation of environmental management (Shen and Tam, 2002). Project management must progress from “doing things right” to “doing the right things right.” In doing so, project managers must take responsibility for the project’s results, including the sustainability aspects of that result (Abdou, 2014). There is also a necessity to promote the balanced view of Brundtland (1987) on building a sustainable society where economic, environmental and social factors are considered on equal footing (Edum-Fotwe and Price, 2009; Shen, Tam, Tam and Ji, 2010). However, research on these criteria leading to project success in Hong Kong’s construction industry has not been widely conducted.

This chapter discusses the development of project success. Section 2.2 shows how project management research has supported society’s development. The historical development of project success, including success criteria and critical success factors, is discussed in Section 2.3.

2.2 Project Management Research

Project and project management have existed for a long period of time. Projects like the Egyptian Pyramids (circa 2700 to 2500 B.C.) and the Great Wall of China (221 B.C. to A.D. 1644) were resourced, planned and executed more than 1,000 years ago. Project management has been used for centuries to create change or deal with change in societies (Cleland and Ireland, 2006). In the first part of 20^{th} century, World War I and World War II cultivated engineers and managers of diverse disciplines through large military and defence projects, including cargo ship building and the Manhattan Project’s building of the first atomic bomb

(Cleland and Ireland, 2006). These important projects advanced modern project management in the second half of the 20th century and beyond.

A number of project time management tools were developed through the 1950s, including the Gantt chart, the critical path method (CPM) and the program evaluation review technique (PERT) (Baccarini, 1999a). In the 1960s, several new tools were developed (for example, the work breakdown structure), which led to the development of cost/schedule control systems criteria (C/SCSC or C/SC^2) (Morris, 1997; Weaver, 2007). The 1970s, which saw an unprecedented expansion of project management in applications, also observed the development of project management as a distinctive discipline (Snyder, 1987). Practices, tools and techniques were major interests to project practitioners for execution. As a result, a trend in the 1980s placed an increased emphasis on the "front end" of projects (Barnes and Wearne, 1993). Gareis (1989) developed the "management by projects" concept stating that many general management situations can be dealt with in project environments (Gareis, 1989). Shenhar and Dvir (2004) identified central concepts in project management development after Gaddis (1959) presented a seminal article on project managers in the *Harvard Business Review*. The perception of project management changes every few years (Table 2.1). Four generations are recognised in the four decades before the new millennium: (1) scheduling in the 1960s; (2) teamwork in the 1970s; (3) uncertainty reduction in the 1980s; and (4) simultaneity in the 1990s (Shenhar and Dvir, 2004).

Table 2.1. *Generations of project management conceptualisation (Shenhar et al., 2004)*

Period	Central Concept	Main Thrust	Means
1960s	Scheduling	Coordinating activities	Information technology, planning
1970s	Teamwork	Cooperation between participants	Process facilitation, role definition
1980s	Uncertainty reduction	Making stable decisions	Search for information, selective redundancy, risk management
1990s	Simultaneity	Orchestrating contending demands	Responsiveness, collaboration
2000s	Adaptation	One size does not fit all	Adaptive approach
	Strategic alignment	Connect project management to business	Build a project strategy
	Globalisation	Off-shore projects	Virtual coordination

Jugdev and Müller (2005) defined four periods of foci in defining success.

1. **Period 1:** Success is measured on project implementation and handover (1960s – 1980s)
2. **Period 2:** Emphasis is on the developing of critical success factor (CSF) lists (1980s – 1990s)
3. **Period 3:** Significant contributions to the literature with the emergence of integrated frameworks on project success (1990s – 2000s)
4. **Period 4:** Strategic project management (21st century) has a continued emphasis on project management success at the organisation level.

Employing project management success from project-level to organisation-level shifts attention to effectiveness metrics and reflects a holistic view on the value of project management as a core or strategic asset (Jugdev and Müller, 2005).

Soderlund (2011) reviewed 30 leading management and organisation journals published over the last five decades and identified 305 articles related to project management. Articles were categorised into seven schools of thought: (1) optimisation school; (2) factor school; (3) contingency school; (4) behaviour school; (5) governance school; (6) relationship school; and (7) decision school. Turner, Huemann, Anbari and Bredillet (2010) categorised the development of project management into nine schools of thought: (1) optimisation school; (2) modelling school; (3) governance school; (4) behaviour school; (5) success school; (6) decision school; (7) process school; (8) contingency school; and (9) marketing school (Bredillet, 2010; Turner *et al*., 2010). Their key ideas, variables and lines of the development are shown in Table 2.2. In addition, Silvius (2017) tried to establish sustainability as a new school of thought in project management.

Table 2.2. *Key ideas and variables/units of analysis of the nine schools of project management research (Bredillet, 2010)*

School of Project Management	Key Idea	Subschools	Came to Prominence	Key Variable or Unit of Analysis
Optimization School	Optimize project duration by mathematical processes		Late 1940s	Time
Modeling School	Use of hard- and soft-systems theory to model the project	Hard systems Soft systems	1950s Mid-1990s	Time, cost, performance, quality, risk, etc.
Governance School	Govern the project and the relationship between project participants	Contracts Temporary organization Project-based organization	1970s Mid-1990s Late 1990s	The project, its participants, and governance mechanisms
Behavior School	Manage the relationships between people on the project	OB HRM	Mid-1970s Early 2000s	People and teams working on projects
Success School	Define success and failure Identify causes		Mid-1980s	Success criteria and success factors
Decision School	Information processing through the project life cycle	Project selection Information processing	Late 1980s Late 1980s	Information on which decisions are made
Process School	Find an appropriate path to the desired outcome		Late 1980s	The project, its processes and subprocesses
Contingency School	Categorize the project type to select appropriate systems		Early 1990s	Factors that differentiate projects
Marketing School	Communicate with all stakeholders to obtain their support	Stakeholders Internal marketing Value of project management	Mid-1990s Mid-1990s Mid-2000s	Stakeholders and their commitment to the project and project management

As discussed, modern project management is an evolving, diverse discipline dealing with changes in the environment and society (Cleland and Ireland, 2006). In the last two decades, concerns about climate change and sustainable development have required that projects, particularly infrastructure projects, be conceptualised, designed and implemented with built-in characteristics of economic, environmental and social sustainability (EPFI, 2013). Many projects failed due to an overrun of cost and time or unexpected opposition from stakeholders (Iyer and Jha, 2005).

This study identifies gaps in knowledge leading to construction project implementation success. It focuses on building economically feasible, environmentally friendly and socially acceptable projects in Hong Kong. This study falls within the success school of project management research as named by Turner *et al*. (2010) or the factor school (i.e., success factors, project outcomes and performance) in the categorisation by Soderlund (2011). To better understand the meaning of project success in building a sustainable society, it is important to review historical developments of success criteria attached to projects.

2.3 Historical Development of Project Success

"Success" is a term that Longman Dictionary of Contemporary English describes as "achieving what you want or intend" (Longman, 2003). Academicians have discussed how to define project success and measure project performance. There is no standardised definition for project success or accepted methodology for its measurement (Baccarini, 1999b; McCoy, 1986).

It is important to differentiate between project success criteria and success factors. Success criteria are measures against which the success or failure of a project is to be judged. Success factors are inputs to the management system that lead directly to the success of the project. Although each is important, they are distinct (Collins and Baccarini, 2004; Dinsmore and Cooke-Davies, 2006). Different success criteria are associated with different critical success factors (CSF) (Pinto and Prescott, 1990).

2.3.1 Success Criteria

Differentiation between project success and project management success is important. Baccarini (1999b) distinguished that the logical framework method (LFM) covers both project management success and product success. Project management success is subordinated to product success (Baccarini, 1999b). Product success deals with goal and purpose (or higher-level objectives of the project). Project management success deals with inputs and outputs related to the process. Project success should not mix with project management success. In addition, there is no direct correlation between the two terms (Baccarini, 1999b).

Cooke-Davies (2004) recognised that both project success and project management success are important to any project. If a project achieves project success without project management success, then an improved process for greater benefits could have been achieved. On the other hand, successful project management without project success indicates that the sponsor or project owner failed to realise project benefits as originally designed (Cooke-Davies, 2004). Project management success measures related to cost-time-quality can be viewed as an internal measure of efficiency. In contrast, product success is concerned with the project's external effectiveness (Shenhar, Levy and Dvir, 1997). In this sense, project management success concerns the process of project implementation. For purpose of this study, project management success is viewed as project implementation success. Therefore, product success is beyond the scope of this research.

Success, which is measured in subjective and objective ways, means different things to different people (Freeman and Beale, 1992). Project managers measure success through cost effectiveness (Altmann, 2005). Pinto and Mantel (1990) confirmed that project success or failure is not a monolithic measure; it must be assessed based on several criteria. What constitutes project failure for one organisation may be viewed as a success in another organisation (e.g., internal efficiency – external effectiveness focus divide in R&D and construction organisation) (Pinto and Mantel, 1990). Neither a standardised definition of project success does not exist nor an accepted methodology of measuring it (Baccarini, 1999b; McCoy, 1986). However, Hartman (2000: 11) declared that a "project is successful if all the stakeholders are happy." People are the initiators, developers, and users of any project. What many project managers fail to realize is that the mis-handling of people affects project outcomes (Bubshait and Farooq, 1999).

Historically, projects have been managed as technical systems rather than behavioural systems using mechanistic approaches to achieve project success in terms of time, cost and quality (Belout and Gauvreau, 2004). With the classic cost, time and quality triangle as a basis, Dinsmore and Cooke-Davies (2006) described additional requirements. Scope and the health, safety and environment (HSE) interplay with five criteria for project management success. This is represented by a pentagon. HSE is part of the social and environmental sustainability impact considerations. There is a form of tension between science (a technical system) and art (a project manager's personal judgement) in choosing project success criteria. Other possible criteria for project success include stakeholder satisfaction, learning effect, motivation, strategic alignment/contribution and preparing for future so that all parties are satisfied during the project and with its outcome (Andersen and Jessen, 2000; Shenhar *et al*., 1997; Wateridge, 1998).

Identifying success criteria devoted to certain projects is an art of the project manager when satisfying key stakeholders. Selecting appropriate project success criteria shows a clear manifestation of the tension between science and art. An added complexity is drawn from developing recognised and mutual success criteria from stakeholders on economic sustainability, environmental sustainability and social sustainability. Dyrhaug and Ingeniør (2002) revealed that the measure of project success is based on the satisfaction of key stakeholders rather than solely meeting technical specifications. Some researchers recommend that project success criteria be clearly defined and agreed upon by key stakeholders prior to the start of a project (Shenhar *et al*., 1997; Wateridge, 1998).

In the 1960s, Martin Barnes introduced the iron triangle as success criteria for a project. The iron triangle illustrates how the objectives of cost, time and quality are interrelated. Shortly after its introduction, Barnes changed the term "quality" to "performance." Lock (2013: 24) quoted from Barnes' private correspondence that "'Quality' implied little more than compliance with spec., but 'performance' I intended to mean 'the project, on completion, does what it is supposed to do.'" At that time, project externality, including sustainability, was not a concern to project stakeholders. In addition, they did not mention the differentiation between project success and project management success.

Morris and Hough (1987), in *The Anatomy of Major Projects*, argued that "on time, in budget, to specification" is often not the best measure of success. Morris *et al.* (1987) identified that a front-end definition is the least understood and managed. Subsequently, it causes problems related to poor definition, wrong expectations, over-optimistic assumptions, inappropriate choice of technology, and poor awareness of externalities (e.g., environmentalist opposition to certain project activities), which leads to poor project outcomes and business performance (Morris and Hough, 1987). Morris (1998) suggested that the management of a front-end definition, including project success criteria, can make or break a project. A project's sustainability requirements, if any, must be defined at the front-end for better management.

Munier (2005) introduced an example of people rejecting a gold mine project in 2003 to defend their health and environment in Esquel, a small town in Patagonia, Argentina. Due to water pollution, Esquel's people stormed the municipality under the slogan "water is more precious than gold." They forced the local municipal council to call for a non-binding referendum on the construction of the mining project. Eventually, the project was declined. The people considered their social and health development more important than economic gain (Munier, 2005). This demonstrated the influence of environmental and social sustainability impacts on the viability of a project.

Pinto (1986), in his classical study on project implementation success, identified specific items for performance measurement (see Table 2.3). According to Slevin and Pinto (1986), success performance may be defined in terms of technical validity (TV) on sound project technical performance, organisational validity (OV) on acceptance by project team members and clients, and organisational effectiveness (OE) on improvement of decision making or performance on the part of clients. On top of traditional schedules and budgets as measures in each project, respective performance attributions given by Pinto (1986) have been categorised in Table 2.3.

Table 2.3. *Items comprising Pinto's performance measures (Pinto, 1986)*

Item	Statement
1	The project has/will come in on schedule.
2	The project has/will come in on budget.
3	The developed project works (or will work if being developed). (TV)
4	The project will be/is used by its intended clients. (OV)
5	This project has/will directly benefit the intended users through increasing efficiency or employee effectiveness. (OE)
6	Given the problem for which it was developed, this project appears to do the best job of solving the problem (i.e., it was the best choice among a set of alternatives). (TV)
7	Important clients directly affected by this project will make use of it. (OV)
8	I am/was satisfied with the process by which this project is being/was implemented. (Pinto did not categorise this item. The author believes that it should be under TV in the context of Hong Kong's construction industry.)
9	We are confident that non-technical start-up problems will be minimal because the project will be readily accepted by its intended users. (OV)
10	This project has/will directly lead to improved or more effective decision making or performance for the clients. (OE)
11	This project will have a positive impact on those who make use of it. (OE)
12	The results of this project represent a definite improvement in performance over the way clients used to perform these activities. (OE)
13	All things considered, this project was/will be a success.

Project performance achievement as described is a task-oriented measure in terms of time, cost and quality. In addition, it links to people in a project system (Turner, 2007). Wateridge (1998) found that project managers focus on short-term success criteria relating to project process to satisfy time and budget constraints set by senior management. Less focus is placed on longer-term success criteria relating to product, including delivering an approved system

(Wateridge, 1998). To achieve improved project success, Wateridge (1998) suggested determining success criteria at the outset to reach a perceived common goal. As such, people's view of the significance and importance of sustainability impacts (economic, environmental and social) on the project and by the project would greatly affect the meaning (or definition) of project success in the project system. However, not many authors write about sustainability impacts on project success. Atkinson (1999), however, is a forerunner in this respect.

Atkinson (1999) argued that the iron triangle (i.e., time, cost and quality) is no more than the two best guesses of resources related to time and cost. These are calculated at a time when the least is known about the project. It is a phenomenon of quality or an emergent property of attitudes and beliefs surrounding the project's life-cycle. When judging project success, project managers put too much emphasis on time and cost at the expense of other criteria (Wateridge, 1995). This may create negligence of additional success criteria, which is a Type II error (Handy, 1994).

To improve Type II error in an IS-IT project, Atkinson (1999) suggested that the square route include the iron triangle, the information system for IS-IT projects (or the technical strength of the resultant system), the benefits to the resultant organisation (or direct benefits), and the benefits to a wider stakeholder community (or indirect benefits) in understanding project success criteria (Atkinson, 1999). Figure 2.1 shows the square route. Table 2.4 breaks down the four perspectives of success criteria. Social and environmental impacts, as well as economic impacts to a surrounding community, are becoming project success criteria under the indirect benefits category of the Atkinson square route model. However, these are not empirically tested.

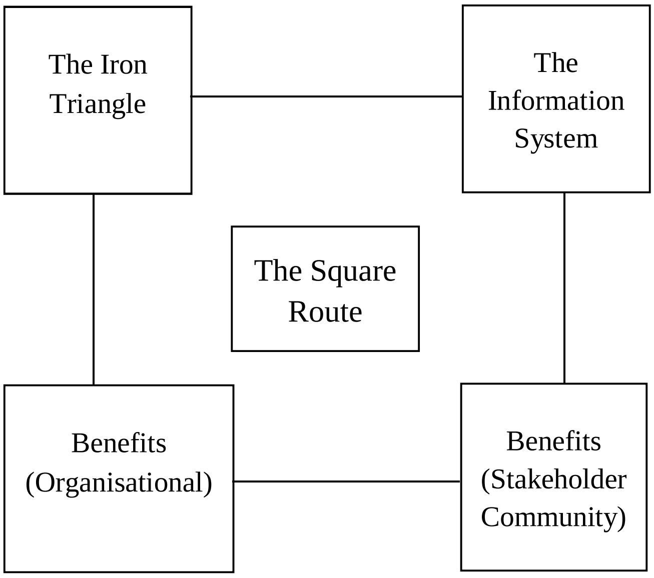

Figure 2.1. *Atkinson's square route (Atkinson, 1999)*

Table 2.4. *Square route to understanding success criteria (Atkinson, 1999)*

Iron Triangle	The Information System	Benefits (Organisation)	Benefits (Stakeholder Community)
Cost;	Maintainability;	Improved efficiency;	Satisfied users;
Quality;	Reliability;	Improved effectiveness;	**Social and environmental impact;**
Time.	Validity;	Increased profits;	Personal development;
	Information - quality;	Strategic goals;	Professional learning;
	Use.	Organisational-learning;	Contractors profits;
		Reduced waste.	Capital suppliers;
			Content project team;
			Economic impact to surrounding community.

Collins and Baccarini (2004) surveyed 150 Australian project managers on project success criteria. Their study indicated that “community acceptance” was a criterion important to product success and social objectives, standards and expectations of the community. “Environmental” is a criterion important to project management success related to meeting environmental obligations and regulatory compliance. Although these criteria rank at the bottom in the list of project success criteria, they confirm Atkinson’s (1999) thinking in an empirical manner (Collins and Baccarini, 2004).

Baker and Echeverria (2015) developed a project manager’s sustainability checklist” (Baker and Echeverria, 2015) by referencing 10 knowledge areas of the Guide to the Project Management Body of Knowledge (PMBoK Guide, 5^{th} edition) (PMI, 2013). The checklist facilitates project managers by pointing out the necessity of sustainability consideration in each of the project management knowledge areas. Nevertheless, the checklist does not inform project managers on what constitutes project success with respect to sustainability perspectives.

2.3.2 Critical Success Factors

Depending on the project type, project success has been perceived differently over time (Altmann, 2005). It is impacted by new technology, knowledge management techniques and project leadership styles meeting time, cost and functional requirements. The exact mix of success factors differs between project types; the project team must encompass all aspects to a greater or lesser extent (Altmann, 2005).

The concept of critical success factor (CSF) contribution to project success originated from the field of management information systems, which was then used in the development of business strategy research (Grunert and Ellegaard, 1993). Daniel (1961) first discussed success factors in management literature (Amberg, Fischl and Wiener, 2005). To bridge the management information gap in organisations, Daniel (1961) suggested three basic types of information for planning purposes: (1) environmental information describing the social, political, and economic aspects of the climate in which a business operates or may operate in the future; (2) competitive information explaining past performance, programs, and plans of competing companies; and (3) internal information indicating a company's strengths and weaknesses. Bullen and Rockart (1981: 7) agreed with Daniel (1961) in stating that CSFs are:

… the limited number of areas in which satisfactory results will ensure successful competitive performance for the individual, department or organization. CSFs are the few key areas where "things must go right" for the business to flourish and for the manager's goals to be attained.

Nevertheless, Bullen *et al*. (1981) maintained that there is no universal CSFs-setting algorithm. In addition, identification of CSFs for a particular project is a subjective judgement arrived at only after some thought by a project manager.

To help project managers easily observe cause-effect relationships, Belassi *et al*. (1996) suggested a framework as shown in Figure 2.2.

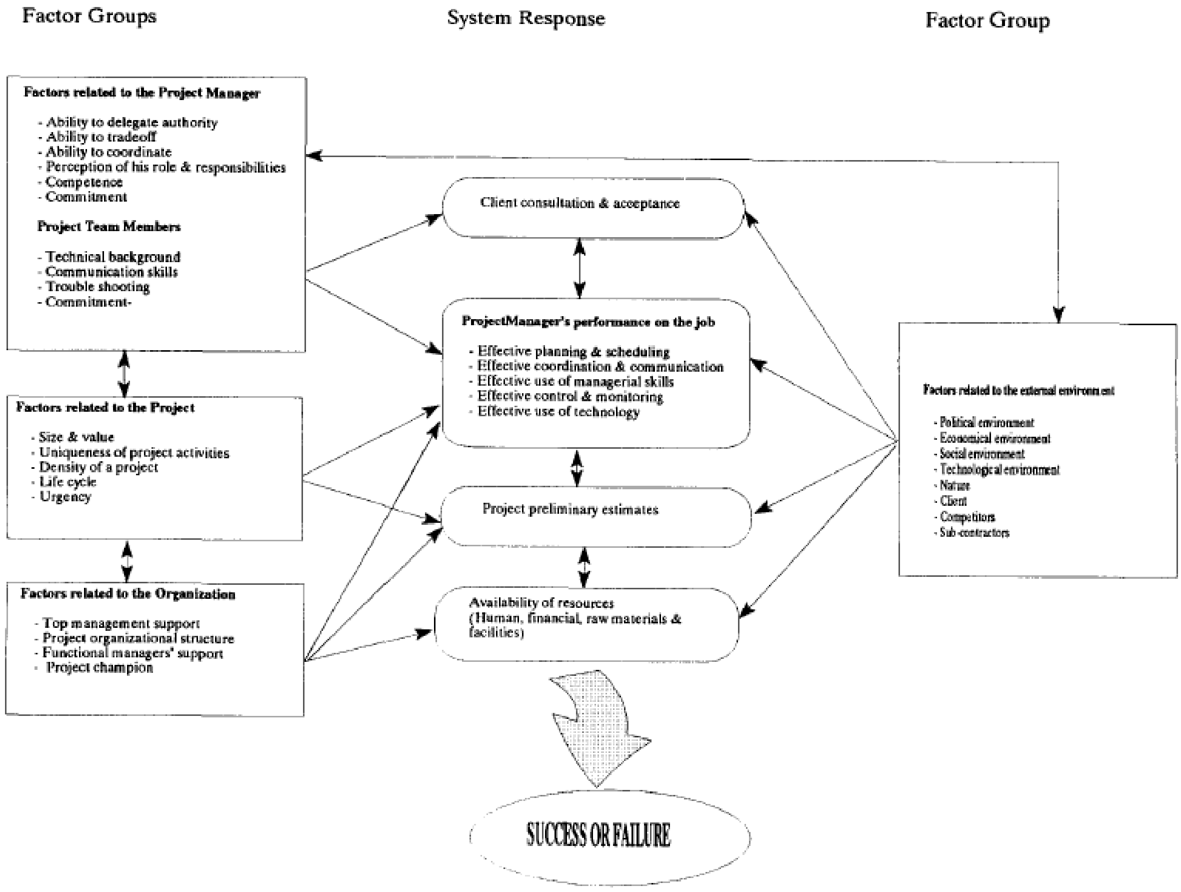

Figure 2.2. *Framework of critical success factors grouping to assess project success/failure (Belassi et al., 1996)*

Success factors are grouped into four areas: (1) factors related to the project; (2) factors related to the project manager and team members; (3) factors related to the organisation; and (4) factors related to the external environment. System response in the framework represents the effect of impacts from intra-relationships between factors in different groups. Belassi *et al.* (1996) admitted that the grouping of critical factors alone would not be sufficient to lead a project to success. Factors in each group can be considered input-related factors affecting project implementation. Several factors in the groups can simultaneously come into play and affect project success or failure. The project manager can adopt this framework to analyse their specific project situations. Atkinson (1999) viewed economic, environmental and social impacts as success criteria (indirect benefits to stakeholder community) to be judged on project success. Belassi *et al*. (1996) viewed them as factors (political, economic, social and technological environment) interplaying with other factor groups. This, in turn, caused project success or failure.

Relatively few researchers examined the process of project implementation in a systematic and empirical manner (Pinto and Prescott, 1987). Most studies, which were conducted from a theoretical perspective, argued for a set of necessary dynamics or conditions to facilitate successful implementation (Archibald, 1977; Cleland and King, 1983; Lock, 1984; Martin, 1976; Pinto and Prescott, 1987). Baker, Murphy and Fisher (1983) was an early survey study on 650 completed aerospace, construction and other projects to identify factors empirically critical to project success (Baker, Murphy and Fisher, 1983; Pinto and Prescott, 1987).

Toor and Ogunlana (2010), in conducting a key performance factor (KPI) study for mega-sized infrastructure projects, explored the significance of KPIs from the viewpoints of different stakeholders. The findings revealed that other than time, cost and quality, KPIs measuring safety, efficient use of resources, reduced conflicts and disputes become increasingly important. They also advocated that the construction industry is slowly shifting from the traditional performance measurement to a mix of both quantitative and qualitative performance measures on those large-scale infrastructure projects (Toor and Ogunlana, 2010).

2.4 Chapter Summary

Hong Kong's construction industry recognises sustainability as a key consideration in project success. Various studies in the construction industry point to the requirements of developing strategy linked to building sustainable construction projects. However, the industry focus has been placed on environmental management rather than working toward a balanced view across the three aspects of sustainability. Stakeholders in the construction industry play a key role in achieving a sustainable society. Professionally and non-professionally recognised participants in the industry should exhibit significant awareness, concern, motivation and implementation throughout the construction project process. The industry's focus on environmental management promotes a balanced view toward building a sustainable society where economic, environmental and social impacts are considered on equal footing. Research on such criteria in Hong Kong's construction industry has not been widely conducted.

This chapter presents background knowledge of project management research, historical development of project success and project management success, success criteria, and critical success factors. Their differentiation has been discussed. The iron triangle's relationship to time, cost and quality was proposed for success monitoring. Project managers at that time did not differentiate between project success and project management success. In the late 1980s, researchers started to appreciate the necessity of front-end definitions on project success criteria. The iron triangle was challenged as being insufficient in judging project success. Atkinson (1999) developed the square route for comprehensive measurement of project success criteria, which included sustainability impacts. Atkinson (1999) recognised this from a theoretical viewpoint; Collins and Baccarini (2004) confirmed his thinking in an empirical study.

Project success, success criteria, and the emerging dimensions of sustainability impacts were reviewed from a project management perspective, which showed many knowledge gaps in this area of study. For instance, researchers could study project success criteria and critical success factors with a contingent or subjectivist approach rather than an objectivist stance. Furthermore, elements of success criteria within each of the sustainability dimensions (economic, environmental and social) have not been researched in-depth, particularly in Hong Kong's construction industry. Major elements comprising of a balanced view of managing project sustainability are discussed in the following chapter.

Chapter 3 Project Sustainability

3.1 Introduction

Most discussions on sustainability and sustainable development focus on global concerns, political issues or local policy interventions. However, a study supported by the U.S. Agency for International Development (USAID), the United Nations Environment Programme (UNEP) and the University of Minnesota addressed this important focus at the project level as it researched how to conduct a project for sustainable development (Gregersen, Lundgren and White, 1994). Gregersen *et al*. (1994) suggested changing the project approach to assure more sustainable benefit flows through project activities for the sake of improving the contribution of projects to sustainable development and avoiding unsustainability.

Sustainability, according to Abidin and Pasquire (2007: 277), is a commitment to:

Economic sustainability *– increasing profitability through efficient use of resources (human, materials, financial), effective design and good management, planning and control;* ***Environmental sustainability*** *– preventing harmful and irreversible effects on the environment by efficient use of natural resources, encouraging renewable resources, protecting the soil, water, air from contaminations and others; and* ***Social sustainability*** *– responding to the needs of society including users, neighbours, community, workers and other project stakeholders.*

Lozar (1993) defined sustainable development for construction project as "… *maximizing the use of natural resources for permanent construction and minimizing environmental degradation over the life cycle of the construction application*" (as cited in Maldonado-Fortunet, 2002: 38-39). Lozar's (1993) definition falls short because it addresses only the resource management and environmental impact of construction projects. It ignores other important attributes of sustainable development, including potential social and economic opportunities and impacts (Maldonado-Fortunet, 2002). Gareis *et al*. (2010) related sustainable development to project management by pointing out that challenges and potentials of sustainable development in project management have not been researched in depth (Gareis, Huemann and Martinuzzi, 2010).

Earlier chapters reviewed the changing criteria of project success, the necessity of incorporating principles of sustainable development into construction projects and the trend of Hong Kong's construction industry to promote sustainability. First, this chapter will review field studies identifying gaps in knowledge. Next, it will formulate research questions.

Eid (2002: 206) pointed out that:

The goal of sustainability is the process of systematically and effectively integrating vital environmental and social concerns into economic development, financial planning, and project management.

In his opinion, the integration of project management, sustainability and industry competitiveness (e.g., quality, markets, equitable market conditions, etc.) delivers a clearer business case for sustainable construction (Eid, 2002).

This research study is inter-disciplinary in nature. Researchers and practitioners have echoed to Brundtland (1987) on sustainable development. Atkinson (1999), Maldonado-Fortunet (2002), Silvius *et al*. (2013) and others have also linked sustainability to project success. To build economically feasible, environmentally friendly and socially acceptable projects required by society, it is necessary to review how project management catered to changes in managing project sustainability. Section 3.2 outlines respective sustainability aspects (economic, environmental and social) in project management. It establishes the meaning of sustainability in project management and leads to the generation of research questions, a hypothesis and a theoretical framework.

3.2 Sustainability in Project Management

Brundtland (1987: 43) defined sustainable development as “the development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” This basic emphasis on a long-term aspect of sustainability and equity between present and future generations continued to be developed over the past decades. Brundtland’s definition indicates that “needs” include a sound environment, just society and healthy economy (Diesendorf, 2000). In the eyes of Diesendorf (2000), “development” covers social and economic improvements in a broad sense, which may include economic growth. The emphasis is on “qualitative improvement in human-being” or “unfolding of human potential” as discussed by the ecological economist Herman Daly (Diesendorf, 2000).

The U.S. National Environmental Policy Act (NEPA), which went into effect on January 1, 1970, created the environmental impact assessment (EIA) (Maldonado-Fortunet, 2002). EIA is defined as the systematic identification and evaluation of potential impacts or effects of proposed projects, plans, programmes, or legislative actions relative to the physical-chemical, biological, cultural, and socioeconomic components of the total environment (Canter, 1996). EIA has been widely used in the global construction industry, including Hong Kong. Many of its principles are integrated into daily works of the construction industry to contribute to sustainability. According to Jaafari (2007), sustainability is a thinking dimension rather than a methodology. There is a lack of consistency and holistic methods to help project participants implement sustainable construction practice at various stages of the project cycle (Shen, Hao, Tam and Yao, 2007). Sustainability considers long-term impact on society (Brundtland, 1987) and project is by definition a temporary endeavour undertaken to create a unique product, service, or result (PMI, 2017). Each project activity during implementation stage may have short-term or long-term impact on society in respective sustainability dimensions (economic, environmental and social). Hence, the nature of project implementation (short-term) and sustainability (long-term) is not in contradiction. They are inter-related. In fact, the project activities within implementation stage offer much influence on sustainability of human being (Lock, 2013).

During the 1970s, project management applications spread from the construction, aerospace and defence industry into nearly every industry (Baccarini, 1999a). Studies to integrate the concept of sustainability into project management continue to grow. However, they tend to approach it from a conceptual, logical, or moral point of view (Silvius *et al*., 2013). A sustainability approach to the development of infrastructure projects considers environmental quality and performance goals. Sustainability constraints must be considered explicitly and systematically within the decision-making process throughout all stages of the project's life cycle. It is especially important during the early funding stage, planning and conceptual design stages and as an additional measure of performance across the life cycle of the project (Maldonado-Fortunet, 2002). The measure of project success from sustainability point of view can be made reference to Brundtland's (1987) suggested sound environment, just society and healthy economy for sustainable development. On project success environmental sustainability, measurement of air quality, CO_2 emissions that cause climate change, waste management and hazardous material handling to prevent harmful to environment, etc. are important. On project success social sustainability measurement, one shall measure the positive contribution and negative detrimental impacts due to the project, such as project impact on human life and community perspective, use of local human and material resources, health and safety improvement at the community, etc. On project success economic sustainability, resources consumption and efficiency, use of appropriate technology, and avoid damage to renewable resources, etc. are important measures. Atkinson (1999) and Maldonado-Fortunet (2002) demonstrate such measurement.

Empirical study emerges as a necessity to understand how the concepts of sustainable development are implemented in practice. The checklist in Table 3.1 was developed in the 2010 IPMA Expert Seminar "*Survival and Sustainability as Challenges for Projects*" (Knoepfel, 2010). It shows areas of interest on translating the concepts of sustainability into action.

Table 3.1. *Checklist for integrating sustainability in project and project management (Knoepfel, 2010)*

Economic Sustainability	Return on Investment	• Direct financial benefits/net present value • Strategic value
	Business Agility	• Flexibility/optionality in the project • Increased business flexibility
Environmental Sustainability	Transport	• Local procurement/supplier selection • Digital communication • Travelling • Transport
	Energy	• Energy used • Emission/CO2 from energy used
	Water	• Water usage • Recycling
	Waste	• Recycling • Disposal
	Materials and Resources	• Reusability • Incorporated energy • Supplier selection
Social Sustainability	Labour Practices and Decent Work	• Employment • Labour/management relations • Health and safety • Training and education • Organisational learning
	Human Rights	• Non-discrimination • Diversity and equal opportunity • Freedom of association • Child labour • Forced and compulsory labour
	Society and Customers	• Community support • Public policy/compliance • Customer health and safety • Products and services labelling • Market communication and advertising • Customer privacy
	Ethical Behaviour	• Investment and procurement practices • Bribery and corruption • Anti-competition behaviour

Silvius *et al*. (2013) conducted an empirical study on 56 projects in Europe. It analysed to what extent organisations initiate, develop, and manage projects with respect to the sustainability maturity model suggested by Silvius and Schipper (2010) (see Figure 3.1). **Business resource**, the basic level, is an effective and efficient use of resources without damaging the environment. At this level, appropriate actions can reduce resource consumption for less non-sustainable effects on project or company operation. In addition, it does not take away from the cause of non-sustainability. During the second level of consideration, the **business process**, resources are used more effectively through optimised process design. For instance, some meetings can be conducted via video conference for cost savings and environmentally-friendly efforts. The third level of consideration, the **business model**, is a sustainability-oriented business model directing the organisation and project to deliver products, services or project outcomes in a sustainable way (for example, introducing online services to an existing business model or partnering with green suppliers for project development). The fourth (and top-level) consideration focuses on providing innovative **products and services** contributing to a more sustainable society. It incorporates the underlying business model, business process and business resources in the maturity model. One example for the products and services consideration is a hybrid car powered by petroleum and electric batteries. This important concept would direct vehicles to be clean and efficient. The model provides support and guidance to evaluate project performance and identify the gap for improvements in future projects.

Figure 3.1. *Sustainability maturity model (Silvius et al., 2010)*

In Silvius *et al*. (2013), consideration of sustainability aspects (economic, environmental and social) appears to be highest at the business resources level (corresponding with a traditional "less bad" approach to sustainability) and lowest at the products/services level (corresponding with a modern approach on "how can we contribute to making things good"). Are they the same for construction projects in Hong Kong? The first research question related to the maturity perspective is:

1. What is the level of sustainability consideration for projects in the construction industry of Hong Kong?

The answer to this question indicates the degree of sustainability consideration on projects in the context of local construction industry.

Lopes and Flavell (1998) suggested that the appraisal process of a project life cycle concentrates on the assessment of financial and technical feasibility (Lopes and Flavell, 1998). Grundy (1998: 45) indicated a similar effect in strategy implementation projects:

We hold the view that wherever possible, benefits (however soft and less tangible) should be targeted – and preferably in economic (of financial) terms. This does not mean that projects should be exactly evaluated (in financial terms) – but one would want to see potential benefits illustrated financially.

Project appraisal, including the assessment of non-financial aspects (such as the managerial role, strategic and synergistic issues, social, political, environmental and technical links, and organisational factors), helps in identifying risk dimensions and their relative importance to the success of project.

There is a growing external influence on projects, which has led to economic disasters for projects. Examples include public opposition to the construction of nuclear power stations based on safety concerns or Concorde aircraft’s high fuel costs and inability to obtain permission to fly supersonically over land (Baccarini, 1999a). These examples lacked external impact assessment to remedy undesirable effects and project failure.

Abidin (2005) suggested that sustainability issues become a project vision in construction projects. An emphasis on efficiency in the traditional project appraisal process can lead to outcomes that are unacceptable from the viewpoint of inter-generational equity (Labuschagne and Brent, 2004). The analysis of environmental and social impacts must ensure that any future environmental liabilities and costs, as well as social impacts from the implementation of the project, are taken into consideration during project appraisal (Labuschagne, Brent and Claasen, 2005). A clear understanding of project life cycles, interactions between life cycles and the external environment and society are a prerequisite for aligning project management frameworks with the principles of sustainable development (Labuschagne and Brent, 2004).

Various authors have written about the general association of sustainability impacts on project management. For example, Gregersen and Contreras (1992) introduced a methodology for the assessment of likely economic impacts on project. Lopes and Flavell (1998) provided a framework for analysing environmental and social risks, etc. Chan, Scott and Chan (2004) recognised that the environment of economic, social, political, physical environment, industrial relation, and level of technology advanced are external factors affecting the success of construction project. Silvius and Schipper (2015, 2016) conducted a general conceptual mapping study (not specific to construction projects) to link a group of nine sustainability dimensions to six criteria for project success. Figure 3.2 shows this relationship. However, they are not specifically developed to link sustainability to project implementation success.

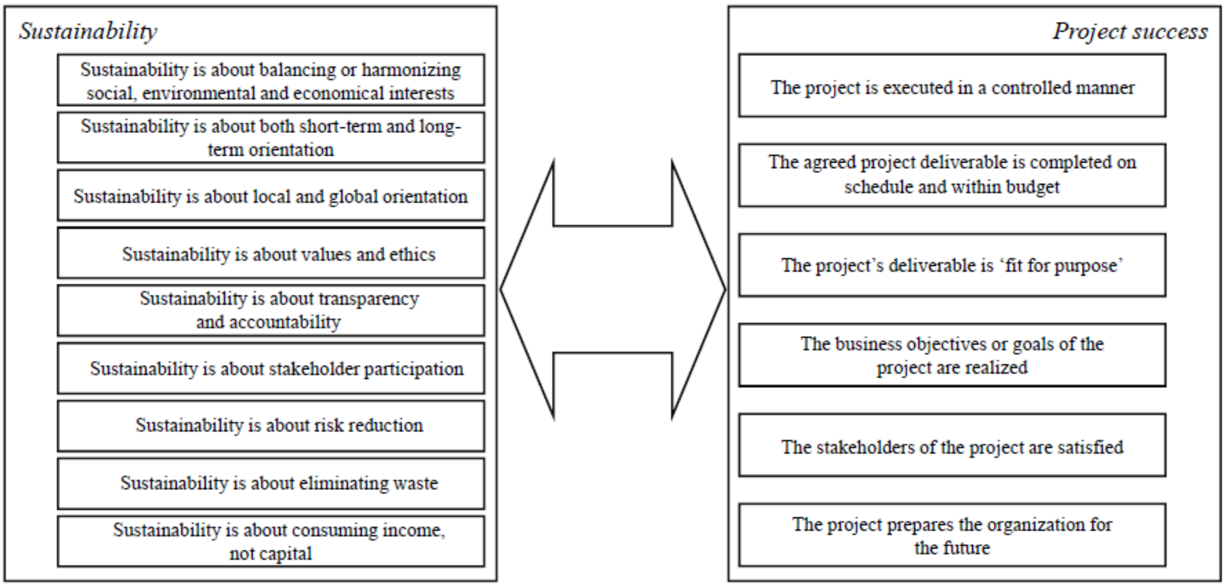

Figure 3.2. *Relating sustainability dimensions to project success (Silvius et al., 2015)*

Maldonado-Fortunet (2002) opined that there are many difficulties to drive project sustainability, including lack of specific sustainability criteria and practical methodology for planning individual construction project. Maldonado-Fortunet (2002) developed specific sustainability criteria for his highway project study. The main parameters included resources, ecology, humans, materials, environmental impact, energy, system efficiency, project delivery and facility indoor quality.

There is a gap in knowledge as suggested by Maldonado-Fortunet (2002) that it is necessary to determine specific sustainability criteria to projects. To date, it has not been determined whether there are specific sustainability criteria toward construction project implementation success in Hong Kong or if a relative importance on success factors exists. Another two research questions related to process perspective have been developed to study Hong Kong's construction industry.

2. To what extent does project sustainability (economic, environmental and social) impact the project implementation success of Hong Kong's construction industry?

If such criteria exist, then:

3. What is the degree of significance of identified sustainability related factors contributing to project implementation success?

The following sub-sections review the current development of each sustainability aspect.

3.2.1 Economic Sustainability Aspect

Gregersen and Contreras (1992) suggested that economic impact assessment is not a mechanistic accounting exercise. It is an attempt to assess project or activity *ex ante* and *ex post* impacts toward the real value to society and individual groups within society. The intent of such an assessment is to provide a background for making more informed decisions regarding the use of scarce resources available to society from the perspective of economic sustainability. Abidin (2005) considered the whole life cycle, cost efficiency and risk assessment in measuring economic issues for a construction project. Gregersen *et al*. (1992), in assessing projects, put emphasis on questions related to financial efficiency (overall cash flow), benefits/costs distribution among interested parties (who pays and who gains) and economic efficiency to assess economic sustainability. The financial analysis must be done from a specific interested party's point of view (e.g., government, business and individual). Economic efficiency analysis is concerned with costs and benefits to society as a whole regardless of who pays and who gains. Both are concerned with profitability. However, economic efficiency looks at profitability from society's point of view. It is the return society obtains with a given use of its limited resources (Gregersen *et al*., 1992).

Gregersen *et al*. (1992) marked a clear demarcation between financial efficiency and economic efficiency and economic sustainability. Silvius *et al*. (2013) focused on financial benefits on commercial projects. Economic benefits are taken care of by governments at a policy level and other initiatives. Depending on the level of project sustainability maturity in an organisation that commissions the project, direct financial benefits are recognised in the business case of project in terms of Cost Savings or Reduced Use of Resources or Improved Business Processes. Projects are selected and evaluated based on short-term return on investment and a combination of short- and long-term strategic value. Selection of project at top sustainability maturity stage is based on a **balanced set of quantitative and qualitative criteria** that reflect both long- and short-term perspectives with economic, environmental and social considerations.

Maldonado-Fortunet (2002) developed a list of economic sustainability factors for construction projects. Factors observe the principles of a project's life cost, sustainability practices, environmentally responsible suppliers and inter-generational equity. Factors include (Maldonado-Fortunet, 2002):

- Reduced resource consumption
- Resource reuse
- Energy savings
- Resource efficiency
- Energy efficiency
- Water efficiency
- Extraction efficiency
- Maximised efficiency of artificial light
- Efficiency during operation
- Appropriate technology
- Non-damage to renewable resources
- Design systems for ease of maintenance and operation
- Maximised use of natural light
- Water recycling system

3.2.2 Environmental Sustainability Aspect

George (1999) suggested that the two principles of inter-generational equity and intra-generational development are a valid test for sustainability across all people affected by project development. The inter-generational equity is a necessary condition for sustainability; the intra-generational equity is a necessary condition for development (George, 1999). These principles are embedded in Principle 3 of the Rio Declaration on Environment and Development of the Earth Summit for sustainable development "to equitably meet developmental and environmental needs of present and future generations" (UNCED, 1992: 2).

Silvius *et al*. (2013), in studying environmental sustainability, looked at the project itself and the performance of suppliers on project. In their opinion, Supplier Know-How & Partnership help in the delivery of project sustainability. Renewable energy and resources are preferred to non-renewable resources (Griffiths, 2007; Hill and Bowen, 1997). Extraction of non-renewable fossil fuels and minerals, as well as their consumption for production, generally produce greenhouse gases (e.g., CO_2) and other deposits affecting the environment. To achieve sustainability, Silvius *et al*. (2013) suggested selecting materials manufacturing for the project based on **energy consumption and/or pollution incorporated in materials production and logistic processes**.

In construction projects, Hill and Bowen (1997) suggested reducing the use of four generic natural resources: (1) energy; (2) water; (3) materials; and (4) land. Moreover, they recommend the maximisation of resource reuse and/or recycling, as well as minimising air, land and water pollution (Abidin, 2005; Griffiths, 2007). Silvius *et al*. (2013) stressed that the minimisation of energy consumption, water consumption and pollution is needed in the design of project deliverability, which results in the recycling and/or purification of water before disposal. Both the delivered project and designed result are required to minimise waste with as much recycling as possible in the deliverable itself (Silvius *et al*., 2013).

Maldonado-Fortunet (2002) developed a list of environmental sustainability-related factors for construction projects. These factors observe the principles of preferential use of renewable energy and resources, reduce the use of four generic natural resources (energy, water, materials, land) with maximisation of resource reuse and/or recycling to minimise air, land and water pollution, and create a healthy and non-toxic environment with landscape and ecological diversity. The factors are categorised into two groups: (1) resources and technology; and (2) control measures. Factors under the resources and technology category include:

- Rapidly renewable materials
- Renewable energy technologies
- Recycled material
- Increase of recycled contents
- Protection of on-site soils
- Reuse of top soils and rock materials
- Vendors using materials with recycled content
- Proper handling, storage and disposal of hazardous and toxic materials
- Materials based on life-cycle assessment
- Minimised construction wastes
- Waste reduction goals during construction
- Waste reduction goals during operation
- Specified materials for location and use
- Green landscape retrofit techniques
- Increase of durability
- Increase of recyclability

Factors under the category of Control Measures include:

- Reduced site disturbance
- Reuse of developed sites
- Ecosystem damage avoidance
- Solid waste avoidance
- Air pollution avoidance
- Water pollution avoidance
- Habitat destruction avoidance
- Avoidance of noise pollution
- Risk of air, water or land pollution
- Erosion and sedimentation control
- Protection of on-site vegetation
- Biodiversity
- Storm water management
- Application of constructed artificial wetland wastewater treatment system
- Procedures for the recycling, reuse and salvage of construction waste
- Indigenous species, species diversity and wildlife habitats in plant selection
- Life support systems conservation
- Control of hazardous materials from construction site

3.2.3 Social Sustainability Aspect

As mentioned, inter-generational equity is a key theme of sustainability (Brundtland, 1987). Apart from the economic and environmental dimensions, inter-generational equity has a social dimension (Hill and Bowen, 1997). Social sustainability is the idea that future generations should have the same or greater access to social resources as the current generation. Social resources include ideas related to culture and basic human rights. For project development, social aspects include availability of a child labour policy, gender diversity, health and safety, heritage preservation, and inclusion of social investment for future generations. Seeking inter-generational equity in project development covering economic, environmental and social sustainability for future generations forms a strong support to sustainable development.

Assessment of social impacts for sustainability includes the processes of analysing, monitoring and managing the intended and unintended social consequences, both positive and negative, of planned interventions (policies, programmes, plans, projects) and any social change processes invoked by those interventions. The major purpose of such assessment is to bring about a more sustainable and equitable biophysical and human environment. It is linked with a wide range of specialist sub-fields involved in the assessment, including: aesthetic impacts (landscape analysis); archaeological and cultural heritage impacts (both tangible and intangible); community impacts; cultural impacts; demographic impacts; development impacts; economic and fiscal impacts; gender impacts; health and mental health impacts; impacts on indigenous rights; infrastructural impacts; institutional impacts; leisure and tourism impacts; political impacts (human rights, governance, democratisation, etc.); poverty; psychological impacts; resource issues (access and ownership of resources); impacts on social and human capital; and other impacts on societies. As such, comprehensive assessment cannot normally be undertaken by a single person, but requires a team approach (Vanclay, 2003). It is convenient to conceptualise social impacts from people's way of life; their culture; their community; political systems; environment; health and wellbeing; personal and property rights; and their fears and aspirations (Vanclay, 2003) in assessing social sustainability. The protection and promotion of human health in a healthy and safe working environment are key factors in project. To minimise social risks in project development, it is important to address the quality of human life in health, safety and environment (HSE) to stakeholder communities.

Silvius *et al*. (2013) in studying social sustainability concern the design of project deliverable and results in a way that Labour Practices and Decent Work, Health and Safety Conditions and the prevention of Bribery and Anti-Competitive Behaviour in the community are observed. Moreover, projects also play a role in Development of Community (e.g., training, education and development of stakeholders, etc.), Diversity and Equal Opportunity (e.g., gender, race, religion, etc.) and Human Rights (e.g., non-discrimination, freedom of association and no child labour, etc.).

Maldonado-Fortunet (2002) developed a list of social sustainability-related factors for construction projects. These factors observed the principles of sustainability, including an improved quality of human life, the creation of healthy non-toxic environments, avoidance of historic and archaeological disturbance, employment increase, use of innovative techniques to increase safety, use of local or regional materials, a means to transplant trees, and a visual impact.

3.3 Chapter Summary

This chapter reviews the development of sustainability and project management in managing project sustainability. Authors have written from different perspectives about the general association of sustainability impacts on project management. Empirical studies have also emerged in recent years. As identified, maturity and process perspectives are two approaches to deal with managing project sustainability. However, they have not been critically assessed. This empirical study fills in the gap. Three research questions are being developed to understand the impacts of each sustainability dimension (economic, environmental, and social) on project implementation success and the relative importance of each sustainability dimension by referencing earlier studies and the situation in the construction industry of Hong Kong. Taking three pillars approach in the study, factors under various sustainability constructs are identified. Although the factors identified are important and are representative elements under the theme of sustainable development or sustainability, they are not exhaustive. Depending on project context, there are other sustainability factors (e.g., use of nuclear energy under environmental sustainability dimension or ethical consumerism under social sustainability dimension) that may influence the success of projects. Since a mixed methods approach is being adopted in this study, appropriate use of methodology, methods and tools including the determination of research hypotheses and framework in the quantitative survey as well as the Delphi technique in the qualitative study are discussed in the following chapter.

Chapter 4 Research Methodology

4.1 Introduction

According to Kuhn (1962), science usually progresses in tiny steps, which refines and extends what is already known. A theory might appear in a research study as an argument, a discussion, or a rationale, and it helps to explain or predict phenomena that occur in the world (Creswell, 2009). There are myriad theories at work in the world. Each theory has its own ontological and epistemological roots (Stokes, 2011). When preparing the Research Proposal (Res 2C) months ago, my *Weltanschauung* has been reviewed. It is important to make clear my ontology and epistemology in the study such that it helps to make good choices of research approach and methodology, and defend them (Klakegg, 2015). Identification of research theme, knowledge gap, research goals and objectives, and setting of research questions are linked to *Weltanschauung*, personal interest, professional experience and literature review.

Section 4.2 outlines the philosophical foundation underpinning this research. Section 4.3 describes the research methodology adopted in this study and systemically shows how it was derived and executed. Section 4.3 explains the ethical considerations, including what anonymity and confidentiality measures have been taken in this study.

4.2 Philosophical Foundations

4.2.1 Ontological and Epistemological Perspectives in Project Management

Philosophical worldview (*Weltanschauung* of the researchers) is a basic set of belief that guides action. The type of belief held by individual researcher steers the selection of appropriate research approach in the study (Creswell, 2009). To select appropriate methodology, it is necessary to make clear the ontology, epistemology and theoretical perspective that the author positioned (Crotty, 1998). Ontology raises basic questions about the nature of reality and the nature of human being in the world (Denzin and Lincoln, 2005) that affects researcher's epistemological position (Guba and Lincoln, 1994). Guba and Lincoln (1994: 108) described ontological questions as "*What is the form and nature of reality and, therefore, what is there that can be known about it?*" For example, if a "real" world is assumed, then what can be known about it is "*how things really are*" and "*how things really work*" (Guba and Lincoln, 1994: 108). Epistemology asks, "*How do I know the world?*" and "*What is the relationship between the inquirer and the known?*" (Denzin and Lincoln, 2011: 91). On a position of realism that espouses objectivity; social phenomena and their meaning are independent of researcher. The posture of the knower must be one of objective detachment or value freedom to be able to discover "*how things really are*" and "*how things really work*". Both ontological and epistemological positions chosen inform the worldview of researcher and lay down the foundation of theoretical perspective and appropriate methodology in research design. On the other extreme is the position of relativism that is aligned with subjectivity. In between the spectrum, it is the constructionism (or named constructivism) which is a version of subjectivism. Constructivist concerns that reality is constructed by people interaction in the world.

4.2.2 Theoretical Perspective

As shown in the previous research questions, there are two perspectives in researching the project implementation success issues of managing project sustainability: (1) maturity perspective; and (2) process perspective. Both can be undertaken by various epistemologies, methodologies and methods (Crotty, 1998). Many researchers in project management espouse objectivity (epistemology) (Ika, 2009) that adopts a theoretical approach of positivism. Ika (2009) collected and reviewed 30 articles on success from two recognised scientific journals (*Project Management Journal* and *International Journal of Project Management*) between 1986 and 2004. The results showed that project success research is characterised by diversity except in epistemological and methodological perspectives (Ika, 2009). Ika's study shows that common assumption on project success is taking a universal set of criteria and critical success factors (in an objective way). The study suggests two alternative assumptions (contingent approach and subjectivist approach) in studying project success. Contingent approach assumes that there is no "one best way" account for project success; and that idiosyncratic criteria and critical success factors exist for specific project context. It is a situational view.

The other alternative assumption as suggested by Ika is subjectivist approach where success and failure are not only subjectively perceived and constructed by people, but they are intertwined in meaning and action. It means that project success can be considered a social construct. Overall, science is the art of reality testing, of taking ideas and confronting them with observable evidence drawn from the phenomena to which they relate (Donovan and Hoover, 2014). Ika in his study has indicated the tension between science and art where actual meaning(s) of project success can be explored through the choice of objectivist and subjectivist viewpoints. Subjectivist viewpoint cannot be negotiable. On the other hand, objectivist viewpoint is based on evidence obtained and subject to challenge by other researchers. In other words, from Ika's viewpoints, research of project success related issues can be carried out by quantitative and/or qualitative research methodologies with focus either on objective or subjective approach.

In this study, the ontological position that project and sustainability are things that exist in a "real" world has been adopted. The form and nature of linkage between project and sustainability can be identified, tested, and known through rigorous research. Considering my *Weltanschauung*, objectivism rather than subjectivism and constructionism has been chosen in this study (Crotty, 1998). The theoretical perspective shall match with the chosen epistemology of objectivism. With reference to the researcher's educational and professional background in engineering and the nature of this study (to objectively assess the sustainability impacts, if any, on project implementation success), post-positivism is the preferred choice over other possible perspectives. The post-positivist worldview represents the thinking after positivism (objective truth of knowledge) where it challenges the traditional notion of the absolute truth of knowledge (Creswell, 2009; Phillips and Burbules, 2000). Guba and Lincoln (2005) mention that post-positivism observes the "real" reality but only imperfectly and probabilistically apprehensible (ontology); research findings can probably be true (epistemology); and empirical study is being adopted with the aim of falsification of hypotheses and that qualitative methods may be included (methodology). The non-falsified hypotheses are taken probably as facts or laws (nature of knowledge) (Guba and Lincoln, 2005). To examine closely between positivism and post-positivism, post-positivism is chosen as the preferred choice in this study due to practicality. Selection of deductive research approach helps to test theory obtained from other studies. It is planned to test theories developed from earlier Europe and international studies see if appropriate effects are identified in the Hong Kong construction industry. This research is going from general to specific in terms of theory development. Hence, inductive research approach is not appropriate in this study.

In the last several decades, there were debates on how best to conduct research. The debate has been on the relative value of two fundamentally different and competing schools of thought – the positivist and phenomenological approaches (Karami, Rowley and Analoui, 2006; Shaw, 1999; Smith, 1998). To explore the nature of research methodology adopted in the field of business and management, Karami *et al.* (2006) ask about in their study "*What type of methodology is appropriate in management studies?*" Recent development of project management research indicates a growing awareness that there is a need for multi-disciplinary, multi-perspective, and multi-method approaches (Klakegg, 2015). This study involving project management and sustainability research fits into the areas of multi-disciplinary and multi-perspective. It also concerns methodological fit to choose appropriate research strategy to fit for situation and purpose.

4.3 Methodology

As mentioned, the selection of appropriate methodology is linked to researcher position on ontology, epistemology and theoretical perspective. Crotty (1998) have summarised a table (see Table 4.1) showing a range of choices available within respective categories including methodology and methods. The choice of appropriate method in conducting a study has to be matched with chosen research methodology such that the whole research process is streamlined.

Table 4.1. *Choices for epistemology, theoretical perspective, methodology and methods (Crotty, 1998)*

Epistemology	Theoretical Perspective	Methodology	Methods
Objectivism Constructionism Subjectivism (*and their variants*)	Positivism (and Post-positivism) Interpretivism • Symbolic interactionism • Phenomenology • Hermeneutics Pragmatism Participatory • Critical inquiry • Feminism Postmodernism (*etc.*)	Experimental research Survey research Ethnography Phenomenological research Grounded theory Heuristic inquiry Action research Discourse analysis Feminist standpoint research (*etc.*)	Sampling Measurement and scaling Questionnaire Observation • Participant • Non-participant Interview Focus group Case study Life history Narrative Visual ethnographic methods Statistical analysis Data reduction Theme identification Comparative analysis Cognitive mapping Interpretative methods Document analysis Content analysis Conversation analysis (*etc.*)

Franklin and Blyton (2011) discussed several approaches to sustainability research, including ethnographic practice, case study method, participatory action research, interviews of a specialist group, grounded theory, surveying, discourse analysis, constructivist approach, etc. According to Franklin *et al.* (2011), there is not a preferred method for researching sustainability. Selection of a method is usually dependent on the specifics of the research context and appropriateness. The process of designing a methodology requires the researcher to have sufficient prior understanding of each methodological option available to them (Franklin and Blyton, 2011).

In Karami *et al*. (2006), an analysis was conducted on the research methodologies adopted by 120 articles drawn from 20 leading management journals published between 1991 and 2000. Findings indicate that the potential of in-depth quantitative studies (a widely accepted approach based on the establishment of reliability and validity) diminishes rapidly under a dynamic change environment. On the other hand, increasing management studies adopt qualitative approach which provides insights and understanding of the problem setting.

Subject to the nature of knowledge, Karami *et al.* (2006) encourage researchers making a right balance between quantitative and qualitative methods in researching business and management problems by recognising the tension between pursuit of laws (and rigorously validated models) and the acknowledgement of contested meaning.

Methodology focuses on the best means for acquiring knowledge about the world (Denzin and Lincoln, 2011). Creswell (2009), in Table 4.2, compared different aspects of quantitative, qualitative and mixed methods in delivering research. It shows that quantitative method requires pre-determined and instrument-based questions for purpose of collecting performance data, attitude data, observational data, and census data. Selection of quantitative method also references to the problem being investigated, the belief in the existence of valid constructs and testing of ideas.

Table 4.2. *Quantitative, mixed and qualitative methods (Creswell, 2009)*

Quantitative Methods →	Mixed Methods ←	Qualitative Methods
Pre-determined	Both pre-determined and emerging methods	Emerging methods
Instrument-based questions	Both open- and closed-ended questions	Open-ended questions
Performance data, attitude data, observational data and census data	Multiple forms of data drawing on all possibilities	Interview data, observation data, document data and audio-visual data
Statistical analysis	Statistical and text analysis	Text and image analysis
Statistical interpretation	Across databases interpretation	Themes, patterns interpretation

Use of mixed methods is not new to project management research. Cameron and Sankaran (2015) have selected three papers published in 2005 and 2006 in well-known academic journals for demonstration. The Milosevic and Patanakul (2005) paper in the International Journal of Project Management (IJPM) adopted case study methodology as the first step to develop constructs for hypothesis testing and then followed by case interviews. It is a qual-QUAN-qual example. The Lee-Kelly (2006) paper in the IJPM surveyed professional workers in defence projects and then followed by in-depth interviews on IT professionals. This QUAN-qual study arrangement serves to use qualitative study to elaborate on the results of the survey conducted in the first step. This is a good use of the two methods in sequence (Cameron and Sankaran, 2015). The paper from Chai and Xin (2006) was published in the IEEE Transactions on Engineering Management (IEEE TM). The study used a case study along with a literature review which was used to generate hypotheses to be tested by a survey. It is an example of qual-QUAN study.

From literature review, Silvius *et al*. (2013) surveyed the degree of project maturity. Silvius *et al*. (2013) and Maldonado-Fortunet (2002) contributed to the process perspective of project sustainability. With success measures from Pinto (1986), such earlier research studies have been adapted to this study for researching the view of Hong Kong construction project managers in managing project sustainability. To answer the three research questions (Q1: maturity perspective; Q2 and Q3: process perspective) stated above, a quantitative study through survey is being conducted as Part 1 of the mixed methods study. This deductive approach brings in theory testing under the situation of Hong Kong construction industry. Nevertheless, the quantitative study though answering the research questions in the “What” form does not generally provide in-depth information to enhance various sustainability aspects for project implementation success. A subsequent qualitative study to supplement earlier quantitative study result is beneficial to project managers. Hence, this mixed methods study is driven by a major quantitative study (QUAN) and followed by a qualitative study (qual). The QUAN-qual study is connected by the results of quantitative study to develop question for the part 2 qualitative research.

Part 1 – Target quantitative study participants

For the quantitative part, without full name list of project managers being identified in the industry, random sampling is not possible. Hence, judgemental sampling for this survey is adopted. The researcher has gained support from the Project Management Institute (Hong Kong Chapter) to distribute the questionnaire to 1,300 local members through e-mail (see Appendix B). In addition, a member list of construction managers provided by the Hong Kong Institute of Construction Managers has been used to contact local project professionals to seek their support on the survey.

Part 2 – Target qualitative study participants

Recruitment of Delphi experts for subsequent qualitative study as discussed in sub-section 4.3.2 links to contacts obtained from attending the International Project Management Association (IPMA) 4th Research Conference on "Project Management and Sustainability". The conference was held on 15th and 16th September 2016 at the Reykjavik University, Iceland. Some experienced academic, researchers and practitioners with interest in researching the subject are invited to join the expert panel.

4.3.1 Quantitative Research Constructs, Variables and Hypotheses

As shown in the literature search above, project management community has not equipped with sufficient sustainability awareness as reflected by the lack of research in this respect (Gareis *et al.*, 2010). Empirical research in understanding the nature of sustainability impacts on project implementation success is not available whether in the context of Hong Kong or otherwise. This study aims to gain better understanding on managing project sustainability in two perspectives, namely maturity perspective and process perspective. The empirical research outcome in Part 1: Quantitative Study with complementary Part 2: Qualitative Study provides some insights to the project management community on managing project sustainability. This sub-section outlines the constructs, variables and hypotheses leading to developing theoretical framework for building up research model.

In choice of research strategy, Yin (2014) proposes three conditions: (1) type of research question posed; (2) extent of control an investigator has over actual behavioural events; and (3) the degree of focus on contemporary vs. historical events (see Table 4.3).

Table 4.3. *Relevant situations for different research strategies (Yin, 2014)*

Strategy	Form of Research Question	Requires Control of Behavioural Events?	Focuses on Contemporary Events?
Experiment	How, why?	Yes	Yes
Survey	Who, what, where, how many, how much?	No	Yes
Archival Analysis	Who, what, where, how many, how much?	No	Yes/No
History	How, why?	No	No
Case Study	How, why?	No	Yes

In this study, the research questions posed are in the form of ‘what’ on contemporary issues where control in participants’ behaviour is not required. Hence, survey strategy as described by Yin (2014) is appropriate for this research study (blue highlights in the table). In consideration of the above and low cost, quick response and access to respondents in the local construction industry for better representation, quantitative survey research was conducted by sending self-administered questionnaire through Internet.

Research Question #1

Question #1 (*What is the level of sustainability consideration for projects in Hong Kong’s construction industry?*) aims to understand the status quo of project sustainability maturity in

Hong Kong's construction industry. The purpose of this question is to measure current position of organisational strategy that commissions the project. According to Silvius *et al.* (2013) project maturity model, sustainability matured organisation would define a wise use of natural resources (Business Resources) and social responsibility as one of the guiding principles for the design of the Business Processes, Business Model and the development of Products and Services in the organisational strategy. Survey participants were asked to indicate the level of project sustainability maturity in their organisation (in descending order: Products and Services (top level), Business Model, Business Processes, Business Resources (lowest level) or not to mention sustainability related statement in organisational strategy (None)). Chi-Square (χ^2) test is used to identify goodness-of-fit for the four levels of maturity. It generates ideas on what are organisations' view as a whole in the construction industry towards managing project sustainability, and that the results obtained would be useful in future research.

<u>Research Question #2</u>

Question #2 (*To what extent does project sustainability [economic, environmental and social] impact project implementation success of Hong Kong's construction industry?*) relates to the process perspective. Table 1.2 shows that hypotheses link sustainability impacts (independent variables) to project implementation success (dependent variable). These are framed to answer the research questions on process perspective.

The three pillars approach has been adopted in this study. Research framework (see Figure 1.1) is structured to address various sustainability impacts on project implementation success. Under the three pillars approach, each of the sustainability dimensions (economic, environmental and social) is theoretically important to projects and operations towards sustainable development. It is therefore necessary to split the hypotheses into three dimensions such that each hypothesis framed with respect to each sustainability dimension can be tested in answering respective research questions. Hypotheses are framed based on independent variables in respective constructs for testing their impacts on depending variable (project implementation success). Included in the questionnaire, survey participants were asked what were important in their last completed projects on project implementation success.

The three hypotheses in the research framework linking economic sustainability, environmental sustainability and social sustainability to project implementation success (dependent variable) are as follow:

1. **Economic Sustainability Impact:**

   H_{10}: There is no impact relationship between economic sustainability and project implementation success.

   H_{11}: There is an impact relationship between economic sustainability and project implementation success.

2. **Environmental Sustainability Impact:**

   H_{20}: There is no impact relationship between environmental sustainability and project implementation success.

   H_{21}: There is an impact relationship between environmental sustainability and project implementation success.

3. **Social Sustainability Impact:**

   H_{30}: There is no impact relationship between social sustainability and project implementation success.

   H_{31}: There is an impact relationship between social sustainability and project implementation success.

<u>Economic Sustainability Construct</u>

In the research framework, the three sustainability constructs are established representing several elements within respective construct. According to Silvius *et al.* (2013), several elements are identified in the economic sustainability construct, including cost saving or reduced use of resources, Improved Business Processes, Balanced Set of Quantitative and Qualitative Sustainability Criteria, extra revenues from new business models for existing products and services, and extra revenues from innovated products and services. Since extra revenues can only be measured upon completion of project, the elements of extra revenues are excluded in the construct of economic sustainability impacts towards project implementation success. The three independent variables remained in the construct are, namely: (1) Cost Savings or Reduced Use of Resources; (2) Improved Business Processes; and (3) Balanced Set of Quantitative and Qualitative Criteria. Figure 4.1 shows the construct of economic sustainability impact.

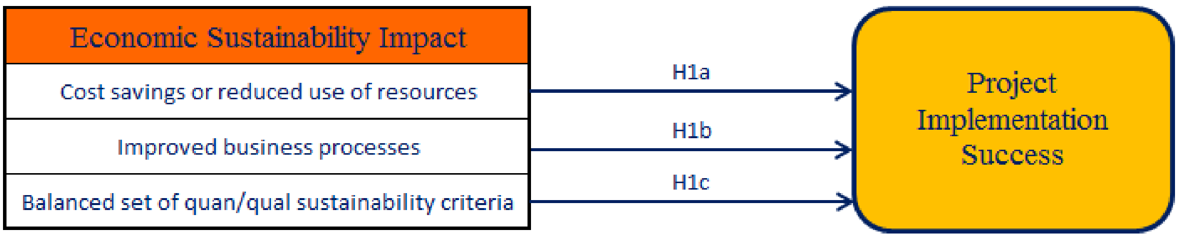

Figure 4.1. *Construct of economic sustainability impact*

Environmental Sustainability Construct

There are five elements under the environmental sustainability construct: (1) Supplier Know-How & Partnership; (2) Energy Consumption and/or Pollution in Materials Manufacturing and Delivery; (3) Energy Consumption as Project Design Parameter; (4) Water Consumption and Pollution as Project Design Parameter; and (5) Waste in Project Design with Maximum Recycling. Figure 4.2 shows the construct of environmental sustainability impact.

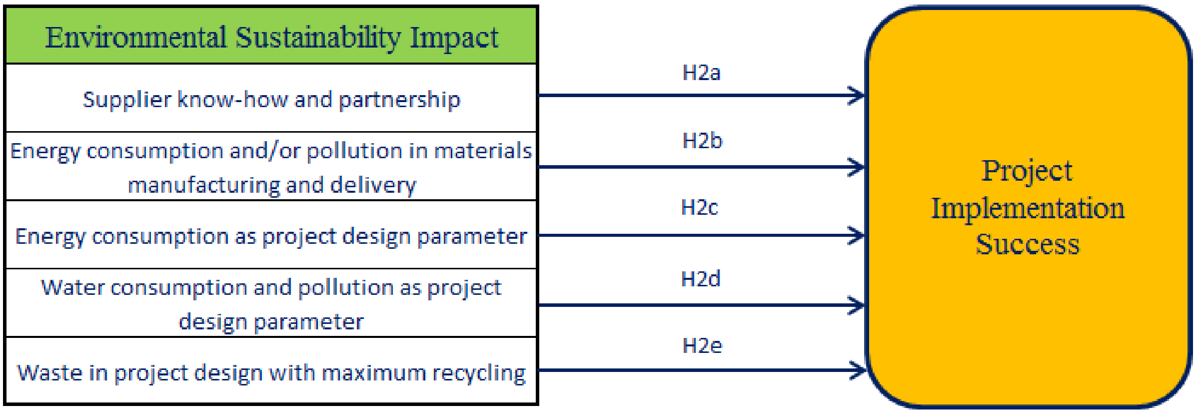

Figure 4.2. *Construct of environmental sustainability impact*

Social Sustainability Construct

There are six elements under the social sustainability construct: (1) Labour Practices and Decent Work; (2) Health and Safety Conditions; (3) Development of Community Activities (e.g., training, education, etc.); (4) Diversity and Equal Opportunity (e.g., gender, race, etc.); (5) Human Rights (e.g., no child labour, etc.); and (6) Bribery and Anti-Competitive Behaviour. Figure 4.3 shows the construct of social sustainability impact.

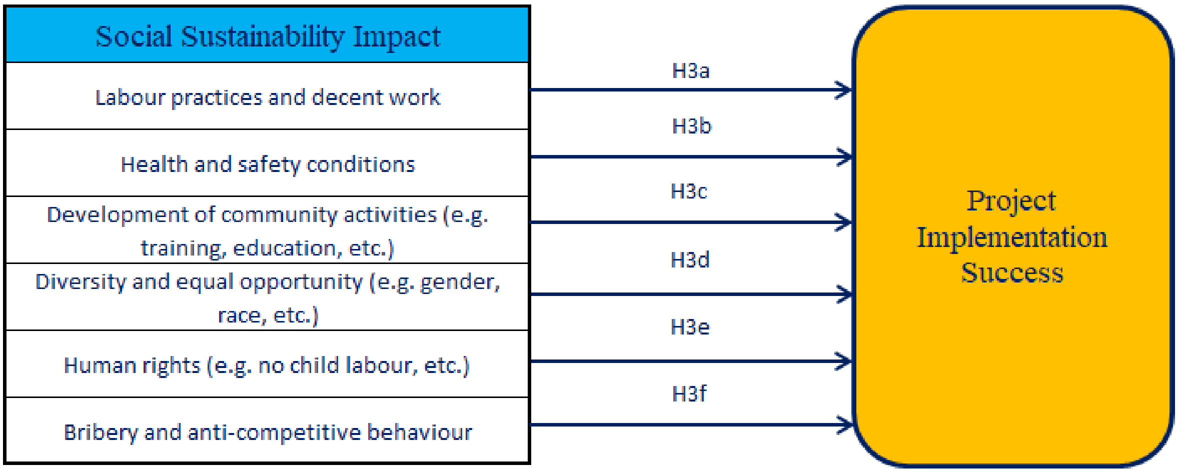

Figure 4.3. *Construct of social sustainability impact*

<u>Research Question #3</u>

Question #3 (*What is the degree of significance of identified sustainability-related factors contributing to project implementation success?*) determines sustainability-related factors (success factors) as significant contributions to project implementation success. Maldonado-Fortunet (2002) identified several significant factors for highway construction projects. In this study, they are categorised into economic, environmental and social sustainability aspects. Survey participants can indicate the degree of significance in their project context.

Surveying project managers in the construction industry is an efficient method to collect data. It complies with what it is supposed to do in a deductive study and that questionnaire will be prepared to elicit information from 55 judgmental survey participants (by referencing Silvius *et al*. (2013) 56 projects and Maldonado-Fortunet (2002) 64 participants). As this research intends to learn what construction project managers in Hong Kong understand managing project sustainability, a micro-level analysis which focuses on individual or actor-centred (Grix, 2004) would be appropriate. In this study, local construction project manager is taken as unit of analysis. They provide views and thoughts of sustainability impacts on project implementation success. It aims to find out the level of sustainability considerations in projects under the project sustainability maturity model in preparation for future study and that relevant sustainability impacts on project implementation success will be determined for situation in the Hong Kong construction industry.

4.3.2 Qualitative Research Method

To develop better understanding on managing construction project sustainability in Hong Kong, it is proposed to conduct quantitative part (explanatory) before subsequent qualitative data collection and analysis (exploratory) to generate a more in-depth knowledge on the subject. In other words, mixed methodology of QUAN-qual is being adopted to triangulate and complement results in the study. Unlike quantitative method, qualitative method is emerging in nature. Mixed methods research employs both techniques in a single study. Although recent research shows that increasing use of mixed methods are becoming popular in the project management community (Cameron, Sankaran and Scales, 2015), no previous study on this topic using mixed methods can be found in literature. Therefore, there is no exact reference in method selection.

In this mixed methods research, results obtained from the survey is used to derive question in subsequent qualitative study. Due to no social sustainability impact success criterion identified significant, there is a necessity to understand whether the degree of importance of social sustainability impact is lower than that of economic and environmental counterparts or simply it is not important. It leads to the development of qualitative study Question (Q): "*Is there any difference in terms of degree of importance on respective Economic Sustainability Impact, Environmental Sustainability Impact and Social Sustainability Impact impacting on project implementation success of construction project?*"

In the last decade, the Delphi method has been commonly applied in the field of construction management research (Chan, Yung, Lam, Tam and Cheung, 2001; Hallowell and Gambatese, 2010; Manoliadis, Tsolas and Nakou, 2006; Yeung, Chan and Chan, 2009; Yeung, Chan, Chan and Li, 2007). For graduate studies, many utilised Delphi as tool to develop, identify, forecast and validate a variety of research areas in writing PhD dissertations (Skulmoski, Hartman and Krahn, 2007). The objective of this systematic and iterative research technique is to obtain consensus about the judgment of a group of experts on a specific topic. Consensus building is a process to generate ideas, understand problems, identify opportunities or solutions, settle complex issues or develop forecasts using a series of data collection and analysis techniques interspersed with feedback (Keeney *et al*., 2011; Skulmoski *et al*., 2007). The Delphi process mitigates the variability of individual response. According to Chan, Yung, Lam, Tam and Cheung (2001), the Delphi method can offer a merit in situation where it is important to define areas of uncertainty or disagreement among experts. Therefore, the Delphi method is considered a suitable research tool in this exploratory study. It streamlines the rather subjective expert opinions to complement results obtained from the quantitative study.

The Delphi method was first developed by the U.S. RAND Corporation in the 1950s to pool expert judgment with reference to military planning and new technology. Many variations of Delphi have been developed, including classical, modified, decision, policy, real time, e-Delphi, technological, online, argument and dis-aggregative (Keeney, 2009). Differentiation between these types of Delphi is shown in Table 4.4. (Keeney, Hasson and McKenna, 2011).

Table 4.4. *Types of Delphi and main characteristics (Keeney et al., 2011)*

Classical Delphi	Uses an open first round to facilitate idea generation to elicit opinion and gain consensus Uses three or more postal rounds Can be administered by e-mail
Modified Delphi	Modification usually takes the form of replacing the first postal round with face-to-face interviews or focus group May use fewer than three postal or e-mail rounds
Decision Delphi	Same process usually adopted as a classical Delphi Focuses on making decisions rather than coming to consensus
Policy Delphi	Uses the opinions of experts to come to consensus and agree future policy on a given topic
Real Time Delphi	Similar process to classical Delphi except that experts may be in the same room Consensus reached in real time rather than by post Sometimes referred to as a consensus conference
e-Delphi	Similar process to the classical Delphi but administered by e-mail or online survey
Technological Delphi	Similar to the real time Delphi but using technology, such as handheld keypads allowing experts to respond to questions immediately while the technology works out the mean/median and allows instant feedback allowing experts the chance to re-vote moving towards consensus in the light of group opinion
Online Delphi	Same process as classical Delphi but questionnaires are completed and submitted online
Argument Delphi	Focused on the production of relevant factual argument Derivative of the Policy Delphi Non-consensus Delphi
Dis-aggregative Delphi	Goal of consensus not adopted Conducts various scenarios of the future for discussion Uses cluster analysis

Lim and Yang (2009) exemplify the research of critical sustainability criteria and indicators for Australian road infrastructure projects by Delphi. The highly structured and formalised nature of communication in Delphi to extract unbiased opinions and finally, with consensus between the expert members has made the method increasingly popular (Lim and Yang, 2009). Focus group discussion may be an alternative tool possible to the qualitative part of the study. However, difficulty in terms of time and cost in arranging focus group discussion meeting(s) for busy local and international experts is expected.

For the Delphi portion, three selection requirements are applied when forming an expert panel: (1) project management academic with peer reviewed publications in sustainability (i.e., book, edited book chapter, journal, etc.); (2) construction project manager with extensive experience in managing sustainability activities in Hong Kong; and (3) at least five years of recent experience in researching, teaching or practicing sustainability in project management. Potential experts who have satisfied two of the three selection criteria are invited to participate. Experts with a heterogeneous background are maintained so the e-Delphi research outcomes not only triangulate the quantitative survey findings but complement the same at a wider perspective. In each round of the e-Delphi questionnaire, the researcher must disclose results obtained from the last round of discussion to the panel experts. Panellists will be asked to re-consider their answers and make necessary changes. Figure 1.2 shows the Delphi research process in this study.

In this qualitative study, experience is drawn from local and international experts to contrast and elaborate the quantitative survey results obtained from local project managers. Since managing project sustainability is new to the project management community in Hong Kong (and other parts of the world), it may not be possible to recruit sufficient local experts to participate in the study. Furthermore, participation of experienced European and American experts on managing project sustainability can enrich the process of knowledge creation in Hong Kong. International experts based on their advancement in the field of managing project sustainability may provide insights to this study. Comparing pros and cons of various methods (i.e., interview, focus group, Delphi), Delphi uses e-mail (e-Delphi) identified as the most suitable tool in this study. This saves time and cost in arranging meetings as compared to interview and focus groups, particularly when different time zones are involved. e-Delphi also avoids situations in which outspoken experts dominate the focus group's discussion.

According to Skulmoski *et al*. (2007), the number of experts on a Delphi panel can range from 3 to more than 20. In this study, 12 experts from local and international academic and professional area in this field (project sustainability) were recruited through peer introduction and other methods. A consensus level is set at 70% for Delphi questions related to degree of importance of respective sustainability impacts on construction project implementation success. The expert panel has come to a consensus once the pre-determined percentage of the panel has come to an agreement (Keeney *et al*., 2011).

The Delphi expert panel creates two possible problems. First, this method can exaggerate the concept of expertise and place too much value on the opinions of the participants. Second, the anonymity of the participants relieves their accountability, which can lead to careless responses. In this mixed methods research, a qualitative study with e-Delphi is used for triangulating and complementing the quantitative study results. It is to some extent minimising the suggested problems because contradiction between the two studies can be further evaluated.

Often, the e-Delphi method is not considered as rigorous as other research methods. This may be due to a lack of standard statistical tests ensuring the validity and reliability of the research (Ju and Jin, 2013). Stopping criteria for e-Delphi data collection include strong consensus obtained (more than 70%) or a clear indication that no more differences in answers can be expected.

To answer the research questions, 55 survey responses from local construction project managers were collected to complete the quantitative portion. Twelve local and international experts were recruited to arrange an e-Delphi panel to gain consensus for completing the qualitative portion of the mixed methods study.

4.4 Ethical Considerations

This research project not only observes relevant LSBU code of practice, but also follows the *Ethics Guide 2015: Advice and guidance* offered by the Chartered Association of Business Schools (CABS, 2015) in the UK. This revised version was developed by several institutions in the UK, including CABS, where the School of Business at LSBU is a member institution. This guide is intended to provide advice and guidance to researchers (including student researchers) about ethical questions and issues to consider. The document contains nine categories of ethical principles. Some categories are general (e.g., integrity, honesty, transparency in scholarship) while others are directly linked to the data collection process (e.g., respect for persons and prevention of harm, informed consent, protecting privacy, ensuring confidentiality, maintaining anonymity).

As the survey is being conducted in Hong Kong, it is necessary to comply with local practices and guidelines on research ethics and business integrity. If a discrepancy is identified between local standards and those mentioned, the more stringent standard will prevail. The *Operational Guidelines and Procedures* (HKU, 2015) of the Human Research Ethics Committee of the University of Hong Kong has been adopted as cross reference. The adoption of such guidelines and procedures from a local research-focused university would help avoid pitfalls in the locality. Furthermore, the study involves collecting information from local project managers. These managers, in many cases, are also members of the local engineering institution. It is worthwhile to observe relevant ethical standards in the profession. The *Ethics in Practice: A Practical Guide for Professional Engineers* (HKIE, 2011), which is jointly developed by the Hong Kong Institution of Engineers and the Hong Kong Ethics Development Centre (HKEDC) of the Independent Commission Against Corruption (ICAC), is taken as additional reference.

The study adopts mixed methods research, which takes a quantitative approach before a qualitative study. Samples of the quantitative study are drawn from project managers in Hong Kong's construction industry. The e-Delphi experts for the qualitative study are drawn from local and international academic or experienced professionals in the field. As this research context does not require analysis and evaluation of individual or reporting individual opinion, the issues of anonymity are less problematic than in other social research, for instance, in the case of reporting opinion of informants and research participants processing a combination of attributes that make them readily identifiable (Wiles, Crow, Heath and Charles, 2006). In this study (both quantitative and qualitative), results are published based on collective responses of research participants rather than disclosing individual opinion.

4.4.1 Anonymity Measures

Anonymity means that the participants cannot be identified by anyone, to certain extent including the researcher. It is one of the nine ethical principles in the *Ethics Guide 2015* that requires protecting privacy, ensuring confidentiality and maintaining anonymity of participants (principle 6). Sample responses from survey participants are putting into a separate file with number assigned in according to their sequence of response received (i.e., #1 for the first response and #2 for the second response, etc.). In analysing the responses, opinion attached to individual respondent cannot be identified by others. Though the researcher can still cross check with full name list in other file by e-mail address, etc., to identify individual response, but it takes extra effort to do it. For respondents taking the survey on the Webpage, the researcher can only recognise their IP address and respondent ID that could not be linked to name of the respondents. The results of the quantitative study are published without disclosing individual response.

For the e-Delphi study, 12 local and international experienced academics and professionals were invited to form the e-Delphi expert panel. Participants were drawn from scholars with related subject publications or experienced professionals in the field. Experts may know each other. Participants must remain anonymous to avoid experts with strong characters influencing the study result. Potential experts are invited individually. The e-Delphi study has taken three rounds of information exchange. Each expert has been assigned a letter from A to L to replace their names in the study. Group response instead of individual response is returned to member experts for further comments to avoid the possibility of identifying individual position. Upon obtaining consensus (majority at 70% level), the group response is final. Results are published on a collective response basis.

4.4.2 Confidentiality Measures

Confidentiality means that the participants can be identified by the researcher but access to this information will not go beyond the researcher. Relevant code of practice from the London South Bank University and the principle 6 of the *Ethics Guide 2015: Advice and Guidance* apply. Individual responses whether obtained from survey or e-Delphi study are being kept securely by the researcher. Data are stored in a password protected USB key and the key is being kept locked in a safety box located at the researcher's home. The researcher will destroy all data five years after graduation. As this is a DBA research project, it is only the author can obtain full details of individual response. No co-researcher works on the same project. To protect the participants, research project supervisors can only read the responses without knowing the real name of participants. Data collected in physical form are securely locked in filing cabinet and that soft data is stored in personal computer with password protected. The author has made clear in the information sheet and informed consent what is to be done with the data collected and how individual identity and data provided would be protected.

4.5 Chapter Summary

In planning a study, researcher needs to consider the philosophical worldview assumption that he or she brings to the study. In this research, my ontological position has been assumed. The worldview that project and sustainability exist in the real world and the form and nature of their interrelationship can be identified, tested and known through vigorous research. A range of choices under the epistemology, theoretical perspective, methodology and methods have been selected. The process of objectivism, post-positivism and mixed methods on QUAN-qual is chosen to carry out the study. In the mixed methods approach, quantitative survey is conducted to generate knowledge on maturity and process perspectives prior to carrying out qualitative study in relation to managing project sustainability towards project implementation success. Key considerations for the survey and e-Delphi have been discussed. As described above, the study involves surveying local construction project managers and establishing e-Delphi panel with local and international experts. Ethical considerations are reference research ethics requirements of the London South Bank University to safeguard relevant "*Code of Practice for Research Involving Human Participants*" in the research process. Data collection and analysis processes started upon approval obtained from the University Research Ethics Committee in April 2016. Following chapter describes details of the survey questionnaire, data collection, analysis and the findings generated in the quantitative study.

Chapter 5 Quantitative Data Collection and Analysis

5.1 Introduction

This chapter discusses the survey portion of the mixed methods study. The rationale of adopting a quantitative study is to test the maturity and process aspects of managing project sustainability in the construction industry of Hong Kong. The exploratory part of this research exercise aims to find out the views of local construction project managers about impacts of various sustainability dimensions on project implementation success. Completion of this quantitative study answers the "What" of the research questions. Section 5.2 describes the development of survey questionnaire. Section 5.3 outlines the process of quantitative data collection from project managers in the local construction industry. Section 5.4 analyses the collected data for respective research questions with descriptive and inferential statistics discussed. Hypotheses are tested and findings are generated.

5.2 Questionnaire Development

The survey questionnaire is composed of five sections. The Background describes basic information about the survey and questionnaire. Section 1 is designed to understand construction project sustainability maturity levels in Hong Kong. Section 2 relates to the measure of project implementation success. Section 3 measures respective sustainability process impacts of economic, environmental and social dimensions on project implementation. At the end of the questionnaire, Section 4 collects demographic information from the respondents. The following sub-sections describe each section in the questionnaire.

5.2.1 Background

This section introduces the purpose of this research. It investigates project sustainability maturity levels and sustainability impacts on construction project implementation success in Hong Kong. Respondents are advised that anonymous survey data will be used in aggregate form. They are assured of confidentiality. Information on informed consent is included; respondents are notified of their right to withdraw from the study at any time without providing a reason. Instructions are given on how to complete and submit the questionnaire.

A questionnaire for this study is shown in Appendix C. This is partly adapted from Silvius *et al*. (2013), Pinto (1986) and Maldonado-Fortunet (2002).

5.2.2 Section 1

There is one question under Section 1. Q1 is adapted from Silvius *et al*. (2013) on degree of maturity for organisation managing project sustainability. In this question, respondents are asked to identify sustainability position in their organisational strategy that commissions the project. In accordance with Silvius *et al*. (2013), there are four levels of maturity. At the bottom level, sustainability is considered through improved use of business resources. At the top level of maturity, the organisation would consider strategy on wise use of natural resources and consider social responsibility as one of the guiding principles for the design of business processes, business model and development of products and services for the organisation. Survey participants were asked whether their organisational strategy included a sustainability-related statement or mentioned degree of maturity in their strategy statement in terms of business resources, business processes, business model or innovative products and services (maturity perspective).

5.2.3 Section 2

There is one question under Section 2. Q2, which is adapted from Pinto (1986), looks at project implementation success. In the questionnaire, there are 12 elements (see Section 2 of Appendix C) that constitute the meaning of project success (see the last item in Section 2 of Appendix C). Survey participants are asked to indicate their opinion on each element in a 7-point Likert scale (Strongly Disagree = 1, Disagree = 2, Slightly Disagree = 3, Neutral = 4, Slightly Agree = 5, Agree = 6, Strongly Agree = 7). This question identifies the meaning of project implementation success in the context of Hong Kong's construction industry.

5.2.4 Section 3

There are six questions under Section 3. They are categorised into three sub-sections: (1) economic sustainability impact; (2) environmental sustainability impact; and (3) social sustainability impact. Each sub-section contains two questions. One question is adapted from Silvius *et al*. (2013) on sustainability impacts on project (process perspective). The other question is adapted from Maldonado-Fortunet (2002) on degree of importance on factors identified.

Q3 under the economic sustainability impact section includes the elements of Cost Savings or Reduced Use of Resources, Improved Business Processes and "a balanced set of quantitative and qualitative criteria that reflect long- and short-term perspectives" on sustainability. Two elements relating to extra revenue are excluded from the analysis. They are useful only to the author's future study. In the same sub-section, Q4 displays 14 economic sustainability-related elements (Maldonado-Fortunet, 2002). Survey participants are invited to consider respective degrees of importance to success. The 14 elements are:

1. Reduce resource consumption
2. Resource re-use
3. Energy savings
4. Resource efficiency
5. Energy efficiency
6. Water efficiency
7. Extraction efficiency
8. Maximise efficiency of artificial light
9. Efficiency during operation
10. Use of appropriate technology
11. Avoid damage to renewable resources
12. Design systems for ease of maintenance and operation
13. Maximise use of natural light
14. Used water recycling system

Q5 under the environmental sustainability impact sub-section consists of elements relating to: (1) selection of project supplier based on their know-how & partnership that helps products and services sustainability; (2) selection of material based on energy consumption and/or pollution incorporated in the materials during manufacturing and logistic processes; and (3) minimising energy and water consumption, waste and pollution in project deliverable. There are 34 environmental sustainability-related elements (Maldonado-Fortunet, 2002) under Q6. Survey participants can determine their respective significance. The 34 elements are:

1. Use of rapidly renewable materials
2. Use of renewable energy technologies
3. Use of recycled materials
4. Increase of recycled content
5. Protection of on-site soil
6. Re-use of top soils and rock materials
7. Use of vendors that have materials with recycled content
8. Proper handling, storage and disposal of hazardous and toxic materials
9. Materials based on life-cycle assessment
10. Minimise construction waste
11. Waste reduction goals during construction
12. Waste reduction goals during operation
13. Specify materials appropriate for their location and use

14. Green landscape retrofit techniques
15. Increase durability
16. Increase recyclability
17. Reduce site disturbance
18. Re-use of developed sites
19. Ecosystem damage avoidance
20. Solid waste avoidance
21. Air pollution avoidance
22. Water pollution avoidance
23. Habitat destruction avoidance
24. Avoid noise pollution
25. Risk of air, water or land pollution
26. Erosion and sedimentation control
27. Protect on-site vegetation
28. Promote biodiversity
29. Storm water management
30. Application of constructed artificial wetland wastewater treatment system
31. Require procedures for the recycling, re-use and salvage of construction waste
32. Use of indigenous species, species diversity and wildlife habitats in plant selection
33. Life support systems conservation
34. Control of hazardous materials from construction site

Q7 under the social sustainability impact sub-section considers factors relating to: (1) improving Labour Practices and Decent Work; (2) improving Health and Safety Conditions, including activities for the development of the community (e.g., training, education and development of stakeholders, etc.); (3) improving Diversity and Equal Opportunity (e.g., gender, race, religion, etc.); (4) improving Human Rights (e.g., non-discrimination, freedom of association and no child labour, etc.); and (5) preventing Bribery and Anti-Competitive Behaviour.

There are eight social sustainability-related elements under Q8 (Maldonado-Fortunet, 2002). Survey participants can determine their respective significance. The eight elements are: (1) improve quality of human life; (2) create healthy non-toxic environment; (3) avoid historic and archaeological disturbance; (4) employment increase; (5) use of innovative technique to increase safety; (6) use materials made locally or regionally; (7) consider means to transplant trees; and (8) visual impact.

5.2.5 Section 4

This section collects demographic information of the survey participants. There are five questions in this section. Q9 collects gender information. The purpose of Q10 is to understand background professional qualification of respondents though many of them are expected to be member of PMI with Project Management Professional (PMP) qualification. The Q11 is to collect respondents' project experience. In addition, the Q12 is to make clear the role of respondents in the project they referred to. Q13 is specifically requested by the Hong Kong Chapter of the Project Management Institute (PMI) to suit their in-house requirement.

5.3 Quantitative Data Collection

The ethical review committee approved the data collection process in April 2016. The unit of analysis for this study is the project manager. The researcher has approached the Project Management Institute (Hong Kong Chapter) for assistance. There are 1,300 local members registered under the Hong Kong Chapter. However, a full member list could not be disclosed.

After rounds of discussion, the Hong Kong Chapter agreed to support the study by notifying local members to take the survey (see Appendix B). In addition to PMI members, the researcher contacted members of the Hong Kong Institute of Construction Managers through LinkedIn. Some members agreed to take the survey. Due to the study's time constraint and practical difficulty encountered during data collection (not very active response from potential participants), there are only 55 valid respondents answered the questionnaire. Out of the 55 respondents, 28 project management professional (PMP) and remaining respondents have other professional qualifications (e.g., PRINCE2 or Chartered Surveyor).

The data collection process has followed the procedures approved by the LSBU Ethical Review Committee. Letter of Invitation was sent to the PMI (Hong Kong Chapter) (Appendix A) and other potential respondents (Appendix D). The PMI (Hong Kong Chapter) has reviewed details of the Letter of Invitation, Information Sheet (Appendix E), and the Survey Instrument (Appendix C) with Informed Consent to be included at the front part of the questionnaire. It took three months to complete the application process. The PMI (Hong Kong Chapter) approved to support the survey in July 2016.

Based on information provided by the Hong Kong Institute of Construction Managers, the researcher has approached individual member via LinkedIn. The researcher has initially contacted potential respondent by telling him/her that:

I am a DBA student of the London South Bank University. May I invite you to take an online survey about managing project sustainability in Hong Kong? Gilman Tam.

The potential respondent can choose to connect via LinkedIn or ignore the invitation. Once the potential respondent has accepted the invitation to connect, they are sent a letter of invitation (Appendix D) and information sheet (Appendix E) with the following message:

Thanks for accepting my invitation to take the online survey! Please read the attached letter of invitation and information sheet before taking the survey through the following Web link. It takes about 30 minutes to complete. Thanks! Gilman Tam.

Link: https://www.surveymonkey.com/r/ManagingProjectSustainability

The Web link connects to SurveyMonkey's online questionnaire. SurveyMonkey accepts and stores survey participants' completed questionnaires. Appendix C shows the captured view of the SurveyMonkey questionnaire. The 55 completed questionnaires were downloaded in Excel for analysis.

5.4 Quantitative Data Analysis

5.4.1 Research Question #1

Question #1 (*What is the level of sustainability consideration for projects in Hong Kong's construction industry?*) identifies organisational maturity in managing project sustainability within Hong Kong's construction industry. The survey instrument in Section 1 addresses this maturity perspective with five choices for the respondents: (1) none of sustainability statement in organisational strategy; (2) organisational strategy mentions wise use of natural resources (business resources); (3) organisational strategy mentions wise use of natural resources and includes sustainability aspects for the design of business processes (business processes); (4) organisational strategy mentions wise use of natural resources and includes sustainability aspects for the design of business processes and business model (business model); and (5) organisational strategy mentions wise use of natural resources and includes sustainability aspects for the design of business processes, business model and development of products and/or services (products and services).

Table 5.1 shows the distribution of the 55 responses. There are five responses showing that "none" of the organisational strategy mentions wise use of natural resources and that no sustainability aspects are included in driving organisational activities. The remaining 50 project managers indicated various degrees of project sustainability maturity in their organisations.

Table 5.1. *Responses on project sustainability maturity perspective*

None	5
Business Resources	13
Business Processes	12
Business Model	9
Products and Services	16

The study identifies 50 out of 55 responses representing 91% of samples showing concern of managing project sustainability. It is not all organisations within the construction industry in Hong Kong having established their organisational strategy in wise use of natural resources and/or deliver social responsibility in their business operation. To further analyse which degree of maturity (Business Resources, Business Processes, Business Model, Products and Services) is most popular to organisations, it is required to examine the preferential selection of the four reported categories with the use of Chi-Square Test for Goodness-of-Fit. Hypotheses are developed as follows:

Null hypothesis, H_0: There is no difference in chosen sustainability maturity linked to organisational strategy in managing project sustainability.

Alternate hypothesis, H_a: There is difference in chosen sustainability maturity linked to organisational strategy in managing project sustainability.

A chi-square statistic was calculated using SPSS version 18.0 to examine if there is a preference among the four levels of project sustainability maturity as reported by survey respondents (project managers). The four project sustainability maturity levels in descending order are: (1) products and services; (2) business model; (3) business processes; and (4) business resources. The test was found to be statistically insignificant, X^2 (3, n = 50) = 2.00, p = .572. Therefore, the null hypothesis cannot be rejected. There is no difference in chosen sustainability maturity linked to organisational strategy in managing project sustainability. Thus, the Hong Kong construction industry does not display overall level of project sustainability maturity in managing project.

Project Maturity

	Observed N	Expected N	Residual
Business Resources	13	12.5	.5
Business Processes	12	12.5	-.5
Business Model	9	12.5	-3.5
Products and Services	16	12.5	3.5
Total	50		

Test Statistics

	Project Maturity
Chi-square	2.000[a]
Df	3
Asymp. Sig.	.572

a. 0 cells (.0%) have expected frequencies less than 5. The minimum expected cell frequency is 12.5.

Figure 5.1. *Chi-square test on project sustainability maturity*

5.4.2 Research Question #2

Question #2 asks: *To what extent does project sustainability (economic, environmental and social) impact project implementation success of Hong Kong's construction industry?* Unlike Question #1 and its project maturity perspective, Question #2 aims to understand the status quo of project sustainability toward project implementation success in Hong Kong's construction industry.

Understanding the meaning of project implementation success is a pre-requisite to the study of this process perspective. Pinto (1986) classic study has built up the structure of project implementation success with the help of PMI in the America. Nevertheless, the meaning of project implementation success has not been explored in the context of Hong Kong. In other words, no reference can be made with respect to constituents of success criteria toward project implementation success in the context of Hong Kong construction industry. It is important to identify applicable success criteria for local construction projects before proceeding to study sustainability related elements. The analysis is structured to be carried out in 3 steps:

1. Identify underlying success criteria for local construction project implementation success;
2. Identify sustainability impact(s) which is significant to project implementation success;
3. Further analysis of sustainability impact on constituent project implementation success criteria.

5.4.2.1 Success Criteria Underlying Project Implementation Success

Section 2 of Survey Instrument has adopted Pinto's structure - to collect project managers' opinion on the meaning of project implementation success. There are 12 items comprising of independent variables in the Pinto's structure on the dependent variable - "*All things considered, the project was a success*". Therefore, a set of 12 Pinto suggested success criteria (independent variables) on project implementation success (dependent variable) is shown:

Success Criteria

1. project schedule
2. project budget
3. project developed works
4. project used by intended clients
5. project efficiency and effectiveness directly benefited users
6. project doing best job of solving that problem
7. project affected important client made use of it
8. project processes
9. project minimal non-technical start-up problem
10. use of project directly led to more effective decision making or performance
11. project positive impact on use
12. project results improve client's managerial performance

Using SPSS 18.0, a stepwise multiple regression was conducted to see if the 12 identified success criteria could predict the project implementation success of local construction projects. Figure 5.2 shows descriptive statistics on success criteria and project implementation success.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
Project on Schedule	55	1	7	4.75	1.734	3.008
Project within Budget	55	1	7	4.93	1.698	2.884
Project Developed Work	55	1	7	5.73	1.079	1.165
Client Use	55	2	7	5.89	.994	.988
Benefit Efficiency and Effectiveness	55	3	7	5.58	.975	.952
Project to Solve Problem	55	2	7	5.40	1.132	1.281
Important Client to Use Project Result	55	4	7	5.71	.762	.580
Project Process	55	2	7	5.20	1.129	1.274
Minimal Start-up Problem	55	1	7	4.80	1.458	2.126
Better Decision Making or Performance	55	2	7	4.91	1.110	1.232
Positive Impact on Client	55	3	7	5.73	.932	.869
Improve Managerial Performance	55	2	6	5.04	.962	.925
Project Implementation Success	55	2	7	5.64	.910	.828
Valid N (listwise)	55					

Figure 5.2. *Descriptive statistics on success criteria and project implementation success*

Appendix F shows the SPSS output with stepwise regression model. Several assumptions have been checked for the regression. An analysis of standardised residual was carried out, which showed that the data contained no outlier (Std. Residual Min = -1.918, Std. Residual Max = 2.354). The data also met the assumption of non-zero variances (Project on Schedule, Variance = 3.008; Project within Budget, Variance = 2.884; Project Developed Work, Variance = 1.165; Client Use, Variance = .988; Benefit Efficiency and Effectiveness, Variance = .952; Project to Solve Problem, Variance = 1.281; Important Client to Use Project Result, Variance = .580; Project Process, Variance = 1.274; Minimal Start-up Problem, Variance = 2.126; Better Decision Making or Performance, Variance = 1.232; Positive Impact on Client, Variance = .869; Improve Managerial Performance, Variance = .925; Project

Implementation Success, Variance = .828). The test of Variance Inflation Factor (VIF) for collinearity has been conducted. The data met the assumption of collinearity with results indicate that multicollinearity was not a concern for all predictors. Myers (1990) indicates that researchers need to worry multicollinearity at a VIF value of 10 or above (Field, 2005). The maximum VIF value in this study is 1.990 (Project on Schedule). The histogram of standardised residuals indicated that the data contained approximately normally distributed errors, as did the normal P-P plot of standardised residuals, which showed points that were not completely on the line, but close. The assumptions seem to have been met and that the analysis conducted can probably generate a model applicable to the construction industry in Hong Kong.

Using the stepwise method, it was found that four predictors explain a significant amount of the variance in the value of Project Implementation Success. The four independent variables namely: (1) Client Use (β = .324, $p < .05$), (2) Improve Managerial Performance (β = .355, $p < .05$), (3) Positive Impact on Client (β = .280, $p < .05$), and (4) Project within Budget (β = .207, $p < .05$) are entered into the regression model. The result of the *F*-test shows that there is a significant relationship between each of the four independent variables and the dependent variable at a $p < .05$ level of significance (F (4, 50) = 31.405, $p < .05$, R^2 = .715, R^2_{Adjusted} = .693). Correlation between the dependable variable and the linear combination between the four independent variables is .846. The R^2 value of .451 shows that 45.1% of the change in the dependent variable (Project Implementation Success) is due to the change in Client Use. Additional change in dependent variable of 14.4% (59.5% - 45.1%) is contributed by the combination of Client Use and Improve Managerial Performance. Another 8.2% (67.7% - 59.5%) is contributed by the addition of Positive Impact on Client to Client Use and Improve

Managerial Performance. Finally, Project within Budget adds 3.8% (71.5% - 67.7%) contribution, making that the four independent variables combined contribute 71.5% of the explanatory power of the model variance in the Project Implementation Success variable. The remaining eight predictors are excluded from the regression model.

The multiple regression analysis results show that four independent variables are predictors for project implementation success: (1) client use; (2) improve managerial performance; (3) positive impact on client; and (4) project within budget. On the other hand, the research results show that Project on Schedule, Project Developed Work, Benefit Efficiency and Effectiveness, Project to Solve Problem, Important Client to Use Project Result, Project Process, Minimal Start-up Problem, and Better Decision Making or Performance do not have impact on Project Implementation Success.

The multiple regression model of Project Implementation Success for this quantitative study is:

Project Implementation Success = .324 (Client Use) + .355 (Improve Managerial Performance) + .280 (Positive Impact on Client) + .207 (Project within Budget)

5.4.2.2 Sustainability Impact on Project Implementation Success

There are three constructs (economic, environmental, social) of sustainability impact on project implementation success. In each of the construct, there are several sustainability impact success criteria identified in literature. Fourteen sustainability impact success criteria (independent variables) under the three constructs were developed (see Figures 4.1, 4.2 and 4.3).

<u>Economic Sustainability Construct</u>
1. Cost Savings or Reduced Use of Resources
2. Improved Business Processes
3. Balanced Set of Quantitative and Qualitative Sustainability Criteria

<u>Environmental Sustainability Construct</u>
1. Supplier Know-How & Partnership
2. Energy Consumption and/or Pollution in Materials Manufacturing and Delivery
3. Energy Consumption as Project Design Parameter
4. Water Consumption and Pollution as Project Design Parameter
5. Waste in Project Design with Maximum Recycling

<u>Social Sustainability Construct</u>
1. Labour Practices and Decent Work
2. Health and Safety Conditions
3. Development of Community Activities
4. Diversity and Equal Opportunity
5. Human Rights
6. Bribery and Anti-Competitive Behaviour

Section 3 of Survey Instrument with questions adapted from Silvius *et al*. (2013) collects the views of project managers on various sustainability impact success criteria identified toward project implementation success. To construct a regression model with various sustainability impacts on project implementation success, it is necessary to check the assumptions.

Appendix G shows the SPSS output of sustainability impacts with the stepwise regression model. Several assumptions have been checked for the regression. An analysis of standardised residual showed that the data contained no outlier (Std. Residual Min = -2.576, Std. Residual Max = 1.699). The test of variance inflation factor (VIF) for collinearity indicated that multicollinearity was not a concern for all predictors. The maximum VIF value in this sustainability impact study is 1.314 (business processes improvement). The histogram of standardised residuals displayed an approximately normal distributed error, as did the normal P-P plot of standardised residuals. The P-P plot showed points that were close to the line but not completely on it. The assumptions established met the requirements that the analysis conducted can probably generate a model applicable to the construction industry in Hong Kong.

The stepwise method with all 14 sustainability impact criteria under the three constructs was used. It found that two predictors explained a significant amount of variance in the value of project implementation success. The two independent variables were: (1) resources saving ($\beta = .478$, $p < .05$); and (2) Supplier Know-How & Partnership ($\beta = .294$, $p < .05$). The result of the F-test shows a significant relationship between each of the two independent variables and the dependent variable at a $p < .05$ level of significance (F (2, 52) = 12.572, $p < .05$, $R^2 = .326$, $R^2_{\text{Adjusted}} = .300$). Correlation between dependable variable and linear combination between the two independent variables was .571. The R^2 value of .326 shows that 32.6% of the change in the dependent variable (project implementation success) was due to the change in resources saving (24.0%) and additional impact from Supplier Know-How & Partnership (32.6 – 24.0 = 8.6%). Therefore, the two independent variables combined contributed 32.6% of the explanatory power of the model variance in the project implementation success variable. The remaining 12 predictors were excluded from the regression model. However, there are two excluded variables showing a marginal case in the study: (1) Health and Safety ($t = 1.521$, $p = .135$); and Human Rights ($t = 1.403$, $p = .167$).

The multiple regression analysis results show two independent variables that are sustainability impact predictors for project implementation success: (1) resources saving; and (2) Supplier Know-How & Partnership.

The multiple regression model of managing project sustainability for this quantitative study is:

Project Implementation Success =

.478 (Resources Saving) + .294 (Supplier Know-How & Partnership)

Analysis of the above 14 all-in sustainability impact variables under the three constructs show that there is only one significant variable derived from each of the economic and environmental sustainability constructs. Their respective null hypotheses H_{10} and H_{20} have been rejected. In other words, the alternative hypotheses H_{11} and H_{21} hold true. Nevertheless, there is no significant variable identified for the social sustainability construct. Under this situation, the H_{30} null hypothesis for social sustainability construct cannot be rejected. To verify if the same results could be obtained under respective sustainability constructs (against doing all-in 14 predictors in one test), additional regression tests on project implementation success (dependent variable) were conducted on: (1) three economic independent variables; (2) five environmental independent variables; and (3) six social independent variables.

a) **Economic Sustainability Impact on Project Implementation Success** (see Figure 4.1)

Using the stepwise method with all three economic sustainability impact criteria included, it was found that the predictor of resources saving (β = .490, $p < .05$) explains a significant amount of variance in the value of project implementation success. The result of the F-test shows that there is a significant relationship between independent variable and the dependent variable at a $p < .05$ level of significance (F (1, 53) = 16.714, $p < .05$, R^2 = .240, R^2_{Adjusted} = .225). Correlation between dependent variable and independent variable is .490. The R^2 value of .240 shows that 24.0% of the change in the dependent variable (project implementation success) is due to the change in resources saving. Therefore, the single independent variable contributes 24.0% of the explanatory power of the model variance (project implementation success). The remaining two predictors are excluded from the economic sustainability construct regression model.

b) **Environmental Sustainability Impact on Project Implementation Success** (Figure 4.2)

Using the stepwise method with all five environmental sustainability impact criteria included, it was found that the predictor of Supplier Know-How & Partnership (β = .313, $p < .05$) explains a significant amount of variance in the value of project implementation success. The result of the *F*-test shows a significant relationship between independent variable and dependent variable at a $p < .05$ level of significance (F (1, 53) = 5.764, $p < .05$, R^2 = .098, R^2_{Adjusted} = .081). Correlation between dependent variable and independent variable is .313. The R^2 value of .098 shows that 9.8% of the change in the dependent variable (project implementation success) is due to the change in Supplier Know-How & Partnership. Therefore, this single independent variable contributes 9.80% of the explanatory power of the model variance (project implementation success). The remaining four predictors are excluded from the environmental sustainability construct regression model.

c) **Social Sustainability Impact on Project Implementation Success** (Figure 4.3)

Using the stepwise method with all six social sustainability impact criteria included, it was found that none of the predictor was of significance. Hence, no variable entered the equation. As a result, they are all excluded from the social sustainability construct regression model.

Results are the same when comparing all-in analysis and the three separate sustainability construct analyses mentioned. Resources saving and Supplier Know-How & Partnership are the only two sustainability predictors impacting project implementation success.

5.4.2.3 Analysis of Sustainability Impact on Constituent Project Implementation Success Criteria

Further analysis of sustainability impact on constituent success criteria of project implementation success (client use, improve managerial performance, positive impact on client, and project within budget) would better inform project managers on ingredients underlying managing project sustainability. In the following analysis, all-in sustainability variables from within the three constructs are included for analysis against each of the four constituent success criteria.

Sustainability Impact on Client Use

Using same set of sample data and stepwise regression method, Resources Saving (β = .365, $p < .05$) and Human Rights (β = .278, $p < .05$) are identified significant variables on client use. The result of the F-test shows that there is a significant relationship between each of the two independent variables and the dependent variable (Client Use) at a $p < .05$ level of significance (F (2, 52) = 6.234, $p < .05$, R^2 = .193, $R^2_{Adjusted}$ = .162). Correlation between dependent variable and linear combination between the two independent variables is .440. The R^2 value of .193 shows that 19.3% of the change in the dependent variable (client use) is due to the change in resources saving (11.7%) and additional impact from Human Rights (19.3 – 11.7 = 7.6%) making that the two independent variables combined contribute 19.3% explanatory power of the model variance in the Client Use variable. The remaining 12 predictors are excluded from the regression model.

Sustainability Impact on Improve Managerial Performance

Another significant success criterion on project implementation success is improve managerial performance. To conduct sustainability impact analysis on this dependent variable using stepwise regression method, resources saving (β = .314, p < .05) and water consumption/pollution minimisation (β = -.295, p < .05) are identified significant variables related to improve managerial performance. The result of the F-test shows that there is a significant relationship between each of the two independent variables and the dependent variable (improve managerial performance) at a p < .05 level of significance (F (2, 52) = 5.287, p < .05, R^2 = .169, R^2_{Adjusted} = .137). Correlation between dependent variable and linear combination between the two independent variables is .411. The R^2 value of .169 shows that 16.9% of the change in the dependent variable (improve managerial performance) is due to change in water consumption/pollution minimisation (8.6%) and additional impact from resources saving (16.9 - 8.6 = 8.3%) making that the two independent variables combined contribute 16.9% explanatory power of the model variance in the improve managerial performance variable. The remaining 12 predictors are excluded from the regression model. However, there are six excluded variables showing a marginal case in the study (see Appendix H):

1. Waste Minimisation (t = 1.921, p = .060)
2. Human Rights (t = 1.688, p = .098)
3. Health and Safety (t = 1.665, p = .102)
4. Diversity and Equal Opportunity (t = 1.664, p = .102)
5. Supplier Know-How & Partnership (t = 1.560, p = .125)
6. Labour Practices (t = 1.552, p = .127).

Sustainability Impact on Positive Impact on Client

The third sustainability impact analysis is on positive impact on client. Stepwise regression analysis identified that resources saving (β = .572, p < .05), Human Rights (β = .421, p < .05) and Business Process Improvement (β = -.329, p < .05) are significant independent variables on positive impact on client. The result of the *F*-test shows that there is a significant relationship between each of the three independent variables and the dependent variable (Positive Impact on Client) at a $p < .05$ level of significance (F (3, 51) = 9.360, $p < .05$, R^2 = .355, R^2_{Adjusted} = .317). Correlation between dependent variable and linear combination between the three independent variables is .596. The R^2 value of .355 shows that 35.5% of the change in the dependent variable (Positive Impact on Client) is due to the change in Resources Saving (14.3%), impact from Human Rights (27.5 – 14.3 = 13.2%), and impact from Business Processes Improvement (35.5 – 27.5 = 8.0%) making that the three independent variables combined contribute 35.5% the explanatory power of the model variance in the Positive Impact on Client. The remaining eleven predictors are excluded from the regression model. However, Water Consumption/Pollution Minimisation (t = -1.588, p = .118) in the excluded variables shows a marginal case in the study.

<u>Sustainability Impact on Project within Budget</u>

The last sustainability impact analysis is on Project within Budget. Same stepwise regression analysis is adopted. The only significant sustainability impact variable identified is Supplier Know-How & Partnership (β = .414, $p < .05$) on Project within Budget. The result of the *F*-test shows that there is a significant relationship between independent variable and dependent variable (Supplier Know-How & Partnership) at a $p < .05$ level of significance (F (1, 53) = 10.975, $p < .05$, R^2 = .172, R^2_{Adjusted} = .156). Correlation between dependent variable and independent variable is .414. The R^2 value of .172 shows that 17.2% of the change in the dependent variable (Project within Budget) is due to the change in Supplier Know-How & Partnership. The remaining 13 predictors are excluded from the regression model.

Table 5.2 summarises the findings of significant sustainability impacts on constituent success criteria of project implementation success. It shows that Resources Saving impacts three out of four constituent success criteria. Human Rights impacts two success criteria. The remaining three sustainability impacts (Business Processes Improvement, Water Consumption/Pollution Minimisation, Supplier Know-How & Partnership) are respectively impacting one constituent success criterion. Overall, the combined sustainability impacts (Resources Saving, Business Processes Improvement, Human Rights) explain 35.5% of the variation of Positive Impact on Client, which is one of four constituent success criteria for project implementation success.

Table 5.2. *Findings of significant sustainability impacts on constituent success criteria*

		Client Use	Improve Managerial Performance	Positive Impact on Client	Project within Budget
Economic Sustainability	Resources Saving	β = .365 R^2 = .117	β = .314 R^2 = .083	β = .572 R^2 = .143	-
	Business Processes Improvement	-	-	β = -.329 R^2 = .080	-
Environmental Sustainability	Water Consumption/Pollution Minimisation	-	β = -.295 R^2 = .086	-	-
	Supplier Know-How & Partnership	-	-	-	β = .414 R^2 = .172
Social Sustainability	Human Rights	β = .278 R^2 = .076	-	β = .421 R^2 = .132	-
	Explanatory Power:	R^2 = .193	R^2 = .169	**R^2 = .355**	R^2 = .172

$p < .05$

5.4.3 Research Question #3

Question #3 asks: *What is the degree of significance of identified sustainability-related factors contributing to project implementation success?* This research question aims to understand the status quo of sustainability-related success factors toward project implementation success in Hong Kong's construction industry. Questions are adapted from Maldonado-Fortunet (2002) based on the importance of 56 factors. These factors are categorised into three sustainability constructs (see Table 5.3): economic (14 elements); environmental (34 elements); and social (8 elements).

Table 5.3. *List of factors by sustainability constructs*

Economic Sustainability Construct	Environmental Sustainability Construct	Social Sustainability Construct
Reduce resources consumption	Use of rapidly renewable materials	Improve quality of human life
Resources reuse	Use of renewable energy technologies	Create healthy non-toxic environment
Energy savings	Use of recycled materials	Avoid historic and archeological disturbance
Resource efficiency	Increase recycled content	Employment increase
Energy efficiency	Protect on-site soil	Use of innovative technique to increase safety
Water efficiency	Re-use of top soils and rock materials	Use materials made locally or regionally
Extraction efficiency	Use vendors that have materials with recycled content	Consider means to transplant trees
Maximise efficiency of artificial light	Proper handling, storage and disposal of hazardous and toxic materials	Visual impact
Efficiency during operation	Select materials based on life-cycle assessment	
Use of appropriate technology	Minimise construction waste	
Avoid damage to renewable resources	Waste reduction goals during construction	
Design systems for ease of maintenance and operation	Waste reduction goals during operation	
Maximise use of natural light	Specify materials appropriate for their location and use	
Used water recycling system	Green landscape retrofit techniques	
	Increase durability	
	Increase recyclability	
	Reduce site disturbance	
	Re-use of developed sites	

	Ecosystem damage avoidance	
	Solid waste avoidance	
	Air pollution avoidance	
	Water pollution avoidance	
	Habitat destruction avoidance	
	Avoid noise pollution	
	Risk of air, water or land pollution	
	Erosion and sedimentation control	
	Protect on-site vegetation	
	Promote biodiversity	
	Strom water management	
	Application of constructed artificial wetland wastewater treatment system	
	Require procedures for the recycling, re-use and salvaged of construction waste	
	Use of indigenous species, species diversity, wildlife habitats in plant selection	
	Life support systems conservation	
	Control of hazardous materials from construction site	

Economic Sustainability Factors

In each of the factors under the economic sustainability construct, survey respondents have indicated their opinions on degree of importance using Likert scale (Not Important = 1, Least Important = 2, Important = 3, Very Important = 4, Most Important = 5). The distribution of responses on each factor is shown in Table 5.4. Having checked internal consistency of the Likert items making up the scale using Cronbach's alpha reliability test ($\alpha = .901$), the scale is internally consistent on the 14 economic sustainability factors. Table 5.5 shows the summary statistics of responses on economic sustainability factors with mean = 3.129.

Table 5.4. *Response distribution of economic sustainability factors*

	Not Important	Least Important	Important	Very Important	Most Important
Reduce resources consumption	1	3	22	24	5
Resources reuse	3	14	23	11	4
Energy savings	1	7	22	18	7
Resource efficiency	3	2	27	16	7
Energy efficiency	1	4	29	10	11
Water efficiency	4	11	28	9	3
Extraction efficiency	8	14	24	8	1
Maximise efficiency of artificial light	11	23	13	5	3
Efficiency during operation	0	2	30	14	9
Use of appropriate technology	1	6	29	12	7
Avoid damage to renewable resources	2	16	23	8	6
Design systems for ease of maintenance and operation	0	2	17	24	12
Maximise use of natural light	4	17	28	3	3
Used water recycling system	4	21	23	5	2

Table 5.5. *Summary statistics of economic sustainability factors*

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.901	.900	14

Summary Item Statistics

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Item Means	3.129	2.382	3.836	1.455	1.611	.188	14

With the assigned score in the form of Likert scale and the number of responses in each of the degree of importance (the distribution), total score on each factor can be evaluated. The factors summary score and their ranking are shown in Table 5.6 and Table 5.7, respectively.

From the project manager's perspective, the top 10 factors on economic sustainability are:

1. Design systems for ease of maintenance and operation (score = 211)
2. Efficiency during operation (score = 195)
3. Reduce resources consumption (score = 194)
4. Energy efficiency (score = 191)
5. Energy savings (score = 188)
6. Resource efficiency (score = 187)
7. Use of appropriate technology (score = 183)
8. Avoid damage to renewable resources (score = 165)
9. Resources reuse (score = 164)
10. Water efficiency (score = 161)

Table 5.6. *Summary of score on each economic sustainability factor*

	Total Score	**Ranking**
Reduce resources consumption	194	3
Resources reuse	164	9
Energy savings	188	5
Resource efficiency	187	6
Energy efficiency	191	4
Water efficiency	161	10
Extraction efficiency	145	12
Maximise efficiency of artificial light	131	14
Efficiency during operation	195	2
Use of appropriate technology	183	7
Avoid damage to renewable resources	165	8
Design systems for ease of maintenance and operation	211	1
Maximise use of natural light	149	11
Used water recycling system	145	12

Table 5.7. *Ranking of economic sustainability factors*

Ranking	Economic Sustainability Factor
1	Design systems for ease of maintenance and operation
2	Efficiency during operation
3	Reduce resources consumption
4	Energy efficiency
5	Energy savings
6	Resource efficiency
7	Use of appropriate technology
8	Avoid damage to renewable resources
9	Resources reuse
10	Water efficiency
11	Maximise use of natural light
12	Extraction efficiency
12	Used water recycling system
14	Maximise efficiency of artificial light

Of the top 10 economic sustainability factors, four can be categorised into efficiency achievements: (1) efficiency during operation; (2) energy efficiency; (3) resource efficiency; and (4) water efficiency. Another four relate to resources saving: (1) reduce resources consumption; (2) energy savings; (3) avoid damage to renewable resources; and (4) resources reuse. The remaining two items link to effective system design and use of technology: (1) design systems for ease of maintenance and operation; and (2) use of appropriate technology.

Environmental Sustainability Factors

Using same evaluation method as per economic sustainability factors above, Table 5.8 shows the response distribution of environmental sustainability factors. The Cronbach's alpha reliability test result (α = .968) shows that the measuring scale is internally consistent. Table 5.9 shows the summary statistics of the 34 environmental sustainability factors with mean = 2.973.

Table 5.8. *Response distribution of environmental sustainability factors*

	Not Important	Least Important	Important	Very Important	Most Important
Use of rapidly renewable materials	14	19	13	8	1
Use of renewable energy technologies	3	13	29	6	4
Use of recycled materials	4	24	16	10	1
Increase recycled content	3	26	14	12	0
Protect on-site soil	6	13	23	12	1
Re-use of top soils and rock materials	5	21	22	7	0
Use vendors that have materials with recycled content	3	23	21	8	0
Proper handling, storage and disposal of hazardous and toxic materials	2	1	12	27	13
Select materials based on life-cycle assessment	3	7	25	17	3
Minimise construction waste	4	1	25	20	5
Waste reduction goals during construction	4	4	27	16	4
Waste reduction goals during operation	2	6	25	20	2
Specify materials appropriate for their location and use	5	16	24	5	5
Green landscape retrofit techniques	5	21	21	5	3
Increase durability	2	3	28	15	7
Increase recyclability	6	14	23	9	3
Reduce site disturbance	5	6	22	19	3
Re-use of developed sites	13	18	13	7	4
Ecosystem damage avoidance	4	4	33	7	7
Solid waste avoidance	5	4	36	7	3
Air pollution avoidance	3	2	28	17	5
Water pollution avoidance	2	1	31	16	5
Habitat destruction avoidance	4	6	31	7	7
Avoid noise pollution	3	4	32	12	4
Risk of air, water or land pollution	2	1	37	11	4
Erosion and sedimentation control	4	4	30	14	3
Protect on-site vegetation	7	25	13	8	2
Promote biodiversity	8	19	20	7	1

Strom water management	2	8	31	11	3
Application of constructed artificial wetland wastewater treatment system	9	18	21	6	1
Require procedures for the recycling, re-use and salvaged of construction waste	3	10	28	11	3
Use of indigenous species, species diversity, wildlife habitats in plant selection	8	20	20	7	0
Life support systems conservation	6	10	29	8	2
Control of hazardous materials from construction site	2	2	10	26	15

Table 5.9. *Summary statistics of environmental sustainability factors*

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.968	.969	34

Summary Item Statistics

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Item Means	2.973	2.327	3.909	1.582	1.680	.155	34

The summary score of individual factor and their respective ranking are shown in Table 5.10 and Table 5.11, respectively. The top 10 environmental sustainability factors are:

1. Control of hazardous materials from construction site (score = 215)
2. Proper handling, storage, and disposal of hazardous and toxic materials (score = 213)
3. Increase durability (score = 187)
4. Minimise construction waste (score = 186)
5. Water pollution avoidance (score = 186)
6. Air pollution avoidance (score = 184)
7. Risk of air, water, or land pollution (score = 179)
8. Waste reduction goals during operation (score = 179)
9. Waste reduction goals during construction (score = 177)
10. Avoid noise pollution (score = 175)
11. Select materials based on life-cycle assessment (score = 175)

Two factors of equal score are ranked under items 4, 7 and 10. There are two items ranked 10. Therefore, there are a total of 11 items identified under the environmental sustainability construct.

Table 5.10. *Summary of score on each environmental sustainability factor*

	Total Score	**Ranking**
Use of rapidly renewable materials	128	34
Use of renewable energy technologies	160	19
Use of recycled materials	145	24
Increase recycled content	145	24
Protect on-site soil	154	21
Re-use of top soils and rock materials	141	28
Use vendors that have materials with recycled content	144	27
Proper handling, storage and disposal of hazardous and toxic materials	213	2
Select materials based on life-cycle assessment	175	10
Minimise construction waste	186	4
Waste reduction goals during construction	177	9
Waste reduction goals during operation	179	7
Specify materials appropriate for their location and use	154	21
Green landscape retrofit techniques	145	24
Increase durability	187	3
Increase recyclability	154	21
Reduce site disturbance	174	12
Re-use of developed sites	136	32
Ecosystem damage avoidance	174	12
Solid waste avoidance	164	18
Air pollution avoidance	184	6
Water pollution avoidance	186	4
Habitat destruction avoidance	172	15
Avoid noise pollution	175	10

Risk of air, water or land pollution	179	7
Erosion and sedimentation control	173	14
Protect on-site vegetation	138	30
Promote biodiversity	139	29
Storm water management	169	16
Application of constructed artificial wetland wastewater treatment system	137	31
Require procedures for the recycling, re-use and salvaged of construction waste	166	17
Use of indigenous species, species diversity, wildlife habitats in plant selection	136	32
Life support systems conservation	155	20
Control of hazardous materials from construction site	215	1

Table 5.11. *Ranking of environmental sustainability factors*

Ranking	Environmental Sustainability Factor
1	Control of hazardous materials from construction site
2	Proper handling, storage and disposal of hazardous and toxic materials
3	Increase durability
4	Minimise construction waste
4	Water pollution avoidance
6	Air pollution avoidance
7	Risk of air, water or land pollution
7	Waste reduction goals during operation
9	Waste reduction goals during construction
10	Avoid noise pollution
10	Select materials based on life-cycle assessment
12	Ecosystem damage avoidance
12	Reduce site disturbance
14	Erosion and sedimentation control
15	Habitat destruction avoidance
16	Storm water management
17	Require procedures for the recycling, re-use and salvaged of construction waste
18	Solid waste avoidance
19	Use of renewable energy technologies
20	Life support systems conservation
21	Increase recyclability
21	Protect on-site soil
21	Specify materials appropriate for their location and use
24	Green landscape retrofit techniques
24	Increase recycled content

24	Use of recycled materials
27	Use vendors that have materials with recycled content
28	Re-use of top soils and rock materials
29	Promote biodiversity
30	Protect on-site vegetation
31	Application of constructed artificial wetland wastewater treatment system
32	Re-use of developed sites
32	Use of indigenous species, species diversity, wildlife habitats in plant selection
34	Use of rapidly renewable materials

Out of the top 10 (actually 11 elements) environmental sustainability factors, four items link to pollution (water pollution avoidance, air pollution avoidance, risk of air/water/land pollution, avoid noise pollution). Another three items relate to waste (minimise construction waste, waste reduction goals during operation, waste reduction goals during construction). Two items link to hazardous material (control of hazardous materials from construction site, proper handling/storage/disposal of hazardous and toxic materials). The remaining two are proper system and material selection (increase durability, select materials based on life-cycle assessment).

Social Sustainability Factors

There are eight social sustainability factors identified from the literature (Maldonado-Fortunet, 2002). In the survey, project managers indicated their preference on the degree of importance of factors as shown in Table 5.12. The Cronbach's alpha reliability test result (α = .791) shows that the measuring scale is internally consistent. Table 5.13 shows the summary statistics of the eight social sustainability factors with mean = 3.118.

Table 5.12. *Response distribution of social sustainability factors*

	Not Important	Least Important	Important	Very Important	Most Important
Improve quality of human life	3	3	22	22	5
Create healthy non-toxic environment	2	1	12	23	17
Avoid historic and archeological disturbance	4	7	30	10	4
Employment increase	9	19	13	12	2
Use of innovative technique to increase safety	3	4	19	18	11
Use materials made locally or regionally	5	20	19	8	3
Consider means to transplant trees	6	20	21	7	1
Visual impact	2	7	33	11	2

Table 5.13. *Summary statistics of social sustainability factors*

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.791	.790	8

Summary Item Statistics

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Item Means	3.118	2.582	3.945	1.364	1.528	.238	8

With the same evaluation method as in the analysis of economic sustainability factors, the summary scores on each social sustainability factor are shown in Table 5.14. Based on the scores, ranking of each social sustainability factor is determined (see Table 5.15). The ranking of eight social sustainability factors are:

1. Create healthy non-toxic environment (score = 217)
2. Use of innovative technique to increase safety (score = 195)
3. Improve quality of human life (score = 188)
4. Visual impact (score = 169)
5. Avoid historic and archeological disturbance (score = 168)
6. Use materials made locally or regionally (score = 149)

7. Employment increase (score = 144)
8. Consider means to transplant trees (score = 142)

Table 5.14. *Summary of score on each social sustainability factor*

	Total Score	Ranking
Improve quality of human life	188	3
Create healthy non-toxic environment	217	1
Avoid historic and archeological disturbance	168	5
Employment increase	144	7
Use of innovative technique to increase safety	195	2
Use materials made locally or regionally	149	6
Consider means to transplant trees	142	8
Visual impact	169	4

Table 5.15. *Ranking of social sustainability factors*

Ranking	Social Sustainability Factor
1	Create healthy non-toxic environment
2	Use of innovative technique to increase safety
3	Improve quality of human life
4	Visual impact
5	Avoid historic and archeological disturbance
6	Use materials made locally or regionally
7	Employment increase
8	Consider means to transplant trees

There are only eight social sustainability factors in the list, in which, two are related to health and safety (i.e., create healthy non-toxic environment and use of innovative technique to increase safety). Another two items relate to benefiting the community (i.e. improve quality of human life and employment increase). The remaining four items link to disturbance to community (i.e., visual impact, avoid historic and archeological disturbance, use materials made locally or regionally, and consider means to transplant trees).

This section analyses the collected survey data by using various analytical tools. Meaningful findings are summarised in Table 5.16.

Table 5.16. *Findings of the quantitative study*

Research Question	Study Perspective	Purpose of Analysis, and Sustainability Dimension	Findings	Remarks
#1: What is the level of sustainability consideration for projects in Hong Kong's construction industry?	Project Sustainability Maturity Perspective	Understand project sustainability maturity by analysing organisational sustainability strategies. It is not required to differentiate respective sustainability dimension (economic, environmental and social)	1) Not all project organisations in Hong Kong's construction industry adopt sustainability-linked organisational strategy. 2) Hong Kong's construction industry does not display overall level of project sustainability maturity in managing projects (null hypothesis not rejected).	Understanding of project sustainability maturity helps with resource allocation and strategy development when building a sustainable society. A further study with larger sample size is recommended.
#2: To what extent does project sustainability (economic, environmental and social) impact project implementation success of Hong Kong's construction industry?	Project Sustainability Process Perspective	**A**: FIND OUT THE MEANING OF PROJECT IMPLEMENTATION SUCCESS IN HONG KONG'S CONSTRUCTION INDUSTRY To identify the constituents of success criteria for project implementation success in the context of Hong Kong's construction industry, the sustainability dimension is not applicable.	Four significant independent variables were identified: (1) Client Use (β = .324, p < .05), (2) Improve Managerial Performance (β = .355, $p < .05$), (3) Positive Impact on Client (β = .280, $p < .05$), and (4) Project within Budget (β = .207, $p < .05$). Project Implementation Success = .324 (Client Use) + .355 (Improve Managerial Performance) + .280 (Positive Impact on Client) + .207 (Project within Budget)	The four independent variables contributed a 71.5% explanatory power of the model variance in the project implementation success variable.
		B: FIND OUT SUSTAINABILITY IMPACT CRITERIA ON PROJECT IMPLEMENTATION SUCCESS All sustainability dimensions are included (using stepwise regression,	Null hypotheses H_{10} (economic) and H_{20} (environmental) rejected; H_{30} (social) cannot be rejected. Two significant independent variables identified: (1) Resources Saving (β = .478, $p < .05$), and (2) Supplier Know-	The two independent variables contributed a 32.6% explanatory power of the model variance in the project implementation success (dependent variable). No social

		14 sustainability impact criteria under three sustainability constructs are regressed on project implementation success).	How & Partnership (β = .294, $p < .05$). Project Implementation Success = .478 (Resources Saving) + .294 (Supplier Know-How & Partnership)	sustainability criterion was identified as a significant impact on a dependent variable. Two excluded variables showed a marginal case in the study: Health and Safety (t = 1.521, p = .135); Human Rights (t = 1.403, p = .167).
		C: FOLLOW-UP ANALYSIS TO B TO RE-CONFIRM RESPECTIVE SUSTAINABILITY DIMENSION CRITERIA ON PROJECT IMPLEMENTATION SUCCESS Economic (3 independent variables, IV), environmental (5 IV) and social (6 IV) sustainability dimensions	Economic Dimension: Resources Saving (β = .490, $p < .05$) Environmental Dimension: Supplier Know-How & Partnership (β = .313, $p < .05$) Social Dimension: No sustainability impact criterion identified significant	Economic Dimension: F-test: (F (1, 53) = 16.714, $p < .05$, R^2 = .240, $R^2_{Adjusted}$ = .225) Environmental Dimension: F-test: (F (1, 53) = 5.764, $p < .05$, R^2 = .098, $R^2_{Adjusted}$ = .081) Comparing all-in analysis **B** and respective sustainability analyses **C** shows the same results. Resources Saving, and Supplier Know-How & Partnership are the ONLY two sustainability predictors that impact on project implementation success.
		D: FURTHER UNDERSTAND ALL-IN (14) SUSTAINABILITY IMPACTS ON RESPECTIVE CONSTITUENT SUCCESS CRITERIA (CLIENT USE, IMPROVE MANAGERIAL PERFORMANCE, POSITIVE IMPACT ON CLIENT, AND PROJECT WITHIN BUDGET) OF PROJECT IMPLEMENTATION SUCCESS	i. Sustainability Impact on Client Use Resources Saving (β = .365, $p < .05$) and Human Rights (β = .278, $p < .05$) are identified significant variables on Client Use.	F-test: (F (2, 52) = 6.234, $p < .05$, R^2 = .193, $R^2_{Adjusted}$ = .162) The two independent variables combined contribute 19.3% explanatory power of the model variance in the Client Use variable.
			ii. Sustainability Impact on Improve Managerial Performance Resources Saving (β = .314, $p < .05$) and Water Consumption/Pollution Minimisation (β = -.295, $p < .05$) are identified significant variables on Improve	F-test: (F (2, 52) = 5.287, $p < .05$, R^2 = .169, $R^2_{Adjusted}$ = .137) The two independent variables contributed a 16.9% explanatory power of the model variance in the improve managerial performance variable. Six excluded variables

			Managerial Performance.	are marginal cases: 1) Waste Minimisation (t = 1.921, p = .060); 2) Human Rights (t = 1.688, p = .098); 3) Health and Safety (t = 1.665, p = .102); 4) Diversity and Equal Opportunity (t = 1.664, p = .102); 5) Supplier Know-How & Partnership (t = 1.560, p = .125); 6) Labour Practices (t = 1.552, p = .127).
			iii. Sustainability Impact on Positive Impact on Client Resources Saving (β = .572, $p < .05$), Human Rights (β = .421, $p < .05$) and Business Processes Improvement (β = -.329, $p < .05$) are significant independent variables on Positive Impact on Client.	F-test: (F (3, 51) = 9.360, $p < .05$, R^2 = .355, $R^2_{Adjusted}$ = .317) The three independent variables contributed a 35.5% explanatory power of the model variance in the positive impact on client. Water Consumption/Pollution Minimisation (t = -1.588, p = .118) in the excluded variables shows a marginal case in the study.
			iv. Sustainability Impact on Project within Budget The only significant sustainability impact variable identified is Supplier Know-How & Partnership (β = .414, $p < .05$) on Project within Budget.	F-test: (F (1, 53) = 10.975, $p < .05$, R^2 = .172, $R^2_{Adjusted}$ = .156) 17.2% of the change in the dependent variable (Project within Budget) is due to the change in Supplier Know-How & Partnership.
#3: What is the degree of significance of identified sustainability-related factors contributing to project implementation success?	Project Sustainability Process Perspective	Economic (14 elements)	Cronbach's alpha reliability test, α = .901 Mean = 3.129 Top 10 important factors on economic sustainability are: 1) Design systems for ease of maintenance and operation (score = 211); 2) Efficiency during operation (score = 195); 3) Reduce resources consumption (score = 194); 4) Energy efficiency	Of the top 10 economic sustainability factors, four items are <u>efficiency achievements</u> (Efficiency during operation, Energy efficiency, Resource efficiency, Water efficiency). Four items relate to Resources Saving (Reduce resources

			(score = 191); 5) Energy savings (score = 188); 6) Resource efficiency (score = 187); 7) Use of appropriate technology (score = 183); 8) Avoid damage to renewable resources (score = 165); 9) Resources reuse (score = 164); and 10) Water efficiency (score = 161)	consumption, Energy savings, Avoid damage to renewable resources, Resources reuse). Another two (2) items link to effective system design, and use of technology (Design systems for ease of maintenance and operation, Use of appropriate technology)
		Environmental (34 elements)	Cronbach's alpha reliability test, α = .968 Mean = 2.973 Top 10 environmental sustainability factors are: 1) Control of hazardous materials from construction site (score = 215); 2) Proper handling, storage and disposal of hazardous and toxic materials (score = 213); 3) Increase durability (score = 187); 4) Minimise construction waste (score = 186); 4) Water pollution avoidance (score = 186); 6) Air pollution avoidance (score = 184); 7) Risk of air, water or land pollution (score = 179); 7) Waste reduction goals during operation (score = 179); 9) Waste reduction goals during construction (score = 177); 10) Avoid noise pollution (score = 175); 10) Select materials based on life-cycle assessment (score = 175). Please note that items 4, 7, and 10 are each having two factors of equal score	Out of the top 10 (actually 11 elements) environmental sustainability factors, four (4) items link to pollution (Water pollution avoidance, Air pollution avoidance, Risk of air, water or land pollution, Avoid noise pollution). Three (3) items relate to waste (Minimise construction waste, Waste reduction goals during operation, Waste reduction goals during construction). Another two (2) items link to hazardous material (Control of hazardous materials from construction site, Proper handling, storage and disposal of hazardous and toxic materials). The remaining two (2) items are proper system and material selection (Increase durability, Select materials based on life-cycle assessment)
		Social (8 elements)	Cronbach's alpha reliability test, α = .791 mean = 3.118 Ranking of the eight (8) social sustainability factors are: 1) Create healthy non-toxic environment (score =	There are only eight (8) social sustainability factors in the list, two (2) items are health and safety related (Create healthy non-toxic environment, Use of innovative

			217); 2) Use of innovative technique to increase safety (score = 195); 3) Improve quality of human life (score = 188); 4) Visual impact (score = 169); 5) Avoid historic and archeological disturbance (score = 168); 6) Use materials made locally or regionally (score = 149); 7) Employment increase (score = 144); 8) Consider means to transplant trees (score = 142).	technique to increase safety). Two items benefit the community (improve quality of human life and employment increase). The remaining four items link to disturbance to community (visual impact, avoid historic and archeological disturbance, use materials made locally or regionally, consider means to transplant trees)

5.5 Chapter Summary

This chapter details the quantitative study. Survey method has been adopted. It describes questionnaire development, and the processes of data collection and analysis to answer the three research questions. Table 5.16 summarises the findings obtained from the survey with respect to maturity perspective (Research Q1) and process perspective (Research Q2 and Q3). No social sustainability impact criterion towards project implementation success could be identified significant. A follow up qualitative research study detailed in the next chapter discusses whether social sustainability pillar carries the same level of importance or attention as to economic and environmental sustainability pillars.

Chapter 6 Qualitative Data Collection and Analysis

6.1 Introduction

Findings from quantitative research above indicate that there is no social sustainability related criterion identified significant to construction project implementation success. The result is rather disappointing because sustainability or sustainable development is conceptualised by three intersecting circles. It represents the necessity to realise economic, environmental and social achievements. Does the survey result mean that success criterion of social sustainability impact is inferior to other impact success criteria in construction project implementation success? To complement the quantitative study, an e-Delphi study is proposed. The purpose of this subsequent qualitative study is to understand more of the differences between respective sustainability impacts. Expert views coming out from the e-Delphi panel can be contrasted to earlier survey results obtained from local project managers.

Section 6.2 discusses the formation of e-Delphi panel in this qualitative part of the mixed methods study. Section 6.3 shows the questionnaire development for the invited local and international experts. Unlike the process of quantitative data collection and analysis, the e-Delphi data collection and analysis are interactive in nature. Analysing collected data from previous round of discussion will be used to develop next round of questionnaire towards building consensus among experts. Sections 6.4, 6.5 and 6.6 show the three rounds of data collection and analysis leading to consensus.

6.2 Formation of Delphi Panel

Skulmoski *et al.* (2007), in their study of Delphi process for dissertations and published research, identified no hard and fast rules in determining the number of Delphi panel participants and the number of rounds. They consider that the following were factors to determine the sample size in a Delphi study: (1) heterogeneous or homogeneous samples; (2) decision quality and Delphi manageability trade-off; and (3) internal or external verification. Obviously, potential sample size is positively related to the availability of experts in the field. In Skulmoski *et al*. (2007), the smallest sample size of PhD dissertation can be as low as three Delphi experts. Furthermore, most studies (29 out of 41) are completed in three rounds of discussion.

As subject expert is limited in Hong Kong, international academic and professional experts in the field were invited to join the e-Delphi panel. This setup had the benefit of introducing global visions to the study. The author attended two international project management research conferences with sustainability focus in the past several years. The 2010 IPMA Expert Seminar "*Survival and Sustainability as Challenges for Projects*" was held in Zurich, Switzerland; the 2016 IPMA 4th Research Conference on "*Project Management and Sustainability*" was held at the Reykjavik University, Iceland. These conference attendance lists were used to identify potential experts. A local experts' list was developed from attending local conferences. The author checked the qualification and experience of potential experts through public domain before sending a letter of invitation.

Invited experts had to meet the selection requirements in Section 5.3.2. Approximately 40 potential participants were sent the letter of invitation (see Appendix I), information sheet (see Appendix J), informed consent form (see Appendix K) and e-Delphi first-round questionnaire (see Appendix M). Twelve experts were confirmed to participate with a signed and returned informed consent form. Two experts did not wish to participate and did not sign the consent form. One expert declined because they believed that mankind's impact on climate change is more urgent than sustainability and sustainable development. Another declined because his belief on the three pillars are only aggregated from separate and diverse criteria specific to a project and cannot be generally compared. The remaining invitees did not respond to the invitation e-mail or two-week e-mail reminder. Appendix L shows the background information of the e-Delphi participants.

6.3 Questionnaire Development

The e-Delphi study aimed to identify the degree of importance of respective sustainability impacts. The question derived from the survey result of no social sustainability impact success criterion identified significant against the concept of necessary inclusion of social requirements for sustainability from a three pillar perspective. The Question (Q) in the first-round e-Delphi questionnaire asked:

Is there any difference in terms of degree of importance on respective economic sustainability impact, environmental sustainability impact and social sustainability impact impacting on project implementation success of a construction project?

Space was provided in the questionnaire to collect responses from panel members. Appendix M shows the first-round questionnaire.

6.4 First-Round Data Collection and Analysis

Twelve responses were collected in the first-round discussion. Respondent H required a clear and concise definition on respective sustainability impacts. (Economic: - %, Environmental: - %, Social: - %). Respondent I suggested that "*Concepts as 'commissioning' and 'decommissioning' must be considered and applied during the initiating/designing project* *phase*" (Economic: - %, Environmental: - %, Social: - %). Respondents H and I did not provide views on degree of importance of respective sustainability impacts.

Balanced View

Some respondents (E, G and K) put equal weight on the three pillars. Respondent E put up a harmony view on sustainability, stating that "*It is about the harmony between these three perspectives. So yes, they are equally important*" (Economic: 33%, Environmental: 33%, Social: 33%). Respondent G stated that:

Sustainability will be a best practice when all three pillars get equal attention. Therefore, I think that if we allow enhancement of just one element, saying on that ground that we are sustainable is the wrong way to go.

He accepted that "*going for equal attention on all three pillars will not get the fastest result.*" Nevertheless, we need to bear in mind the planned steps. Respondent G recommended that environmental sustainability be included in the first line of the text (Environmental: 40%, Economic: 30%, Social: 30%).

Respondent K also saw sustainability as "*a holistic and systems concept that integrates all three dimensions.*" She found that environmental sustainability was viewed as more important. However, social sustainability impact "*has an influence on how the options are viewed regarding the economic model and the choice regarding environmental considerations*" (Environmental: 50%, Social: 30%, Economic: 20%).

Economic Prevail

Respondent F was concerned with high land prices and development costs in Hong Kong. This drives certainty of construction project execution, which translates into important investments and time. Economic sustainability can be anticipated quantitatively; environmental sustainability is driven by the government's incentives and statutory requirements. He observed that "*social sustainability is relatively difficult to anticipate its impact and reluctance to be advocated*" (Economic: 50%, Environmental: 30%, Social: 20%).

Respondent L shared the view that "*currently the most relevant criterion to assess and develop a project is economic.*" In the long term, "*sustainability, and even social aspects, take relevance.*" However, project managers are constrained by the short-term view of a project and sponsor (Economic: 50%, Environmental: 30%, Social: 20%).

Respondent C considered the construction industry as fragmented. As such, it is difficult for the industry to coordinate its sustainability efforts. In general, the industry places more importance on economic sustainability. It has become more aware of environmental sustainability, especially in terms of construction waste management. He commented that "*it is still not very conscious of social sustainability unless public protests bring that to its attention like in large scale infrastructure projects*" (Economic: 50%, Environmental: 30%, Social: 20%).

Environmental Prevail

Respondent A assumed that the organisation was mature enough to connect project success beyond measurements of project management success (i.e., on-time, under budget or delivering scope). For the construction industry, he placed "*social and environmental at a higher-degree of importance than the economic pillar*." In particular, he placed safety in the social pillar. He believed that the construction industry must take a lead role in the environmental sustainability pillar. The degree of importance was "*40-40-20 … with 20 being the economic pillar*" (Environmental: 40%, Social: 40%, Economic: 20%).

Respondent B felt that it was a rarity for large organisations to track carbon footprints (some view this as greenwashing). Project teams track their resource use (i.e., energy, waste, etc.). There is no connection to company policy, remuneration of senior management or a connection to local environmental carrying capacity. To him, the environmental issue was the most important (Environmental: 40%, Social: 30%, Economic: 30%).

Respondent D was concerned with the "*important impact on the natural environment surrounding the construction site and the local communities.*" He urged construction project managers to carefully consider those two aspects (Environmental: 50%, Social: 30%, Economic: 20%).

Social Prevail

Respondent J said that there were multiple interdependencies between the three aspects.

Social sustainability is helpful for having well-motivated and collaborating employees … for resolving conflicts with stakeholders. Environmental sustainability is essential for saving the earth (we'll still need it for a while!). Economic sustainability is necessary for accomplishing projects.

Single projects can be economically successful without environmental sustainability. Neglecting this aspect will have a negative impact in the economy, society and in our earth's life. The biggest positive impact will be generated by regarding the interdependencies of multiple influences between the project and the environment. People must be able and willing to cooperate and share their perceptions and insights. "*For sustainable project success, it may be necessary to regard the needs of society*" (Social: 40%, Environmental: 30%, Economic: 30%).

Table 6.1. *First-round question summary score*

Respondent	Economic	Environmental	Social
A	20	40	40
B	30	40	30
C	50	30	20
D	20	50	30
E	33	33	33
F	50	30	20
G	30	40	30
H	-	-	-
I	-	-	-
J	30	30	40
K	20	50	30
L	50	30	20
Total Score	333	373	293
Average Score	33.3	37.3	29.3
Ranking	2	1	3

Table 6.1 shows the summary score of the e-Delphi question. Based on this analysis, a summary description is prepared as shown in Exhibit 6.1. It reflects the result obtained from the first-round discussion on degree of importance of respective sustainability impacts on construction project implementation success. This summary description was sent to e-Delphi participants for verification in the second-round questionnaire.

Exhibit 6.1. *First-round question summary description (derived for second-round questionnaire)*

The **ideal** situation is harmony between the three sustainability impacts (economic, environmental and social) and maintaining multiple interdependencies between these three aspects. If we allow enhancement of just one element, saying on that ground that we are sustainable is the wrong way to go. In **practice**, construction industry needs to take a leading role in environmental sustainability concerning important impact on the natural environment surrounding the construction site and the local communities. Neglecting this aspect will have a negative impact in both the society and economy, and in the whole life on earth. So for sustainable construction project implementation success, it may be necessary to regard the needs of society though industry practitioners put more importance to economic sustainability. The ranking of degree of importance on construction project sustainability impact is: 1) Environmental Sustainability Impact (50%), 2) Economic Sustainability Impact (30%), and 3) Social Sustainability Impact (20%).

6.5 Second-Round Data Collection and Analysis

Preparation of the second-round questionnaire began shortly after the analysation of the first-round questionnaire. The second-round questionnaire has one question, which streamlines the degree of importance of respective sustainability impacts on construction project implementation success.

In the second-round discussion, e-Delphi experts were asked to read the summary statement derived from combined responses in the first-round questionnaire (see Exhibit 6.1). The summary statement reflects the degree of importance of economic, environmental and social sustainability impacts on construction project implementation success. Respondents in this round were asked to consider whether the summary statement from the first round responses were to their satisfaction. The second-round questionnaire instructed them to put “Yes, I agree" in the box allocated if they agreed with the summary statement (Appendix N). Otherwise, the respondents were asked to modify the statement.

Ten responses were collected during the second-round discussion. Respondents C and E did not return the questionnaire. Of the 10 responses, Respondents A, F, G, I and J selected "Yes, I agree" (Environmental: 50%, Social: 20%, Economic: 30%). In the second round, Respondent H indicated the need for a balanced view (Environmental: 33.3%, Social: 33.3%, Economic: 33.3%). The respondent did not mention weighting on degree of importance in the previous round. In addition, Respondent D opined that an environmental sustainability impact of 50% is high and a social sustainability impact of 20% is low. The respondent made minor adjustments (Environmental: 40%, Social: 30%, Economic: 30%) before pointing out that "*in practice, this is very difficult to achieve because any project activity toward one sustainable objective have potential side effects on the other objectives.*"

On the other hand, Respondent B put more weight on economic sustainability impact (Environmental: 30%, Social: 30%, Economic: 40%). He was concerned that "*one does not pay the true cost for diesel, water, metals, accidents, air pollution, etc.*" in construction projects. He believed that "*even this disposition … does not recognize the fact that costs are not truly internalized.*"

Respondent K recognized that environmental sustainability was a dominant concern of construction projects due to impacts of the construction environment on the natural environment. She shared similar thoughts on true costs. In addition, she noted that sustainability is a holistic concept and "*looking at individual aspects without concerning the* *combined impact of all three hides the true costs and opportunities*" (Environmental: 40%, Social: 30%, Economic: 30%).

Respondent L put more weight on environmental sustainability impact (Environmental: 40%, Social: 30%, Economic: 30%). In addition, this respondent indicated that:

… the relative importance of the three aspects is also relative to the project context. It will not be the same in developing countries, where the social impact may gain weight … or in heavily developed ones, where environmental sustainability may take a clear bigger stance.

Table 6.2 shows the summary score of the second-round question.

Table 6.2. *Second-round question summary score*

Respondent	Economic	Environmental	Social
A	30	50	20
B	40	30	30
C	-	-	-
D	30	40	30
E	-	-	-
F	30	50	20
G	30	50	20
H	33.3	33.3	33.3
I	30	50	20
J	30	50	20
K	30	40	30
L	30	40	30
Total Score	313.3	433.3	253.3
Average Score	31.3	43.3	25.3
Ranking	2	1	3

Based on feedback from respondents on degree of importance of respective sustainability impacts on construction project implementation success, Exhibit 6.2 shows the amendment to summary description. The underlined words reflect the difficulty in achieving a holistic approach to sustainability due to potential side effects. In addition, environmental and social costs are not truly internalised. The amendment also includes the view of relative importance of these three aspects being country and project specific. The degree of importance on construction project sustainability impact has been slightly adjusted with no change in ranking: (1) environmental sustainability impact (45%); (2) economic sustainability impact (30%); and (3) social sustainability impact (25%). The analysed result was sent to e-Delphi participants for verification in the third-round questionnaire.

Exhibit 6.2. *Second-round question summary description (amended for third-round questionnaire)*

> The **ideal** situation is harmony between the three sustainability impacts (economic, environmental and social) and maintaining multiple interdependencies between these three aspects. However, it is very difficult to achieve a holistic approach to sustainability, because any project activities toward one sustainable objective have potential side effects on the other objectives. Environmental and social costs not being truly internalized is another difficulty. Furthermore, the relative importance of these three aspects is country specific and also relative to the project context. If we allow enhancement of just one element, saying on that ground that we are sustainable is the wrong way to go. In **practice**, construction industry needs to consider above the others environmental sustainability concerning important impact on the natural environment surrounding the construction site and the local communities. For this reason, neglecting this aspect will have a negative impact in both the society and economy, and in the whole life on earth. So for construction projects achieving implementation success sustainably, it may be necessary to regard the needs of society though industry practitioners put more importance to economic sustainability. The ranking of degree of importance on construction project sustainability impact should be: 1) Environmental Sustainability Impact (45%), 2) Economic Sustainability Impact (30%), and 3) Social Sustainability Impact (25%).

6.6 Third Round Data Collection and Analysis

The third-round questionnaire was prepared after analysed results from second-round responses were completed. In this round of discussion, there remained one question. Only 50% responses (5 of 10) agreed on the question summary statement in the previous round. Therefore, there was a necessity to refine and streamline the summary statement content targeting to a higher percentage of consensus. The content of Exhibit 6.2 has been incorporated into the third-round questionnaire (see Appendix O). Respondents are again being instructed to put down "Yes, I agree" in the box allocated should they agree to the revised description of summary statement. Otherwise, respondents are requested to modify the statement again in the box provided.

There are 11 responses collected in the third-round discussion. Respondent E did not return the questionnaire. There are 10 of 11 responses agreeing to the summary statement as described in the third-round questionnaire. The only objection came from Respondent H, stating "*No, I disagree.*" He believed that:

… the ranking of degree of importance on construction project sustainability impact is equal. Probably: (1) Environmental Sustainability Impact (33.3%); (2) Economic Sustainability Impact (33.3%); and (3) Social Sustainability Impact (33.3%). Sustainability impact balancing is very important.

There were additional comments from Respondents B and K. Respondent B wanted to specifically describe "*carbon emissions forming the highest priority*" in the environmental sustainability impact. Moreover, he considered that "*the contractual mechanism needs to be considered as well, potentially with a bonus for achieving a set reduction of carbon emissions*" meant to be trying to internalise the cost against economic sustainability impact.

Respondent K reiterated the concept of ranking that "*the holistic approach to sustainability is country specific, based on societal concerns and project context.*" She quoted an example:

… in a particular context where unemployment is high and potential for environmental degradation is lower, the sustainability approach could be to find environmental approaches

that place priority on social impact of employment which also addresses societal socio-economic development concerns.

Any sustainability model needs to look at the combined impact of the three dimensions. The additional comments from Respondents B and K are in line with the summary statement. Therefore, the e-Delphi study achieved a consensus rate of 90.9% (10/11), which is above the pre-determined 70% cut-off level. Hence, the Part 2 qualitative study was terminated at this round of discussion. The e-Delphi panel members were notified with the discussion outcomes.

6.7 Chapter Summary

This chapter details the qualitative portion of a mixed methods study. The e-Delphi research methodology was adopted. The formation of an e-Delphi expert panel and questionnaire is discussed. Three rounds of discussion exist, including 12 local and international experienced experts. The first-round questionnaire draws expert views on what constitutes importance on respective sustainability dimensions. This exercise collected the balanced view, as well as the views of economic prevail, environmental prevail and social prevail. Their opinions were categorised into ideal and practical situations. Moreover, relative degree of importance on respective sustainability impacts were summarised and presented to experts in the subsequent second-round discussion.

In the second-round questionnaire, experts were asked to amend the summary statement developed from previous responses. They also made adjustments on the relative degree of importance of respective sustainability impacts. The second-round responses did not reach the pre-determined 70% agreement level. Therefore, the responded contents and reply on degree of importance were amended for a third round. Third-round responses indicated that most experts agreed to the revised summary statement and the relative degree of importance on respective sustainability impacts. In addition, an environmental sustainability impact appears to be of relative importance over economic and social sustainability impacts for construction projects. The e-Delphi study stopped at this round. The following chapter summarises the findings from this QUAN-qual mixed methods study.

Chapter 7 Discussion and Conclusions

7.1 Introduction

With both the quantitative and qualitative data collected and analysed in previous chapters, Section 7.2 relates research goals, objectives and questions to findings. Section 7.3 discusses and interprets results leading to conclusions. Section 7.4 expounds the contributions of this mixed methods study to theory building (knowledge) and implications to researchers (research) and project managers (practice) in the field of managing project sustainability. Section 7.5 outlines the limitations of this study. Section 7.6 recommends research areas for future work.

7.2 Relating Research Goals, Objectives and Questions to Findings

Table 7.1 details the findings corresponding to respective research questions in this mixed methods study. The key findings are:

Project Sustainability Maturity Perspective

From the project sustainability maturity perspective, not all organisations in Hong Kong's construction industry are considering sustainability-linked organisational strategies. Organisations in the local construction industry do not display an overall degree of maturity representing the industry in managing project sustainability.

Identified Criteria

Four constituent success criteria were identified, including client use, improve managerial performance, positive impact on client and project within budget were identified. They explain 71.5% of project implementation success in the local construction industry.

Project Sustainability Process Perspective

From the project sustainability process perspective, two sustainability impact criteria were identified, including Resources Saving (economic) and Supplier Know-How & Partnership (environmental). They contribute to 32.6% of Hong Kong's construction project implementation success (dependent variable).

Social Sustainability

No significant social sustainability impact criterion was identified in the quantitative study. The subsequent qualitative e-Delphi study panel formed the opinion that the three sustainability dimensions are not of equal importance in practice. The final e-Delphi expert ranking of the degree of importance on respective construction project sustainability impact is: environmental (45%); economic (30%); and social (25%).

Sustainability Impact Criteria

Five sustainability impact criteria were identified, including Resources Saving, Business Process Improvement, Water Consumption/Pollution Minimisation, Supplier Know-How & Partnership, and Human Rights that could influence constituent success criteria (client use, improve managerial performance, positive impact on client, project within budget of local construction project implementation success. The combined impact of Resources Saving, Human Rights and Business Processes Improvement are significant with 35.5% explanatory power of the model variance in the positive impact on client.

Project Sustainability Process Perspective

From the project sustainability process perspective, the quantitative study identified success factors from respective sustainability dimensions (economic, environmental and social) contributing to local construction project implementation success. The top 10 economic sustainability factors are categorised into Efficiency Achievements (efficiency during operation, energy efficiency, resource efficiency, water efficiency), Resources Saving (reduce resources consumption, energy savings, avoid damage to renewable resources, resources reuse) and Effective System Design and Use of Technology (design systems for ease of maintenance and operation, use of appropriate technology).

The top 10 (actually 11 elements) environmental sustainability factors are Pollution (water pollution avoidance, air pollution avoidance, risk of air, water or land pollution, avoid noise pollution), Waste (minimise construction waste, waste reduction goals during operation, waste reduction goals during construction), Hazardous Material (control of hazardous materials from construction site, proper handling, storage and disposal of hazardous and toxic materials) and Proper System and Material Selection (increase durability, select materials based on life-cycle assessment).

Eight social sustainability factors were identified, including Health and Safety (create healthy non-toxic environment, use of innovative technique to increase safety), Benefiting the Community (improve quality of human life, employment increase) and Disturbance to Community (visual impact, avoid historic and archeological disturbance, use materials made locally or regionally, consider means to transplant trees).

Table 7.1. *Linkages between research goals, objectives, questions and findings*

Research Goals	Research Objectives	Research Questions	Findings
Goal 1: Through exploratory study, project managers gain a better understanding of sustainability attributes within the realm of project management.	Objective 1: Learn the perception of project managers in respect to project sustainability maturity levels for projects in Hong Kong's construction industry	Question 1: What is the level of sustainability consideration for projects in Hong Kong's construction industry?	From the project sustainability maturity perspective: 1) Not all project organisations in Hong Kong's construction industry adopt sustainability-linked organisational strategy. 2) Hong Kong's construction industry does not display an overall level of project sustainability maturity in managing projects.
	Objective 2: Identify project sustainability success criteria for judging project implementation success in Hong Kong's construction industry	Question 2: To what extent does project sustainability (economic, environmental and social) impact the project implementation success of Hong Kong's construction industry?	1: Identified four independent variables: (1) client use; (2) improve managerial performance; (3) positive impact on client; and (4) project within budget combined contribute to 71.5% explanatory power of the model variance for construction project implementation success in Hong Kong.
			2: From the project sustainability process perspective, two sustainability impact criteria were identified: (1) resources saving; and (2) supplier know-how & partnership. When combined they contribute to 32.6% explanatory power of the model variance for Hong Kong's construction project implementation success (dependent variable). No social sustainability impact criterion was identified as significant. A subsequent qualitative e-Delphi study panel formed the opinion that the three sustainability

			dimensions are not of equal importance in practice. The final e-Delphi expert ranking of the degree of importance on construction project sustainability impact is: (1) environmental sustainability impact (45%); (2) economic sustainability impact (30%); and (3) social sustainability impact (25%).
			3: Identified that four constituent success criteria (client use, improve managerial performance, positive impact on client, project within budget) for construction project implementation success could be influenced by one or more of the following sustainability impacts: (1) resources saving; (2) business processes improvement; (3) water consumption/pollution minimisation; (4) supplier know-how & partnership; and (5) human rights. The combined impact of resources saving, human rights and business processes improvement are significant with 35.5% explanatory power of the model variance in the positive impact on client.
Goal 2: Project success is promoted considering the organisation and management of project sustainability undertaken by the project management community.	Objective 3: Understand the significance of literature-identified factors toward various constructs of project sustainability.	Question 3: What is the degree of significance of identified sustainability-related factors contributing to project implementation success?	From the project sustainability process perspective, the top 10 important factors related to **economic sustainability** are: (1) efficiency achievements (efficiency during operation, energy efficiency, resource efficiency, water efficiency); (2) resources saving (reduce resources consumption, energy savings, avoid damage to renewable resources,

			resources reuse); and (3) effective system design, and use of technology (design systems for ease of maintenance and operation, use of appropriate technology).
			The top 10 (actually 11 elements) **environmental sustainability** factors are: (1) pollution (water pollution avoidance, air pollution avoidance, risk of air/water/land pollution, avoid noise pollution); (2) waste (minimise construction waste, waste reduction goals during operation, waste reduction goals during construction); (3) hazardous material (control of hazardous materials from construction site, proper handling/storage/disposal of hazardous and toxic materials); and (4) proper system and material selection (increase durability, select materials based on life-cycle assessment).
			Only eight **social sustainability** factors were identified in three categories: (1) health and safety (create healthy non-toxic environment, use of innovative technique to increase safety); (2) benefiting the community (improve quality of human life, employment increase); and (3) disturbance to community (visual impact, avoid historic and archeological disturbance, use materials made locally or regionally, consider means to transplant trees).
Goal 3: Additional research is instigated on this	Objective 4: Shed light on the future of project management	This mixed methods study has contributed to knowledge creation and management practice improvement for construction projects. It has also	

subject with knowledge obtained from this study.	in raising and integrating sustainability issues into the project management process	benefitted the project management community by promoting awareness of managing project sustainability. Suggested future work for researchers is included to drive researching in this field of study.

7.3 Discussion and Conclusions

7.3.1 Discussion

This study is characterised by its mixed method research methodology. A quantitative survey on local construction project managers precedes a follow up qualitative e-Delphi study recognising the tension between pursuit of laws (quantitative) and understanding of contested meaning (qualitative) (Karami *et al*.,2006). Quantitative method requires pre-determined and instrument-based questions for purpose of collecting performance data, attitude data, and observational data, etc. where in-depth meaning cannot be obtained. Adoption of quantitative method can effectively and efficiently identify problem areas, the belief in the existence of valid constructs and testing of ideas. On the other hand, qualitative study supports in-depth discussion on contested meaning. In practice, both quantitative and qualitative methods complement to each other. In this study, quantitative results show a lack of social sustainability impact criterion and that leads to developing qualitative e-Delphi investigation on degree of importance on respective sustainability impacts (economic, environmental, social). The e-Delphi experts discuss and form consensus opinions to complement the inadequacy of quantitative study.

There are six areas of findings worth discussion.

1. <u>Project Sustainability Maturity Level</u>

No discernible project sustainability maturity level appears in projects within Hong Kong's construction industry. Yet organisations generally consider project sustainability important.

Silvius *et al*. (2013) showed that overall average level of sustainability consideration in projects is 25.9%. Most projects in their study consider Business Resources (bottom level maturity) rather than Product/Services (top level maturity). Their study focused on European projects rather than projects specific to the construction industry.

In Question #1 of this study, the researcher aimed to understand the level of sustainability consideration for projects in Hong Kong's construction industry. Such project sustainability consideration can be reflected in the sponsor organisational strategy. From survey responses, five projects' sponsor organisations do not consider any statements or ambitions regarding sustainability. Fifty projects represent 91% of samples that, to a certain degree, consider some forms of sustainability in their organisational strategies.

Not all project organisations adopt sustainability statements or ambitions in their organisational strategy. However, a high percentage of sustainability recognition in Hong Kong's construction industry represents a positive move toward a sustainable society. The result is not surprising because the industry considers sustainability an important focus (CII, 2008).

Nevertheless, with those samples analysed using Chi-square test for goodness-of-fit, results show that the null hypothesis cannot be rejected. Hong Kong's construction industry does not display overall level of project sustainability maturity in managing projects. Some projects choose basic business resources as their target. Others choose higher degrees of project sustainability maturity in their organisational strategies (see Table 5.1). In other words, local construction organisations value project sustainability. However, their project sustainability maturity levels vary. A more in-depth understanding of project sustainability maturity can assist in the building of a better society. A further study with a larger sample size along the project sustainability maturity perspective is recommended.

2. Traditional Success Criteria and Project Implementation Success

Pinto (1986) identified success criteria measure of a project. As the study did not focus on Hong Kong's construction industry, it is necessary to find the meaning of project implementation success in the locality. Four traditional success criteria explain majority part of project implementation success in Hong Kong's construction industry.

Using a 7-point Likert scale, survey participants were asked to use the success criteria to share their opinions on implementation success. Analysis shows four significant success criteria contributing to project implementation success in Hong Kong's construction industry: (1) Client Use (β = .324, p < .05); (2) Improve Managerial Performance (β = .355, p < .05); (3) Positive Impact on Client (β = .280, p < .05); and (4) Project within Budget (β = .207, p < .05). These four success criteria combined contribute a 71.5% explanatory power of the model variance in Project Implementation Success. It is a very significant finding because it reflects the constituent success criteria and meaning of implementation success of a project in the local construction industry. Subsequent analysis of sustainability impacts on project implementation success makes use of this result finding.

Of the four success criteria, the criterion of "*the project has come in on budget*" for project implementation success was well-received by many industries, particularly the construction industry. Another criterion related to organisational validity (OV). The criterion of "*the* *project is used by its intended clients*” is a measure on organisational validity because the project results upon completion of implementation must be accepted by clients or end users. The remaining two criteria are related to organisational effectiveness (OE). They are “*the results of this project represent a definite improvement in performance over the way clients used to perform these activities*” and “*the project will have a positive impact on those who make use of it*” (Pinto, 1986).

These two OE success criteria represent the purpose of a project to be executed. Interestingly, none of the technical validity (TV) success criteria are significant in the study. It may be due to an established check and balance system in the construction industry. Project design, processes and technology must be verified and approved by many independent authorities. Survey respondents may not take technical validity as a critical measure to project implementation success with a well-established check and balance system already in smooth operation.

3. Significant Sustainability Impact Criteria

Two significant sustainability impact criteria (within economic and environmental constructs) contribute to project implementation success in Hong Kong’s construction industry. However, without any criterion representing social sustainability impact being identified, the sustainability success criteria in the quantitative study were derived from Silvius *et al*. (2013) research. There are 14 elements to be tested covering economic (three items), environmental (five items) and social (six items) sustainability impacts on project implementation success. The tested results are very interesting. There are only two sustainability impact success criteria out of 14 items being identified as significant to local construction project implementation success: (1) Resources Saving (β = .478, p < .05); and (2) Supplier Know-How & Partnership (β = .294, p < .05). These two success criteria combined explain a 32.6% of the model variance in the Project Implementation Success. Resources Saving belonging to economic sustainability construct and the Supplier Know-How & Partnership belonging to environmental sustainability construct. Many of the theoretically derived sustainability impacts from Silvius *et al*. (2013) (see Figures 4.1, 4.2 and 4.3) are found not significant to construction project implementation success in Hong Kong. Furthermore, there is no success criterion under the social sustainability construct found significant in the study. Nevertheless, there are two marginal cases to the construct of social sustainability: (1) Health and Safety, p = .135; and Human Rights, p = .167. These two items may be insignificant due to limited sample size. A better and clearer picture may be painted if future studies adopt a larger sample size.

The identified sustainability impact success criteria seem logical in practical sense. Resources Saving is directly linked to project financial performance. Less resources consumption translates into lower project cost and that higher return on investment is expected. It reflects a better chance to generate favourable outcome in economic sense. The other criterion is Supplier Know-How & Partnership. In Hong Kong's construction industry, there are many consultants or contractors providing services to the project owner. Yip and Poon (2009) confirmed that consultants, contractors and non-professionally-recognised participants exhibited significant awareness, concern, motivation and implementation on sustainable development throughout their research period (2000 to 2004). Therefore, the project owner would normally employ and partner with service providers on their technical know-how and experience to meet environmental sustainability challenge.

4. Traditional Constituent Success Criterion

Each traditional constituent success criterion for project implementation success links to certain sustainability impact element(s). To further understand sustainability impact on project implementation success, it is beneficial to conduct a regression analysis of sustainability impact(s) on each constituent success criterion. The all-in sustainability impact items taken as independent variables are included against each of the constituent success criterion as dependent variable.

i. **Sustainability Impact on Client Use:** Two sustainability impacts, Resources Saving and Human Rights, are found significant to Client Use. These two independent variables explain 19.3% of the change in the dependent variable (Client Use). Resources Saving is within the construct of economic sustainability and the Human Rights is within the construct of social sustainability. Client Use is part of project implementation success that links to less resources consumption in the project (economic sustainability performance) and respects human rights of the society (social sustainability performance). Project managers should target to maximise resources saving in the project implementation process starting from design stage through planning, execution, monitor and control till project closing. During the process, clients would concern whether the project violates the norm of human rights in the work activities. Therefore, project managers should be aware of such concern of client for a better chance of project implementation success.

ii. **Sustainability Impact on Improve Managerial Performance:** Two sustainability impacts, Resources Saving and Water Consumption/Pollution Minimisation, are found significant to Improve Managerial Performance. These two independent variables explain 16.9% of the change in the dependent variable (Improve Managerial Performance). Resources Saving is within the construct of economic sustainability and the Water Consumption/Pollution Minimisation is within the construct of environmental sustainability. Improve Managerial Performance is part of project implementation success that links to less resources consumption in the project (economic sustainability performance) and targets to minimise water consumption and pollution on site (environmental sustainability performance). To implement construction project successfully in Hong Kong, project managers shall make sure that it is required to maximise resources saving in the project implementation process starting from design stage through planning, execution, monitor and control till project closing. To a further extent, they have to reduce the consumption of water on site with extreme care about pollution thereof to the neighbourhood community. Otherwise, project will be judged less success in implementation due to negatively impacted environmental concern.

In this analysis, there are six excluded variables showing a marginal case (see Appendix H): (1) Waste Minimisation (t = 1.921, p = .060); (2) Human Rights (t = 1.688, p = .098); (3) Health and Safety (t = 1.665, p = .102); (4) Diversity and Equal Opportunity (t = 1.664, p = .102); (5) Supplier Know-How & Partnership (t = 1.560, p = .125); and (6) Labour Practices (t = 1.552, p = .127). The two excluded variables (Waste Minimisation and Supplier Know-How & Partnership) belong to the construct of environmental sustainability, while the remaining four items are under the construct of social sustainability. Further study on such sustainability impacts on Improve Managerial Performance is recommended.

iii. **Sustainability Impact on Positive Impact on Client:** Three sustainability impacts, Resources Saving, Human Rights and Business Processes Improvement, are found significant to Positive Impact on Client. These three independent variables explain 35.5% of the change in the dependent variable (Positive Impact on Client). Resources Saving is within the construct of economic sustainability and the Human Rights is within the construct of social sustainability. These two significant variables are of the same impacting criteria as in Client Use (mentioned above). In addition, Business Processes Improvement is within the construct of economic sustainability. Positive Impact on Client is part of project implementation success that links to less resources consumption in the project and business processes improvement by the project (economic sustainability performance). Furthermore, the criterion of Human Rights reflects the norm of the society (social sustainability performance). In the Hong Kong construction industry, project managers shall make sure that project is required to maximise resources saving in the project implementation process starting from design stage through planning, execution, monitor and control till project closing. During project execution, clients also expect that project contributes to business processes improvements and would concern whether the project violates the norm of human rights in the work activities. Therefore, project managers should be aware of such positive impact concerns of clients for a better chance of project implementation success. In this analysis, Water Consumption/Pollution Minimisation is a marginal case which is then excluded. Further study is recommended for comprehensive understanding of sustainability impacts on Positive Impact on Client.

iv. **Sustainability Impact on Project within Budget:** There is only one sustainability impact, Supplier Know-How & Partnership, found significant to Project within Budget. It explains 17.2% of the change in the dependent variable (Project within Budget). Supplier Know-How & Partnership is within the construct of environmental sustainability. Project within Budget as a constituent success criterion of project implementation success is prone to economic performance consideration. However, this economic performance links to Supplier Know-How & Partnership, which is an environmental sustainability concern. It is a very interesting finding because economic consideration is impacted by environmental concern. To implement construction project successfully in Hong Kong, project managers shall consider using suppliers' knowledge and partner with them in the project. It confirms the study findings of Yip and Poon (2009) where consultants, contractors and the like exhibited more concern of sustainability awareness, motivation and action. Nevertheless, it may have impacted the budget concern in an economic sense.

The following summarise the findings of sustainability impact on constituent success criteria of project implementation success (see Table 5.2).

<u>Economic Sustainability:</u>

Resources Saving has a positive impact on Client Use, Improve Managerial Performance and Positive Impact on Client. It is a match with traditional understanding in project management and management in general.

Business Process Improvement has a negative impact on Positive Impact on Client. In other words, if the Business Process Improvement is doing badly, there is more influence on Positive Impact on Client. On the other hand, if the Business Process Improvement is doing well, then there is less influence on Positive Impact on Client.

Environmental Sustainability

Water Consumption/Pollution Minimisation has a negative impact on Improve Managerial Performance. It means that higher water consumption and more pollution (negative performance) from a project have a higher demand to Improve Managerial Performance. Positive performance in water consumption and pollution minimisation would have less of a demand to Improve Managerial Performance.

Supplier Know-How & Partnership has a positive impact on Project within Budget.

Social Sustainability

There is only one sustainability impact identified in this pillar. Human Rights has a positive impact on Client Use and Positive Impact on Client. These two constituent success criteria are directly related to client.

5. Sustainability Impact-Related Factors

Based on degree of importance, categorised sustainability impact-related factors fall into categories (economic: 3; environmental: 4; and social: 3) for Hong Kong's construction industry. Unlike a previous analysis on construction project implementation success criteria, the measurement of degree of importance for sustainability impact factors link to critical success factors of managing project sustainability. Collins *et al*. (2004), as well as Dinsmore and Cooke-Davies (2006), defined the meaning of success criteria (measures against which the success or failure of a project is to be judged) and critical success factors (inputs to the management system that lead directly to the success of the project). Each is important but distinct. Research Question #3 aims to understand the degree of importance of sustainability impact factors identified from literature.

Several key success factors have been identified by construction project managers in the local industry. Under the economic sustainability dimension, the top 10 economic sustainability factors can be grouped into three areas: (1) Efficiency Achievements (efficiency during operation, energy efficiency, resource efficiency, water efficiency); (2) Resources Saving (reduce resources consumption, energy savings, avoid damage to renewable resources, resources reuse); and (3) Effective System Design and Use of Technology (design systems for ease of maintenance and operation, use of appropriate technology). To a certain extent, these areas of success may have some degree of overlapping within its dimension.

Under the environmental sustainability dimension, the top 10 (actually 11 elements) environmental sustainability factors can be grouped into four areas: (1) Pollution (water pollution avoidance, air pollution avoidance, risk of air, water or land pollution, avoid noise pollution); (2) Waste (minimise construction waste, waste reduction goals during operation, waste reduction goals during construction); (3) Hazardous Material (control of hazardous materials from construction site, proper handling, storage and disposal of hazardous and toxic materials); and (4) Proper System and Material Selection (increase durability, select materials based on life-cycle assessment). Again, these areas of environmental success factor may also have overlapped within its sustainability dimension (e.g., reduce waste could reduce pollution) and across other dimensions (e.g., waste reduction help resources saving under the economic sustainability dimension).

Under the social sustainability dimension, eight factors can be grouped into three areas: (1) Health and Safety (create healthy non-toxic environment, use of innovative technique to increase safety); (2) Benefiting the Community (improve quality of human life, employment increase); and (3) Disturbance to Community (visual impact, avoid historic and archeological disturbance, use materials made locally or regionally, consider means to transplant trees). Table 7.2 shows the important success factors contributing to project implementation success.

Table 7.2. *Important factors on project implementation success*

Economic Sustainability Dimension (Three Key Aspects)	Environmental Sustainability Dimension (Four Key Aspects)	Social Sustainability Dimension (Three Key Aspects)
Efficiency achievements	Pollution	Health and safety
Resource savings	Waste	Benefit to the community
Effective system design and use of technology	Hazardous material	Disturbance to the community
	Proper system and material selection	

From above, major results of this quantitative work drive local project managers to:

1. Observe project sustainability maturity in their project organisations. For example, organisation establishing project sustainability policy is a good sign to move towards sustainability.

2. Set the measures of traditional success criteria for project implementation (Client Use, Improve Managerial Performance, Positive Impact on Client, Project within Budget) to make sure appropriate success measures are developed.
3. To drive sustainability success on top of traditional project implementation success, project managers have to observe the requirements of setting additional criteria (Resources Saving, Supplier Know-How & Partnership) during project design and execution.
4. To benefit local project management community and drive construction projects to meet sustainability implementation success, local project managers need to set sustainability impact related factors of resources saving, efficiency achievements, and effective system design and use of appropriate technology for achieving economic sustainability. On environmental sustainability, project managers need to minimise waste and pollution, handle hazardous material carefully, and to make sure of proper system design with material selection based on life-cycle assessment in their construction projects. Regarding social sustainability, project managers find health and safety an important factor, and that the construction project should benefit the local community with minimised disturbance.

Research findings from this study are relevant to the Hong Kong construction industry. It informs project managers that several sustainability success factors drive project implementation success. Consideration of sustainability impact related success factors are new to the project management community in Hong Kong. Project managers are advised to set such success factors at project design stage, “Efficiency Achievement” under economic sustainability dimension for instance, as target to accomplish. Proper mechanism shall be developed in future local construction projects to monitor efficiency during operation, energy efficiency, resource efficiency, water efficiency in order to ensure "Efficiency Achievement" during project execution. Similar arrangement is carried out for setting other success factors. Furthermore, additional monitoring and control measures for such success factors are required on top of traditional measurement system.

6. Importance of Environmental Sustainability

e-Delphi experts formed opinion that environmental sustainability is more important than economic and social sustainability. In the three round e-Delphi panel discussion, the 12 members suggested ideal situations and practical difficulties in managing construction project sustainability for implementation success. The agreed position follows.

Ideal Situation: Experts believed that the harmony of the three sustainability impacts (economic, environmental, and social) is a key to managing construction project sustainability. They are of equal importance. It is important to maintain multiple interdependencies between the three dimensions when project managers perform work activities. In other words, they must balance respective sustainability impacts in projects. It is not a holistic consideration when the project manager allows plans and activities to favour one or two sustainability dimensions without equal attention to the remaining sustainability impact of the third dimension. Therefore, it is the wrong way to go.

On the other hand, experts understand that it is very difficult to achieve a holistic approach to sustainability. This is because one sustainable objective in a project activity can impact the other objectives. For example, lesser use of non-renewable resources for environmental sustainability in a construction project can impact social sustainability related to unemployment in the quarry industry.

Another difficulty relates to the lack of internalisation of environmental and social costs. For example, the social cost of air pollution on healthcare will not be borne by pollution emitters. In general, the relative importance of these three aspects is country specific and relative to project context.

Practical Situation: In practice, the experts agree that environmental sustainability of construction projects are of more important than the other two dimensions (economic and social). Rationale being natural environment surrounding the construction site and local communities has to be protected. Neglecting this aspect will have a negative impact in both the society and economy, and in the whole life on earth. It is a finding in this e-Delphi study where the three sustainability dimensions are not of equal importance. The e-Delphi expert agreed and ranked the degree of importance on construction project sustainability impact: (1) Environmental Sustainability Impact (45%); (2) Economic Sustainability Impact (30%); and (3) Social Sustainability Impact (25%). In delivering construction projects achieving a sustainable implementation success, construction project managers shall make themselves aware of such practical situations. The necessity of driving environmental sustainability in the process of delivering project implementation success. Of course, the importance of driving economic and social sustainability in construction projects cannot be discounted. To a further extent, the degree of importance should reference project context and be country specific.

This qualitative e-Delphi research study provides a clear answer to the research question: "*Is there any difference in terms of degree of importance on respective Economic Sustainability Impact, Environmental Sustainability Impact and Social Sustainability Impact impacting on project implementation success of a construction project?*" This research finding echo to Shen and Tam (2002) study that Hong Kong's construction industry has been interesting in the benefits, barriers and measures in implementing environmental management rather than holistic sustainability impacts.

7.3.2 Conclusions

There are three research questions in this study. The first question aims to understand local construction organisations from the project maturity perspective: *What is the level of sustainability consideration for projects in the construction industry of Hong Kong?* The quantitative study result finds no discernible project sustainability maturity level in projects within the local construction industry. Yet organisations generally consider project sustainability important.

The second question looks for success criteria from the project process perspective: *To what extent does project sustainability (economic, environmental and social) have an impact on the project implementation success of the construction industry in Hong Kong?* Four traditional success criteria (i.e., client use, improve managerial performance, positive impact on client, project within budget) explain the majority (71.5%) of project implementation success in Hong Kong's construction industry. Two significant sustainability impact criteria within economic (Resources Saving) and environmental (Supplier Know-How & Partnership) constructs have a 32.6% impact variation on project implementation success. However, no social sustainability impact criterion identified as significant. A subsequent qualitative e-Delphi study panel formed the opinion that, in terms of degree of importance, environmental sustainability (first) ranks top with economic (second) and social (third) sustainability to follow. To further understand sustainability impact, additional analysis on constituent success criteria was carried out. Each constituent success criterion linked to certain sustainability impact element(s) (see Table 5.2).

The third question studied project process perspective from the angle of success factor: *What is the degree of significance of identified sustainability related factors contributing to project implementation success?* Upon evaluation of 56 sustainability-related factors from literature, 10 areas of important success (economic: 3, environmental: 4, social: 3) were found to contribute to project implementation success (see Table 7.2) in Hong Kong's construction industry.

This research study identified the necessary considerations in managing project sustainability from maturity and process perspectives. To express gratitude to PMI (Hong Kong Chapter) for their support to this study and disseminate research findings to local project community, it plans to work with PMI (Hong Kong Chapter) to organise a seminar for the presentation of success criteria and success factors to construction project professionals. The section below shows the contributions to knowledge and their implications for researchers and project managers in managing project sustainability.

7.4 Contributions to Knowledge and Managerial Implications

7.4.1 Contributions to Knowledge

This research study on sustainability in project management provides several levels of contribution. It contributes to local government's policy formulation to building a sustainable society as called for by Agenda 21 (UNCED, 1992). It also applies to business organisations' project competitiveness and the need for project management communities to fill in knowledge gaps. Additionally, it contributes to raising awareness of project externality as it constructs an improved business case at the project level.

This study examines construction project sustainability maturity levels in Hong Kong. The results inform the Hong Kong government on devising appropriate policies contributing to a sustainable society.

Research results address managerial capability of local construction project managers. It also informs organisations on adopting sustainable development principles at the project level. Project managers could use the findings to improve their competence and performance on project implementation success and sustainability.

This mixed method study advances the understanding of managing project sustainability in Hong's Kong construction industry. Tested findings in the quantitative research contributed to project management's body of knowledge, including: (1) identification of four traditional success criteria (client use, improve managerial performance, positive impact on client, project within budget) specific for project implementation success in the local construction industry; (2) identification of two significant sustainability impact criteria (resources saving within economic construct and Supplier Know-How & Partnership within environmental construct) contributing to local project implementation success with no social sustainability impact criterion identified important; and (3) identification of constituent success criterion for project implementation success linked to one or more sustainability impact element(s) (see Table 5.2). Subsequent e-Delphi study results informed that environmental sustainability is more important than economic and social sustainability dimensions for projects in the construction industry.

The research findings as described above make contributions to local project management community, Hong Kong construction industry and the society as a whole. As shown in Table 1.1 above, the percentage share of GDP in Hong Kong is rising from 5.2% (2017) to estimated 6.1% (2022). Positive impact from this research findings on local construction companies will definitely help the development of society both in quantitative (e.g. efficient operation) and qualitative (e.g. increase in sustainable development potential) dimensions. The research outcomes indicate to i) Hong Kong Government that it is required to urge business organisations building their project sustainability maturity toward a sustainable society; ii) construction companies in Hong Kong that setting of traditional success criteria to suit local environment for better competitiveness; iii) local construction companies on sustainability impact related success criteria, with additional focus on improving environmental sustainability; and iv) project managers in locality to observe critical factors contributing to success in managing project sustainability. To achieve the above, dissemination of research outcomes to relevant government departments, professional associations, and project managers in the community is required. In the author's upcoming projects, the findings will be incorporated.

After decades of research on project success and success criteria, a large amount of work is now included in the project management body of knowledge. This study provides the meaning of project implementation success in the context of Hong Kong's construction industry. It also provides a new angle to look at project success and the consideration of various sustainability dimensions (economic, environmental and social). This research study will give light to project management researchers who are researching in the field of project sustainability. Project managers will benefit by understanding relevant sustainability-related success criteria. They will review critical success factors to improve project implementation success. In Hong Kong, this research study contributes to project implementation success sustainability impact measurement. Two empirically tested sustainability impacts (Resources Saving, Supplier Know-How & Partnership) identified contribute to such sustainability measures of local construction project implementation success. References made to Atkinson (1999) and Maldonado-Fortunet (2002) under Section 3.2, this study introduces resources consumption and efficiency measures on project implementation success economic sustainability; and supplier know-how & partnership measures under the measurement of project implementation success environmental sustainability.

7.4.2 Implications for Researchers

The quantitative research study has some important implications for researchers. The first important implication is that this study provides empirical evidence on the theoretical work of Belassi *et al*. (1996), Atkinson (1999), Silvius *et al*. (2013) and others who have identified the importance of combining project management and sustainability. Specifically, in Hong Kong's construction industry, it does not display overall level of project sustainability maturity in managing projects. Thus, it provides local empirical evidence to researchers in studying project sustainability maturity.

Another important implication for researchers is related to the four constituent success criteria (client use, improve managerial performance, positive impact on client, project within budget) for project implementation success in the context of Hong Kong's construction industry. There is no similar research previously conducted in the local context. Therefore, this research defines the meaning of project implementation success in the local construction industry.

After defining the meaning of project implementation success in the local construction industry, the sustainability impacts criteria (resources saving, Supplier Know-How & Partnership) identified guide researchers to study related phenomenon on project implementation success. Such sustainability impacts (economic, environmental) have empirically tested significant to project implementation success. There is no social sustainability impact identified significant on the same. This research has operated as background work for researchers on future studies. It also provides researchers information on studying sustainability-related success factors contributing to project implementation success.

7.4.3 Implications for Project Managers

In addition to implications for the academic community, there are significant implications for local construction managers, particularly for managers in organisations concerned with project sustainability. As mentioned, past theories informed practitioners to meet requirements of economic sustainability, environmental sustainability, and social sustainability (Atkinson, 1999). There was a lack of empirical research conducted on detail sustainability-linked success criteria for project implementation success in Hong Kong's construction industry.

This study directs local construction project managers to focus on five aspects. First, project managers understand sustainability aspects of organisational strategy for successful implementation of projects. Understanding the status quo of project sustainability maturity in the local construction industry is important to building a sustainable society.

Second, construction project managers can now benchmark the meaning of project implementation success. When done well in a local construction project, the four constituent success criteria will allow the project managers to have a fair chance of project implementation success.

Third, this study helps project managers understand how the elements in the three sustainability pillars can impact project implementation success. It helps project managers think about how to improve their daily activities related to Resources Saving and Supplier Know-How & Partnership. These two success criteria are critical to managing project sustainability.

Fourth, additional implication to project manager relates to different sustainability impact on constituent success criteria. If they find that certain success criterion is important to them, they could identify corresponding sustainability impact for improvement. For example, if project managers find that Improve Managerial Performance is important, then they would focus their effort on Resources Saving, and Water Consumption / Pollution Minimisation for improvement.

The fifth implication is most critical to project managers. In this study, several areas of important success factor for project implementation success are identified within the three sustainability pillars (see Table 7.2). Project managers need to put effort in these areas to gain better chance of success in managing project sustainability.

The focus of this research study has been on attempting to better understand project implementation success with the existence of sustainability impact. Given this improved understanding, project professionals in Hong Kong looking for higher chance of project implementation success need to construct their projects having (1) client use; (2) improve managerial performance; (3) positive impact on client; and (4) project within budget. To do well in promoting positive sustainability impact, it is important to having criteria on Resources Saving and Supplier Know-How & Partnership in project delivery with success factors of a) economic sustainability on efficiency achievements, resources saving, and effective system design, and use of technology; b) environmental sustainability on pollution and waste minimisation, hazardous material control, and proper system and material selection; and c) social sustainability on health and safety, benefiting the community, and avoid disturbance to community. With the above, Hong Kong construction project managers can perform better in managing project sustainability.

7.5 Limitations of the Study

This research project focuses on the views of the project management community toward sustainability. Sustainability is a broad subject. In this study, the community adopted the three-pillar approach (economic, environmental and social) rather than a more comprehensive principles-based approach like Gibson's (2006) core generic criteria. The principles-based approach is mainly used by governmental policies and initiatives where business organisations find it difficult to meet certain principles, such as livelihood sufficiency and opportunity. Business communities normally adopt the three-pillar approach for simplicity and ease of communication (three intersecting circles). Emphasis has been placed on the maturity perspective of project sustainability and the process perspective of individual sustainability impact leading to project implementation success.

Due to time constraints, this study's research design is not longitudinal in nature. This study adopts cross-sectional research rather than longitudinal data. One may argue that analysis of longitudinal sustainability impact data on project implementation success could be better due to a longer time horizon to avoid transient sustainability impact effect. A longitudinal study would increase the length of this mixed methods study by at least another 18 months. A DBA research student could hardly afford this lengthy study period.

Judgmental survey respondents (Hong Kong construction project managers) selected from the field were asked to recall their most recent project because recall of details from distant project activities may be vague. Under this situation, surveyed results may somewhat reduce reliability of reports for the less-recent projects.

There are many advantages to online surveys, including time and cost considerations. Yet there are also limitations on individual interpretation of the questionnaire. Although the questions in the questionnaire are adopted from earlier studies, in which the meanings had been tested, survey respondents may not fully understand the actual meaning attached to the questions. There is a slim chance that respondents do not understand the question's meaning and wrongly indicate answers.

The author is grateful to the Project Management Institute Hong Kong Chapter for granting the opportunity to invite fellow construction industry members to take the online survey. With many samples coming from the PMI (HK) members, the obtained results may have been closely linked to the views of PMI (HK) members working in the construction industry. The views of non-PMI (HK) members in the industry can be added in a subsequent study.

This study surveys construction project managers about their views on sustainability issues in developed projects. Client views, end-user positions and stakeholder positions are not considered. There are potential measurement risks on project implementation success under various sustainability impacts. Bias is likely due to the exclusion of opinions from clients, end-users and other stakeholders in the study.

There are four success criteria defining the meaning of project implementation success in the local construction industry. From the regression model, they represent 71.5% explanatory power. A significant proportion of total variance is unaccounted for implying that additional criterion to success could be missing from this study. It may be due to limited sample size. In the same vein, the two independent variables from economic and environmental sustainability impacts combined contribute 32.6% explanatory power of the model variance to project implementation success (dependent variable). Social sustainability impact criterion was found non-significant. It may also reflect the situation of missing criterion and that larger sample size in future studies may have identified more significant success criteria.

Specifically, a larger sample size will obtain a smaller probability of making a Type II error (meaning the error of implying not having relationship between independent and dependent variables but, in fact, they have relationship). There are 55 samples in this study which is comparably small in sample size. In this study, economic sustainability impact (Resources Saving (β = .478, $p < .05$)), and environmental sustainability impact (Supplier Know-How & Partnership (β = .294, $p < .05$)) are found significant, and that no social sustainability impact was found significant. For larger samples collected, the two marginal excluded social sustainability impact variables may be found significant to project implementation success: Health and Safety (t = 1.521, p = .135); Human Rights (t = 1.403, p = .167).

Regarding recruitment of e-Delphi experts, not all of them are based in Hong Kong. There are limitations on recruiting all e-Delphi experts locally because managing project sustainability is a new topic both in academic study and professional practices. There are about 30% of experts recruited who are familiar with Hong Kong construction industry. The rest of them are based in Europe, United States, Australia, South Africa, and Korea. Since not all e-Delphi experts are familiar with the Hong Kong construction industry, there is possibility that some of the local relevance (for example, impact of high land cost on economic sustainability) may not be fully aware of by all experts. Without such local knowledge, expert decision may not be of local relevance. Nevertheless, the findings obtained from mixed local and international experts bring in integrated global knowledge and experience into local construction industry.

This research is characterised by its sequential mixed method (QUAN-qual). From the quantitative analysis, a question for subsequent qualitative study is developed. The findings in the quantitative part of this research indicate that there is a lack of project sustainability maturity in local construction project organisations; that traditional success criteria for project implementation success are identified together with the criteria for driving success in economic and environmental sustainability; and that some success factors in respective sustainability dimensions are recognised to better manage sustainability impacts for project implementation success. Success criteria and success factors are having its specific function during project implementation (Collins and Baccarini, 2004; Dinsmore and Cooke-Davies, 2006). The findings are streamlined and do not in contradiction.

However, there are limitations in carrying out this QUAN-qual process. For example, there are only economic and environmental sustainability impacts found significant in the quantitative study (social sustainability impact found not significant). A larger sample size (e.g. more than 55 construction project managers in this study) collected in the survey may result in identifying social sustainability impact significant. As a result for complementary qualitative study, a different question may be developed. In this thesis, a subsequent e-Delphi qualitative research serves to complement earlier quantitative results, and understand further the degree of importance of social sustainability impact in managing project sustainability. The e-Delphi study results show that social sustainability impact is least important amongst the three sustainability dimensions. Therefore, the Part 1 (quantitative) and Part 2 (qualitative) results are not in contradiction. The e-Delphi study results show that environmental sustainability impact is most important. It provides opportunities to further study the impact of environmental sustainability in the author's upcoming research agenda.

7.6 Recommendations for Future Work

In terms of future research opportunities, there are at least two areas where this research study can be used as a baseline. First, the four constituent success criteria determined in this study for construction project implementation success can be used for the development of evaluation tools applicable to different project contexts (e.g., highway projects, building development, power plant construction, etc.). It can offer opportunities to refine the meaning of project implementation success under a different project context.

Second, the study presents opportunities to explore rationales behind social sustainability impact criterion not identified as significant in this study. Different research regimes can be used on certain projects (for example, action research). There are many research opportunities on this subject and should not be limited to those suggested. A project manager can evaluate new projects using knowledge obtained in this study to find the best alternative, as well as make project processes more responsive to current environmental, social and economic demands.

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Appendix A: Letter to PMI asking for assistance in survey

UREC Number: 1571

London South Bank
University

27 April 2016

PMI Hong Kong Chapter - VP Education
Dear [redacted]

I am a doctoral candidate in the School of Business at London South Bank University and I am conducting a study on project sustainability maturity level and sustainability impacts on project implementation success for projects in the construction industry of Hong Kong. The objective of this research project is to understand from project manager perspective about managing project sustainability activities in the local construction industry. Being a member of the Project Management Institute (PMI member ID # 778898), I am writing to the Hong Kong Chapter in the hope that PMI (HK) could facilitate my study by notifying the survey to fellow members. Your assistance would have made contributions to managing project sustainability activities in the construction industry of Hong Kong and promote the process of project management leading to building a sustainable society.

Enclosed with this letter is an information sheet about the project and a questionnaire that survey participants have to complete. Should PMI (HK) require to understand my background before making decision, I am most delighted to provide separately my CV which includes my publications in the field of project management. PMI (HK) could help by either posting a hyperlink of the study at the official website for taking the survey or granting me contact details accessible to members working in the construction industry such that I can invite them to participate.

As this emerging sustainability related study is becoming important in the project management academic and professional community, the outcome of this research would have made contributions to PMI development, influencing on PMBoK Guide development, for instance. I hope PMI (HK) would facilitate my survey. Please reply to indicate your decision and preference to the facilitation.

If you have any questions or concerns about this study, you may contact me by phone at (852) 6890 3328 or by email at tamc@lsbu.ac.uk. If you have any questions about your rights on facilitation to this study, you may contact my doctoral research supervisor Professor Shushma Patel by phone at +44 (0) 20 7815 7412, or by e-mail at shushma@lsbu.ac.uk. This study has already been approved by the University Research Ethics Committee on 15 April 2016.

Sincerely,

Gilman Tam

Appendix B: PMI (HK) Chapter e-mail to members supporting the survey

PMI Hong Kong Chapter <admin1@pmi.org.hk> 25 Jul
to me

Dear TAM, Chi Keung ,

PMI Hong Kong Chapter is supporting the captioned research project. Please see details.

Regards,

[redacted]
VP, Professional Practice
PMI Hong Kong Chapter

Invitation to participate in the Research Project: Managing Project Sustainability: A study of the construction industry in Hong Kong

My name is Gilman Tam, a doctoral candidate of London South Bank University in the UK. I am working on my thesis, which investigates project sustainability maturity level and sustainability impacts on project implementation success for projects in the construction industry of Hong Kong.

You are invited as suitable project professional for taking this survey. Your participation to this study is much appreciated. All data obtained will be via anonymous survey, used in aggregate form, and assured of confidentiality. If you choose to participate, please complete the questionnaire below and send it back to me online.

Please read the below message:
1. I have read the attached information sheet on the research. I have had the opportunity to consider details of participation into the survey.
2. I understand that my personal involvement and my particular data from this study will remain strictly confidential.
3. I have been informed about what the data collected will be used for, to whom it may be disclosed, and how long it will be retained.
4. I hereby fully and freely consent to participate in the study which has been fully explained to me.
5. I understand that I am free to withdraw from the study at any time, without giving a reason.

Instructions
Please refer to your last completed project and answer the following questions.There are four sections in this questionnaire. Section 1 measures the level of sustainability consideration on your last completed project; Section 2 refers to its degree of Project Implementation Success; Section 3 requests your opinions on economic, environmental and social sustainability impacts; and Section 4 asks about demographic information. Upon completion, please return the completed questionnaire by pressing the "Done" button located at the bottom of the web page. Thank you for taking the survey!
https://www.surveymonkey.com/r/ManagingProjectSustainability-PMI

To be removed from our mailing list, please click here.

Project Management Insti
Hong Kong Chapter

Appendix C: The Survey Instrument

(with Contents on Informed Consent in the Front Part)

London South Bank University

Managing Project Sustainability: A study of the construction industry in Hong Kong

1. Background

My name is Gilman Tam, a doctoral candidate of London South Bank University in the UK. I am working on my thesis, which investigates project sustainability maturity level and sustainability impacts on project implementation success for projects in the construction industry of Hong Kong. You are identified as suitable project professional for taking this survey. Your participation to this study is much appreciated. All data obtained will be via anonymous survey, used in aggregate form, and assured of confidentiality. If you choose to participate, please complete the questionnaire below and send it back to me online.

Please read the below message:

1. I have read the attached information sheet on the research. I have had the opportunity to consider details of participation into the survey.
2. I understand that my personal involvement and my particular data from this study will remain strictly confidential.
3. I have been informed about what the data collected will be used for, to whom it may be disclosed, and how long it will be retained.
4. I hereby fully and freely consent to participate in the study which has been fully explained to me.
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Instructions

Please refer to your last completed project and answer the following questions. There are four sections in this questionnaire. Section 1 measures the level of sustainability consideration on your last completed project; Section 2 refers to its degree of Project Implementation Success; Section 3 requests your opinions on economic, environmental and social sustainability impacts; and Section 4 asks about demographic information. Upon completion, please return the completed questionnaire by pressing the "Done" button located at the bottom of the web page. Thank you for taking the survey!

Managing Project Sustainability: A study of the construction industry in Hong Kong

2. Section 1

Adapted from Silvius *et al.* (2013) on degree of project sustainability maturity

Section 1 question relates to the level of sustainability consideration in your organisation on project development under the four levels **Project Sustainability Maturity Model**. At bottom level, sustainability is being considered through improved use of Business Resources; and that at a higher level of the maturity model, sustainability is being considered through improved Business Processes; Business Model or at the top level, Products/Services in the organisation are being innovative that contributes to a sustainable society. Please indicate in below question the extent you feel most representing the situation in your organisation.

1. What is the position of sustainability in your organisational strategy that commissions the project?

- ◯ The strategy of the organisation does not include any statements or ambitions regarding sustainability (*none*).
- ◯ The strategy of the organisation mentions a wise use of natural *resources* and/or social responsibility as one of the guiding principles.
- ◯ The strategy of the organisation mentions a wise use of natural *resources* and/or social responsibility as one of the guiding principles for the *(design of the) business processes* of the organisation.
- ◯ The strategy of the organisation mentions a wise use of natural *resources* and/or social responsibility as one of the guiding principles for the *(design of the) business processes and business model* of the organisation.
- ◯ The strategy of the organisation mentions a wise use of natural *resources* and/or social responsibility as one of the guiding principles for the *(design of the business processes, business model and development of) products and services* of the organisation.

Managing Project Sustainability: A study of the construction industry in Hong Kong

3. Section 2

Section 2 questions relate to your evaluation of the ultimate performance of the project in which you were involved.

2. Please indicate the extent to which you agree or disagree with the following statements as they relate to outcome of the project.

	Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
The project has come in on schedule.	○	○	○	○	○	○	○
The project has come in on budget	○	○	○	○	○	○	○
The project that has been developed works.	○	○	○	○	○	○	○
The project is used by its intended clients.	○	○	○	○	○	○	○
The project has directly benefited the intended users: either increase work efficiency or employee effectiveness.	○	○	○	○	○	○	○
Given the problem for which it was developed, the project seems to do the best job of solving that problem (i.e. it was the best choice among the set of alternatives).	○	○	○	○	○	○	○
Important clients, directly affected by the project, have made use of it.	○	○	○	○	○	○	○
I am satisfied with the process by which this project was completed.	○	○	○	○	○	○	○
We are confident that project non-technical start-up problems were minimal (because the project was readily accepted by its intended users).	○	○	○	○	○	○	○
Use of this project has directly led clients to more effective decision making or performance.	○	○	○	○	○	○	○
The project have positive impacts on clients who make use of it.	○	○	○	○	○	○	○
The results of this project represent a definite improvement in client's managerial performance.	○	○	○	○	○	○	○
All things considered, the project was a success.	○	○	○	○	○	○	○

Adapted from Pinto (1986) on project implementation success

Managing Project Sustainability: A study of the construction industry in Hong Kong

4. Section 3

Section 3 questions relate to your evaluation of last completed project on each sustainability dimension (economic, environmental and social). Please indicate the extent to which you agree or disagree with the following statements as they relate to respective sustainability impact on the project.

3. Economic Sustainability Impact

	Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
Direct (financial) benefits are recognised in the business case of project in terms of *cost savings or reduced use of resources.*							
Direct (financial) benefits are recognised in the business case of project in terms of *improved business processes.*							
Direct (financial) benefits are recognised in the business case of project in terms of *extra revenues from new business models for existing products and services.*							
Direct (financial) benefits are recognised in the business case of project in terms of *extra revenues from innovated products and services.*							
Projects are evaluated and selected predominantly based on a balanced set of quantitative and qualitative criteria that reflect both long term and short term perspectives and also *sustainability (economic, environmental and social) aspects.*							

Adapted from Silvius *et al.* (2013) on sustainability impacts as benefits to project

4. How important will be to implement following economic criteria to achieve a better project performance for sustainable development? Please indicate their degree of importance.

	Degree of Importance
Reduce resources consumption	
Resources reuse	
Energy savings	
Resource efficiency	
Energy efficiency	
Water efficiency	
Extraction efficiency	
Maximise efficiency of artificial light	
Efficiency during operation	
Use of appropriate technology	
Avoid damage to renewable resources	
Design systems for ease of maintenance and operation	
Maximise use of natural light	
Used water recycling system	

Adapted from Maldonado-Fortunet (2002) on degree of importance on factors identified

5. Environmental Sustainability Impact

	Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
Suppliers for the project are selected based on how *their know-how and partnership helps our product and services to aid sustainability.*							
Materials for the project are selected also based on the *energy consumption and/or pollution incorporated in the materials during their production and logistic processes.*							
Minimising energy consumption is one of the parameters in the design of the project deliverable and result.							
Minimising water consumption and pollution is one of the parameters in the design of the project deliverable and result.							
The project deliverable and result are designed to *minimise waste* and necessary waste is as much as possible recycled in the deliverable itself.							

Adapted from Silvius *et al.* (2013) on sustainability impacts as benefits to project

6. How important will be to implement following environmental criteria to achieve a better project performance for sustainable development? Please indicate their degree of importance.

	Degree of Importance
Use of rapidly renewable materials	
Use of renewable energy technologies	
Use of recycled materials	
Increase recycled content	
Protect on-site soil	
Re-use of top soils and rock materials	
Use vendors that have materials with recycled content	
Proper handling, storage and disposal of hazardous and toxic materials	
Select materials based on life-cycle assessment	
Minimise construction waste	
Waste reduction goals during construction	
Waste reduction goals during operation	
Specify materials appropriate for their location and use	
Green landscape retrofit techniques	
Increase durability	
Increase recyclability	

Adapted from Maldonado-Fortunet (2002) on degree of importance on factors identified

Reduce site disturbance	
Re-use of developed sites	
Ecosystem damage avoidance	
Solid waste avoidance	
Air pollution avoidance	
Water pollution avoidance	
Habitat destruction avoidance	
Avoid noise pollution	
Risk of air, water or land pollution	
Erosion and sedimentation control	
Protect on-site vegetation	
Promote biodiversity	
Strom water management	
Application of constructed artificial wetland wastewater treatment system	
Require procedures for the recycling, re-use and salvaged of construction waste	
Use of indigenous species, species diversity, wildlife habitats in plant selection	
Life support systems conservation	
Control of hazardous materials from construction site	

Adapted from Maldonado-Fortunet (2002) on degree of importance on factors identified

7. Social Sustainability Impact

	Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
The project's deliverable and result is designed to improve *labour practices and decent work* in the community in which the project result is used.	○	○	○	○	○	○	○
The project's deliverable and result is designed to improve *health and safety* conditions in the community in which the project result is used.	○	○	○	○	○	○	○
The project and its result include activities for the *development of the community* (e.g. training, education and development of stakeholders, etc.).	○	○	○	○	○	○	○
The project's deliverable and result are designed to improve *diversity and equal opportunity* (e.g. gender, race, religion, etc.) in the community	○	○	○	○	○	○	○
The project's deliverable and result are designed to respect and improve *human rights* (e.g. non-discrimination, freedom of association and no child labour, etc.) in the community.	○	○	○	○	○	○	○
The project actively designs its project deliverable and results in a way that *bribery and anti-competitive behaviour* is prevented in the community.	○	○	○	○	○	○	○

Adapted from Silvius *et al.* (2013) on sustainability impacts as benefits to project

8. How important will be to implement following social criteria to achieve a better project performance for sustainable development? Please indicate their degree of importance.

	Degree of Importance
Improve quality of human life	
Create healthy non-toxic environment	
Avoid historic and archeological disturbance	
Employment increase	
Use of innovative technique to increase safety	
Use materials made locally or regionally	
Consider means to transplant trees	
Visual impact	

Adapted from Maldonado-Fortunet (2002) on degree of importance on factors identified

Managing Project Sustainability: A study of the construction industry in Hong Kong

5. Section 4

Demographic information

9. What is your gender?

- ○ Male
- ○ Female

10. Are you certified practitioner in project management profession? (Mark all apply)

- ☐ PMP
- ☐ IPMA A, B, C, D
- ☐ PRINCE2
- ☐ No project management qualification
- ☐ Other (please specify)

11. How many years of project experience?

- ○ Less than 5 years
- ○ 5 years to less than 10 years
- ○ 10 years to less than 15 years
- ○ 15 years to less than 20 years
- ○ 20 years and more

12. Are you project manager for the project that you refer to in this survey? If 'No', please specify your role in the project that you refer to in this survey.

- Yes
- If 'No', please specify

13. Which industry are you working in?

- 1. Agriculture, fisheries, mining and quarrying
- 2. Manufacturing
- 3. Construction
- 4. Supply of electricity, gas and water
- 5. Education
- 6. Banking, financing and insurance
- 7. Accommodation and food services
- 8. Transportation, storage, postal and courier
- 9. Information and communications
- 10. Other professional and business services

Prev Done

Appendix D: Letter of Invitation – Survey (invitation by e-mail)

UREC Number: 1571

London South Bank University

Date: XXXX

Dear Project Manager,

I am a doctoral candidate in the School of Business at London South Bank University and I am conducting a study on project sustainability maturity level and sustainability impacts on project implementation success for projects in the construction industry of Hong Kong. The objective of this research project is to understand from project manager perspective about managing project sustainability activities in the construction industry. You are referred by colleague at the Project Management Institute (Hong Kong Chapter). Your participation into this survey would have made contributions to the industry leading to building a sustainable society.

Enclosed with this email invitation is an information sheet explaining details of this study and a questionnaire that asks a variety of questions about your attitudes relating to managing project sustainability activities in your last completed project. Please read the information sheet and look over the questionnaire. If you choose to participate, please complete the questionnaire and send it back to me either via email or click the hyperlink in the questionnaire to respond online.

I would assure you that your responses will not be identified with you personally, nor will anyone else be able to determine your responses. This is an independent study without sponsorship from any company in the industry and that the study is purely for academic purposes. Nothing you say on the questionnaire will in any way influence your present or future employment with your company.

I hope you will take 15 to 20 minutes to complete this questionnaire. Without the help of people like you, research on managing project sustainability activities in the construction industry of Hong Kong could not be conducted. Your participation is voluntary and there is no penalty if you do not participate.

If you have any questions or concerns about completing the questionnaire or about participating in this study, you may contact me at tamc@lsbu.ac.uk. If you have any questions about your rights as a research participant, you may contact my doctoral research supervisor Professor Shushma Patel by phone at +44 (0) 20 7815 7412, or by e-mail at shushma@lsbu.ac.uk. This study has already been approved by the University Research Ethics Committee on 15 April 2016.

Sincerely,

Gilman Tam

Appendix E: Information Sheet – Survey

UREC Number: 1571

London South Bank
University

Managing Project Sustainability: A study of the construction industry in Hong Kong

Survey Information Sheet

Researcher (DBA Candidate)

Gilman C. K. Tam

School of Business

Telephone: (852) 6890 3328 and e-mail address: tamc@lsbu.ac.uk

Research Supervisor

Professor Shushma Patel

School of Business

Telephone: +44 (0) 20 7815 7412 and e-mail address: shushma@lsbu.ac.uk

- You are being asked to participate in a research study. Please answer ALL questions in the questionnaire. The purpose of this research is to identify level of project sustainability maturity of your last completed project and sustainability impacts on project implementation success for projects in the construction industry of Hong Kong.

- You are eligible to participate in this study if you are working on construction projects in Hong Kong whether in the capacity of project manager or other managerial position; taking the role as sponsor, consulting, contracting, or other service provider.

- The research procedures involve answering the questionnaire subsequent to reading this survey information sheet. Please return the completed questionnaire within two weeks of this invitation.

- It takes about 20 minutes to complete. If you are taking the online version of this survey, please submit electronically after completing the survey by pressing the "Submit" button. If you prefer to reply the completed questionnaire by email, please send it to the sender at tamc@lsbu.ac.uk.

- There are no direct benefits from participation in the study. However, this study may explain the nature of project sustainability maturity level and sustainability impacts on project implementation success which helps the advancement of project management in local construction industry and building a sustainable society.

- You will not be compensated for your participation in this research study. You are free to withdraw from this study at any time without penalty. Please send an email to the researcher (include submission date and time of your completed questionnaire) to ask for withdrawal.

- All research data collected will be stored securely and confidentially. Research results will be published based on analysis of all research data collected and that individual data will not be disclosed. No part of published results is making reference to individual sample to maintain anonymity and confidentiality. Data collected in physical form will be securely locked in filing cabinet and that soft data is stored in USB key with password protected. Relevant code of practice from the London South Bank University and *Ethics Guide 2015: Advice and Guidance* offered by the Chartered Association of Business Schools in the UK apply. The USB key will be kept locked in a safety box located at the researcher's home. The researcher will destroy all data five years after graduation.

- If you have any comments, concerns, or questions regarding the conduct of this research please contact the researcher listed at the top of this form. If you have concerns or complaints about the research; or have questions about your rights as a research participant, please contact my research supervisor listed at the top of this form. Finally, if you remain unhappy and wish to complain formally, you can contact the Chair of the University Research Ethics Committee. Details can be obtained from the university website: https://my.lsbu.ac.uk/page/research-degrees-ethics

Definition

Project Implementation Success: For purpose of this study, project implementation success is defined as that the project, upon completion, will meet the requirements of cost, time, quality, safety and other intended purposes (Pinto, 1986).

Economic Sustainability: It is defined as increasing profitability through efficient use of resources (human, materials, financial), effective design and good management, planning and control (Abidin and Pasquire, 2007).

Environmental Sustainability: It is defined as preventing harmful and irreversible effects on the environment by efficient use of natural resources, encouraging renewable resources, protecting the soil, water, air from contaminations and others (Abidin and Pasquire, 2007).

Social Sustainability: It is defined as responding to the needs of society including users, neighbours, community, workers and other project stakeholders (Abidin and Pasquire, 2007).

Project Sustainability Maturity Model: The model incorporates four levels of sustainability maturity with business resources at the lowest and then higher level of maturity are business processes, business model and then products/services at the top on which different aspects of sustainability are considered in the project (Silvius *et al*., 2013).

Participation in this study is voluntary. There is no cost to you for participating. You may refuse to participate or discontinue your involvement at any time without penalty. You are free to withdraw from this study at any time.

This survey information sheet is for you to keep. Wishing that the above have adequately addressed your concerns and that you agree to participate in this survey study.

Appendix F: SPSS output on success criteria and project implementation success

Variables Entered/Removed[a]

Mode	Variables Entered	Variables Removed	Method
1	Client Use	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
2	Improve Managerial Performance	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
3	Positive Impact on Client	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
4	Project within Budget	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).

a. Dependent Variable: Project Implementation Success

ANOVA[e]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	20.190	1	20.190	43.609	.000[a]
	Residual	24.537	53	.463		
	Total	44.727	54			
2	Regression	26.625	2	13.312	38.240	.000[b]
	Residual	18.102	52	.348		
	Total	44.727	54			
3	Regression	30.283	3	10.094	35.640	.000[c]
	Residual	14.445	51	.283		
	Total	44.727	54			
4	Regression	31.993	4	7.998	31.405	.000[d]
	Residual	12.734	50	.255		
	Total	44.727	54			

a. Predictors: (Constant), Client Use
b. Predictors: (Constant), Client Use, Improve Managerial Performance
c. Predictors: (Constant), Client Use, Improve Managerial Performance, Positive Impact on Client
d. Predictors: (Constant), Client Use, Improve Managerial Performance, Positive Impact on Client, Project within Budget
e. Dependent Variable: Project Implementation Success

Model Summary[e]

Mode	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.672[a]	.451	.441	.680

2	.772[b]	.595	.580	.590
3	.823[c]	.677	.658	.532
4	.846[d]	.715	.693	.505

a. Predictors: (Constant), Client Use
b. Predictors: (Constant), Client Use, Improve Managerial Performance
c. Predictors: (Constant), Client Use, Improve Managerial Performance, Positive Impact on Client
d. Predictors: (Constant), Client Use, Improve Managerial Performance, Positive Impact on Client, Project within Budget
e. Dependent Variable: Project Implementation Success

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	2.012	.556		3.617	.001		
	Client Use	.615	.093	.672	6.604	.000	1.000	1.000
2	(Constant)	1.052	.532		1.979	.053		
	Client Use	.431	.091	.470	4.707	.000	.780	1.282
	Improve Managerial Performance	.407	.095	.430	4.299	.000	.780	1.282
3	(Constant)	.272	.526		.516	.608		
	Client Use	.310	.089	.338	3.479	.001	.669	1.495
	Improve Managerial Performance	.320	.089	.338	3.608	.001	.722	1.385
	Positive Impact on Client	.337	.094	.345	3.594	.001	.688	1.454
4	(Constant)	.089	.504		.177	.861		
	Client Use	.296	.085	.324	3.503	.001	.666	1.501
	Improve Managerial Performance	.336	.084	.355	3.983	.000	.718	1.392
	Positive Impact on Client	.273	.092	.280	2.963	.005	.639	1.565
	Project within Budget	.111	.043	.207	2.592	.012	.895	1.118

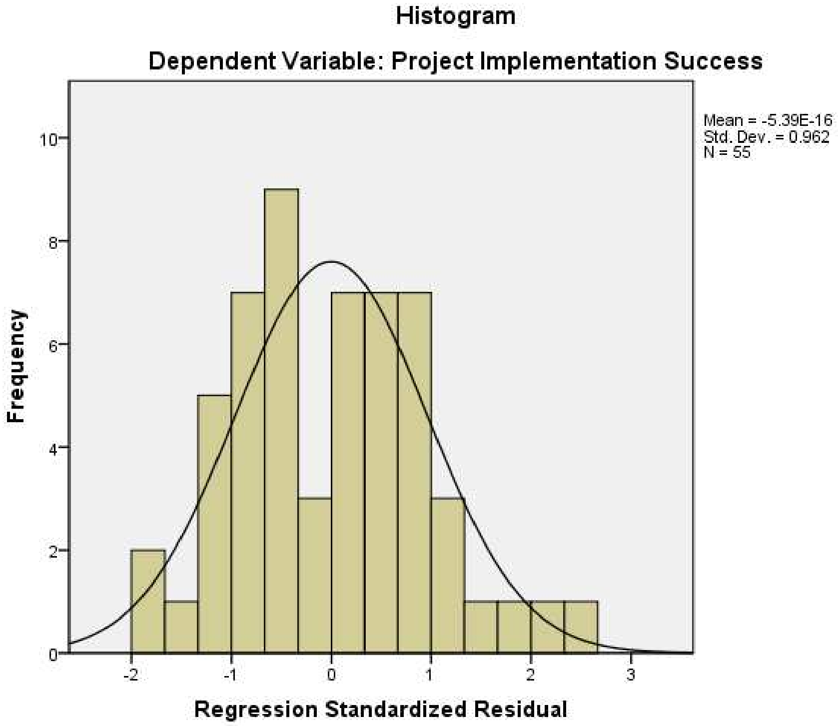
a. Dependent Variable: Project Implementation Success

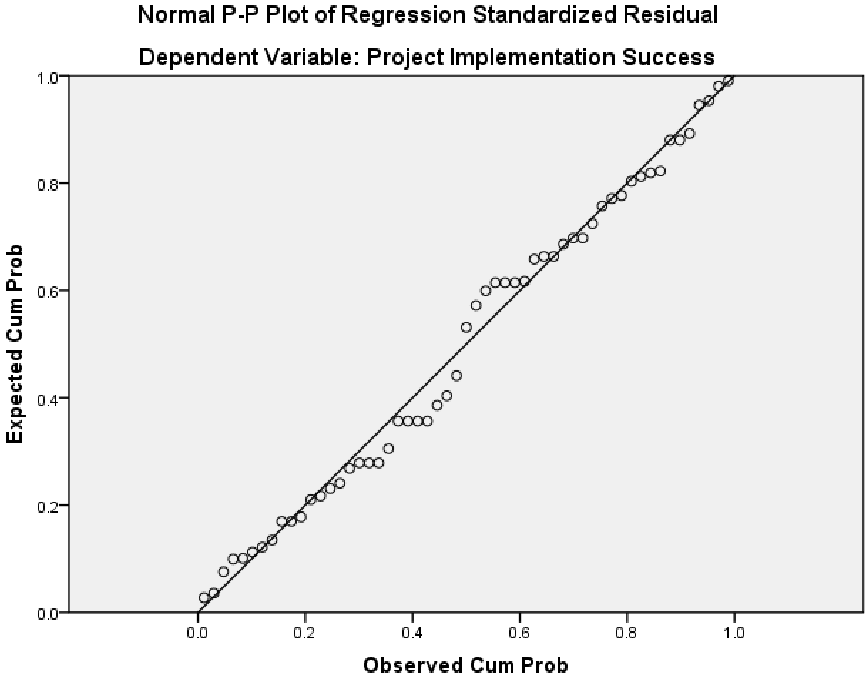
Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	2.39	6.76	5.64	.770	55

Residual	-.968	1.188	.000	.486	55
Std. Predicted Value	-4.212	1.453	.000	1.000	55
Std. Residual	-1.918	2.354	.000	.962	55

a. Dependent Variable: Project Implementation Success





Excluded Variables[e]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics		
						Tolerance	VIF	Minimum Tolerance
1	Project on Schedule	.186[a]	1.840	.072	.247	.972	1.028	.972
	Project within Budget	.271[a]	2.769	.008	.358	.963	1.039	.963
	Project Developed Work	.170[a]	1.677	.099	.227	.974	1.027	.974
	Benefit Efficiency and Effectiveness	.197[a]	1.851	.070	.249	.875	1.143	.875
	Project to Solve Problem	.161[a]	1.428	.159	.194	.797	1.255	.797
	Important Client to Use Project Result	.114[a]	.993	.325	.136	.778	1.285	.778
	Project Process	.272[a]	2.559	.013	.334	.827	1.209	.827
	Minimal Start-up Problem	.188[a]	1.892	.064	.254	.995	1.006	.995
	Better Decision Making or Performance	.277[a]	2.511	.015	.329	.772	1.295	.772
	Positive Impact on Client	.439[a]	4.286	.000	.511	.743	1.346	.743
	Improve Managerial Performance	.430[a]	4.299	.000	.512	.780	1.282	.780
2	Project on Schedule	.193[b]	2.241	.029	.299	.972	1.029	.761
	Project within Budget	.270[b]	3.267	.002	.416	.963	1.039	.757
	Project Developed Work	.184[b]	2.122	.039	.285	.973	1.028	.760
	Benefit Efficiency and Effectiveness	.044[b]	.430	.669	.060	.740	1.351	.659
	Project to Solve Problem	.057[b]	.554	.582	.077	.745	1.342	.700
	Important Client to Use Project Result	.034[b]	.333	.740	.047	.750	1.333	.677
	Project Process	.115[b]	1.071	.289	.148	.675	1.481	.637
	Minimal Start-up Problem	.066[b]	.701	.486	.098	.879	1.138	.689
	Better Decision Making or Performance	.061[b]	.506	.615	.071	.545	1.836	.545
	Positive Impact on Client	.345[b]	3.594	.001	.450	.688	1.454	.669
3	Project on Schedule	.141[c]	1.746	.087	.240	.933	1.071	.661
	Project within Budget	.207[c]	2.592	.012	.344	.895	1.118	.639
	Project Developed Work	.131[c]	1.614	.113	.223	.934	1.071	.660
	Benefit Efficiency and Effectiveness	-.030[c]	-.315	.754	-.044	.704	1.420	.639

	Project to Solve Problem	-.064[c]	-.646	.521	-.091	.658	1.519	.607
	Important Client to Use Project Result	-.014[c]	-.146	.884	-.021	.735	1.361	.610
	Project Process	.073[c]	.740	.463	.104	.665	1.504	.611
	Minimal Start-up Problem	.017[c]	.191	.849	.027	.855	1.170	.653
	Better Decision Making or Performance	.018[c]	.160	.874	.023	.538	1.860	.533
4	Project on Schedule	.006[d]	.060	.952	.009	.503	1.990	.482
	Project Developed Work	.045[d]	.509	.613	.073	.725	1.379	.635
	Benefit Efficiency and Effectiveness	-.006[d]	-.070	.945	-.010	.697	1.435	.603
	Project to Solve Problem	-.091[d]	-.967	.338	-.137	.651	1.537	.578
	Important Client to Use Project Result	.027[d]	.295	.769	.042	.713	1.403	.603
	Project Process	-.002[d]	-.017	.987	-.002	.601	1.663	.588
	Minimal Start-up Problem	-.078[d]	-.880	.383	-.125	.724	1.382	.633
	Better Decision Making or Performance	.010[d]	.098	.923	.014	.537	1.861	.530

a. Predictors in the Model: (Constant), Client Use
b. Predictors in the Model: (Constant), Client Use, Improve Managerial Performance
c. Predictors in the Model: (Constant), Client Use, Improve Managerial Performance, Positive Impact on Client
d. Predictors in the Model: (Constant), Client Use, Improve Managerial Performance, Positive Impact on Client, Project within Budget
e. Dependent Variable: Project Implementation Success

Appendix G: SPSS output on sustainability impacts and project implementation success

Descriptive Statistics

	Mean	Std. Deviation	N
Project Implementation Success	5.64	.910	55
Resources Saving	5.65	1.250	55
Business Processes Improvement	5.20	.890	55
Balanced Quantitative and Qualitative Criteria	4.87	1.306	55
Suppliers Know-how & Partnership	5.04	1.347	55
Pollution/Energy Consumption in Materials Production	4.49	1.574	55
Energy Consumption Minimisation	5.56	1.085	55
Water Consumption/Pollution Minimisation	5.33	1.203	55
Waste Minimisation	5.15	1.353	55
Labour Practices	4.85	1.325	55
Health and Safety	5.49	1.230	55
Community Development	5.11	1.197	55
Diversity and Equal Opportunity	4.53	1.331	55
Human Rights	4.60	1.328	55
Bribery and Anti-Competitive Behaviour	5.64	1.192	55

Variables Entered/Removed[a]

Mode	Variables Entered	Variables Removed	Method
1	Resources Saving	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
2	Suppliers Know-how & Partnership	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).

a. Dependent Variable: Project Implementation Success

Model Summary[c]

Mode	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.490[a]	.240	.225	.801
2	.571[b]	.326	.300	.761

a. Predictors: (Constant), Resources Saving
b. Predictors: (Constant), Resources Saving, Suppliers Know-how & Partnership
c. Dependent Variable: Project Implementation Success

ANOVA[c]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	10.724	1	10.724	16.714	.000[a]
	Residual	34.004	53	.642		
	Total	44.727	54			
2	Regression	14.578	2	7.289	12.572	.000[b]
	Residual	30.149	52	.580		
	Total	44.727	54			

a. Predictors: (Constant), Resources Saving
b. Predictors: (Constant), Resources Saving, Suppliers Know-how & Partnership
c. Dependent Variable: Project Implementation Success

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	3.621	.505		7.177	.000		
	Resources Saving	.356	.087	.490	4.088	.000	1.000	1.000
2	(Constant)	2.670	.605		4.413	.000		
	Resources Saving	.348	.083	.478	4.192	.000	.998	1.002
	Suppliers Know-how & Partnership	.199	.077	.294	2.578	.013	.998	1.002

a. Dependent Variable: Project Implementation Success

Excluded Variables[c]

Model	Beta	t	Sig.	Partial	Collinearity Statistics

		In			Correlation	Tolerance	VIF	Minimum Tolerance
1	Business Processes Improvement	-.037[a]	-.272	.786	-.038	.770	1.298	.770
	Balanced Quantitative and Qualitative Criteria	.055[a]	.457	.650	.063	.999	1.001	.999
	Suppliers Know-how & Partnership	.294[a]	2.578	.013	.337	.998	1.002	.998
	Pollution/Energy Consumption in Materials Production	.031[a]	.252	.802	.035	.986	1.014	.986
	Energy Consumption Minimisation	-.052[a]	-.431	.669	-.060	.994	1.006	.994
	Water Consumption/Pollution Minimisation	-.052[a]	-.426	.672	-.059	.992	1.008	.992
	Waste Minimisation	.056[a]	.449	.655	.062	.948	1.054	.948
	Labour Practices	.195[a]	1.658	.103	.224	1.000	1.000	1.000
	Health and Safety	.227[a]	1.941	.058	.260	1.000	1.000	1.000
	Community Development	.177[a]	1.487	.143	.202	.990	1.010	.990
	Diversity and Equal Opportunity	.083[a]	.687	.495	.095	.996	1.005	.996
	Human Rights	.258[a]	2.224	.031	.295	.993	1.007	.993
	Bribery and Anti-Competitive Behaviour	.095[a]	.778	.440	.107	.977	1.023	.977
2	Business Processes Improvement	-.076[b]	-.577	.567	-.081	.761	1.314	.761
	Balanced Quantitative and Qualitative Criteria	.067[b]	.585	.561	.082	.997	1.003	.997
	Pollution/Energy Consumption in Materials Production	-.047[b]	-.391	.697	-.055	.923	1.083	.923
	Energy Consumption Minimisation	-.066[b]	-.572	.570	-.080	.992	1.008	.992
	Water Consumption/Pollution Minimisation	-.102[b]	-.877	.385	-.122	.966	1.035	.966
	Waste Minimisation	-.058[b]	-.461	.647	-.064	.830	1.205	.830
	Labour Practices	.137[b]	1.177	.245	.163	.950	1.052	.949
	Health and Safety	.175[b]	1.521	.135	.208	.959	1.042	.958
	Community Development	.137[b]	1.193	.238	.165	.970	1.031	.970

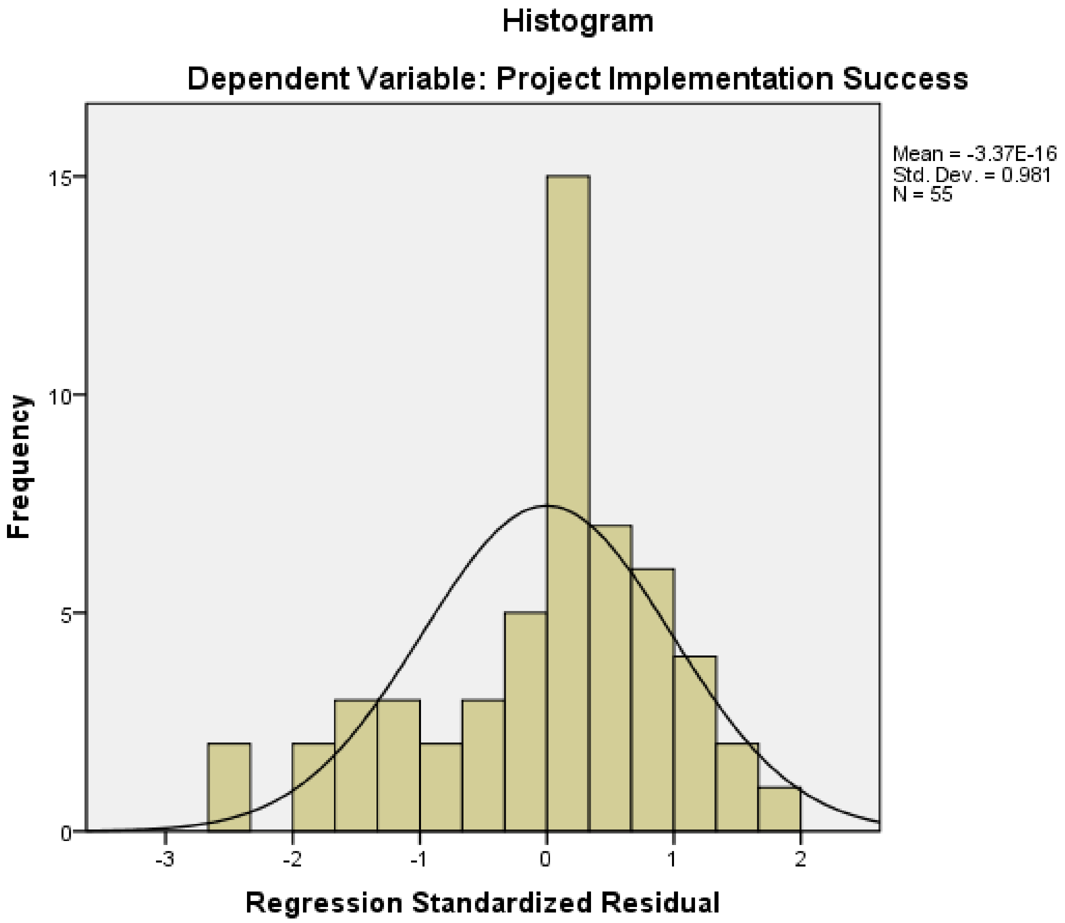
	Diversity and Equal Opportunity	.002[b]	.014	.989	.002	.919	1.088	.919
	Human Rights	.171[b]	1.403	.167	.193	.853	1.173	.853
	Bribery and Anti-Competitive Behaviour	.050[b]	.426	.672	.060	.954	1.048	.954

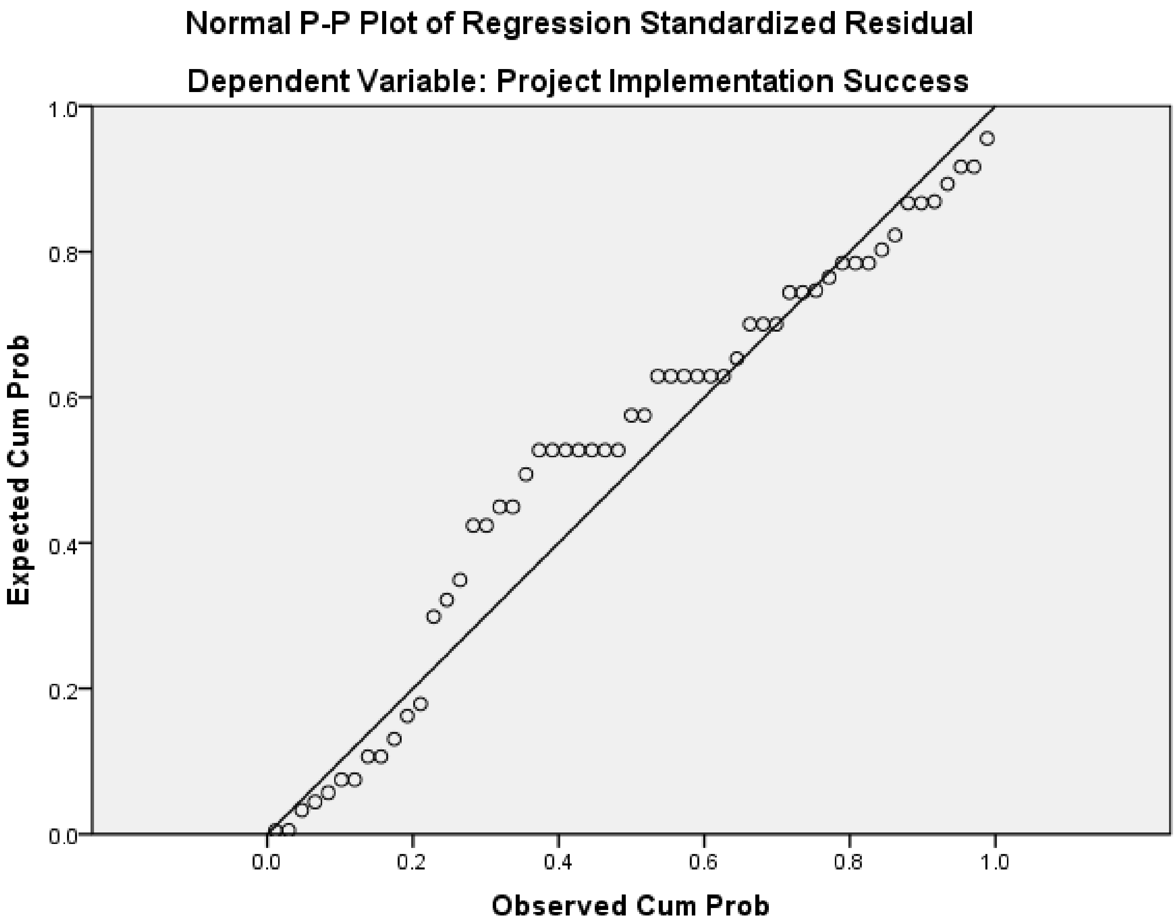
a. Predictors in the Model: (Constant), Resources Saving
b. Predictors in the Model: (Constant), Resources Saving, Suppliers Know-how & Partnership
c. Dependent Variable: Project Implementation Success

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	3.96	6.49	5.64	.520	55
Residual	-1.961	1.294	.000	.747	55
Std. Predicted Value	-3.224	1.651	.000	1.000	55
Std. Residual	-2.576	1.699	.000	.981	55

a. Dependent Variable: Project Implementation Success




Normal P-P Plot of Regression Standardized Residual
Dependent Variable: Project Implementation Success
Expected Cum Prob
Observed Cum Prob
0.0
0.2
0.4
0.6
0.8
1.0

Appendix H: SPSS output on excluded variables of sustainability impacts and Improve Managerial Performance

Excluded Variables[c]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics		
						Tolerance	VIF	Minimum Tolerance
1	Business Processes Improvement	-.022[a]	-.144	.886	-.020	.770	1.298	.770
	Balanced Quantitative and Qualitative Criteria	-.019[a]	-.146	.884	-.020	.999	1.001	.999
	Suppliers Know-how and Partnership	.145[a]	1.102	.275	.151	.998	1.002	.998
	Pollution/Energy Consumption in Materials Production	-.052[a]	-.388	.699	-.054	.986	1.014	.986
	Energy Consumption Minimisation	-.114[a]	-.863	.392	-.119	.994	1.006	.994
	Water Consumption/Pollution Minimisation	-.295[a]	-2.321	.024	-.306	.992	1.008	.992
	Waste Minimisation	-.043[a]	-.318	.752	-.044	.948	1.054	.948
	Labour Practices	.170[a]	1.299	.200	.177	1.000	1.000	1.000
	Health and Safety	.156[a]	1.188	.240	.163	1.000	1.000	1.000
	Community Development	.016[a]	.121	.904	.017	.990	1.010	.990
	Diversity and Equal Opportunity	.125[a]	.948	.347	.130	.996	1.005	.996
	Human Rights	.197[a]	1.510	.137	.205	.993	1.007	.993
	Bribery and Anti-competitive Behaviour	-.082[a]	-.611	.544	-.084	.977	1.023	.977

2	Business Processes Improvement	-.009[b]	-.062	.951	-.009	.769	1.300	.768
	Balanced Quantitative and Qualitative Criteria	.074[b]	.557	.580	.078	.911	1.098	.905
	Suppliers Know-how and Partnership	.197[b]	1.560	.125	.213	.972	1.028	.966
	Pollution/Energy Consumption in Materials Production	.082[b]	.588	.559	.082	.822	1.217	.822
	Energy Consumption Minimisation	.264[b]	1.357	.181	.187	.415	2.407	.415
	Waste Minimisation	.346[b]	1.921	.060	.260	.469	2.133	.469
	Labour Practices	.194[b]	1.552	.127	.212	.993	1.007	.986
	Health and Safety	.210[b]	1.665	.102	.227	.973	1.028	.965
	Community Development	.096[b]	.730	.468	.102	.928	1.078	.928
	Diversity and Equal Opportunity	.214[b]	1.664	.102	.227	.930	1.075	.927
	Human Rights	.211[b]	1.688	.098	.230	.991	1.009	.984
	Bribery and Anti-competitive Behaviour	-.034[b]	-.260	.796	-.036	.951	1.051	.951

a. Predictors in the Model: (Constant), Resources Saving

b. Predictors in the Model: (Constant), Resources Saving, Water Consumption/Pollution Minimisation

c. Dependent Variable: Improve Managerial Performance

Appendix I: Letter of Invitation – e-Delphi

UREC Number: 1571

London South Bank
University

Date: XXXX

Dear Dr. XXX,

I am a doctoral candidate in the School of Business at London South Bank University and I am conducting a study on project sustainability maturity level and sustainability impacts on project implementation success. The objective of this research project is to understand from project manager perspective on managing project sustainability activities in the Hong Kong construction industry. To complement the quantitative results obtained earlier from survey in the local construction industry, an e-Delphi study is proposed inviting local and international experts in the field of managing project sustainability to offer their expert views such that wider scope of experience and insights can be introduced to local project managers. As an expert in the field, you are referred by colleague at the Project Management Institute (Hong Kong Chapter). Your participation into this e-Delphi expert panel would have made contributions to managing project sustainability not only to construction environment in Hong Kong but leading to building a sustainable society.

Enclosed with this email invitation is an information sheet explaining details of this e-Delphi study. Please read the information sheet. If you choose to participate, please sign the informed consent form and send it back to me via email. Upon receipt of your signed informed consent form, I will circulate the questionnaire to you. It may take several rounds of information exchange. In each round of questionnaire, I will collect responses from each member of the e-Delphi expert panel for analysis. Results will be communicated back to you.

I would assure you that your responses will not be identified with you personally, nor will anyone else be able to determine your responses. This is an independent study without sponsorship from any company in the industry and that the study is purely for academic purposes. Nothing you say on the questionnaire will in any way influence your present or future employment with your company or academic institution.

I hope you will participate in this e-Delphi study. Without the help of people like you, research on managing project sustainability activities could not be conducted. Your participation is voluntary and there is no penalty if you do not participate.

If you have any questions or concerns about completing the questionnaire or about participating in this study, you may contact me at tamc@lsbu.ac.uk. If you have any questions about your rights as a research participant, you may contact my doctoral research supervisor Professor Shushma Patel by phone at +44 (0) 20 7815 7412, or by e-mail at shushma@lsbu.ac.uk. This study has already been approved by the University Research Ethics Committee on 15 April 2016.

Sincerely,

GilmanTam

Appendix J: Information Sheet – e-Delphi

UREC Number: 1571

London South Bank University

Managing Project Sustainability: A study of the construction industry in Hong Kong

e-Delphi Information Sheet

Researcher (DBA Candidate)

Gilman C. K. Tam

School of Business

Telephone: (852) 6890 3328 and e-mail address: tamc@lsbu.ac.uk

Research Supervisor

Professor Shushma Patel

School of Business

Telephone: +44 (0) 20 7815 7412 and e-mail address: shushma@lsbu.ac.uk

- As an expert in the field of managing project sustainability, you are invited to join the e-Delphi expert panel in a research study. Please answer ALL questions in the questionnaire. The purpose of this research is to complement and triangulate the quantitative study taken earlier on level of project sustainability maturity and sustainability impacts on project implementation success for projects in the construction industry of Hong Kong.

- You are eligible to join the e-Delphi expert panel because of your academic and professional background. The informant has to meet two out of three of the following selection criteria to be qualified to join the e-Delphi expert panel. They are: 1) project management professional or academic with peer reviewed publications in sustainability (book, edited book chapter or journal, etc.); 2) construction project manager with extensive experience in managing sustainability activities in Hong Kong and/or overseas; and 3) at least five years recent experience in researching, teaching or practicing sustainability in project management.

- The research procedures involve answering the questionnaire subsequent to reading this information sheet. Please return the completed questionnaire within two weeks of each round of information exchange.

- There may be several rounds of information exchange. In each round of questionnaire, it takes no more than 15 minutes to complete. Please send the completed questionnaire back to sender via email at tamc@lsbu.ac.uk. Information collected will be processed to prepare for subsequent round of questionnaire, if any. The research process ends once 70% consensus on each question has been obtained from members of the e-Delphi expert panel.

- There are no direct benefits from participation in the study. However, this study may explain the nature of project sustainability maturity level and sustainability impacts on project implementation success which helps the advancement of project management in local construction industry and building a sustainable society.

- You will not be compensated for your participation in this research study. You are free to withdraw from this study at any time without penalty.

- All research data collected will be stored securely and confidentially. Research results will be published based on analysis of all research data collected and that individual data will not be disclosed. No part of published results is making reference to individual response to maintain anonymity and confidentiality. Data collected in physical form will be securely locked in filing cabinet and that soft data is stored in USB key with password protected. Relevant code of practice from London South Bank University and *Ethics Guide 2015: Advice and Guidance* offered by the Chartered Association of Business Schools in the UK apply. The USB key will be kept locked in a safety box located at the researcher's home. The researcher will destroy all data five years after graduation.

- If you have any comments, concerns, or questions regarding the conduct of this research please contact the researcher listed at the top of this form. If you have concerns or complaints about the research; or have questions about your rights as a research participant, please contact my research supervisor listed at the top of this form. Finally, if you remain unhappy and wish to complain formally, you can contact the Chair of the University Research Ethics Committee. Details can be obtained from the university website: https://my.lsbu.ac.uk/page/research-degrees-ethics

Definition

e-Delphi Expert Panel: The panel consists of 12 academics or professionals who are experts in managing project sustainability. Through a multi-staged information exchange among the panel experts, consensus on important issues can be arrived at attempting to complement and triangulate earlier quantitative study on the subject.

Project Implementation Success: For purpose of this study, project implementation success is defined as that the project, upon completion, will meet the requirements of cost, time, quality, safety and other intended purposes (Pinto, 1986).

Economic Sustainability: It is defined as increasing profitability through efficient use of resources (human, materials, financial), effective design and good management, planning and control (Abidin and Pasquire, 2007).

Environmental Sustainability: It is defined as preventing harmful and irreversible effects on the environment by efficient use of natural resources, encouraging renewable resources, protecting the soil, water, air from contaminations and others (Abidin and Pasquire, 2007).

Social Sustainability: It is defined as responding to the needs of society including users, neighbours, community, workers and other project stakeholders (Abidin and Pasquire, 2007).

Participation in this study is voluntary. There is no cost to you for participating. You may refuse to participate or discontinue your involvement at any time without penalty. You are free to withdraw from this study at any time.

This e-Delphi information sheet is for you to keep. Wishing that the above have adequately addressed your concerns and that you agree to participate in this e-Delphi study.

Appendix K: Informed Consent Form – e-Delphi

UREC Number: 1571

Managing Project Sustainability: A study of the construction industry in Hong Kong

Consent for Participation in e-Delphi Study

Please read the below message and tick box:

- ☐ I understand that the project is designed to gather information about academic work on managing project sustainability. I will be one of 12 experts being recruited for this research.
- ☐ I understand that I will not be paid for my participation. I may withdraw and discontinue participation at any time without penalty.
- ☐ Participation involves answering questionnaire. There may be more than two rounds of information exchange. I will be approached repeatedly. I understand that no audio or video tape recording is required for this study.
- ☐ I understand that the researcher will not identify me by name in any reports, and that my confidentiality as an expert participant in this study will remain secure. Subsequent uses of records and data will be subject to standard data use policies which protect the anonymity and confidentiality of individuals and institutions.
- ☐ I understand that this research study has been reviewed and approved by the London South Bank University Research Ethics Committee for studies involving human subjects.
- ☐ I have read and understand the contents in the information sheet provided to me. I have the opportunity to raise questions about the study and the researcher has answered to my satisfaction.
- ☐ I voluntarily agree to participate in this study.

____

My Printed Name   My Signature with Date

Appendix L: Background information of e-Delphi participants

Respondent	Background
A	Respondent A has presented at numerous international conferences on project management (PM) and sustainability, quality, and PM career development. He has authored or co-authored books that introduce cutting-edge green techniques and methods, teach project managers how to maximise resources and get the most out of limited budgets, provide proven techniques and best practices in green project management including risk and opportunity assessments.
B	Respondent B is an expert who chairs sustainable development commission of an international association, and chairs the advisory committee of a local university on energy and environment education. He has a PhD with much experience in undertaking and implementing Environmental Impact Assessments. He has assisted in drafting the newly released GRI G4 Guideline.
C	Respondent C is a professor of project management. He has been active in EURAM (European Academy of Management) with interest in research methods and research practices. He has built up an outreach group that links university research to industry, and has gained experience in directing a large engineering operation delivering projects around the world.
D	Respondent D is an active researcher and is currently conducting research on sustainability and project management at a university. His focus is on how sustainability is incorporated in project management discourse and practice by studying: how the profession makes sense of sustainability, and also sustainability in practice.
E	Respondent E is an experienced lecturer, researcher and consultant, with a focus on project management, sustainability and information management. With background in organisational change and IT projects, he published many academic papers and books. He is now active as an independent researcher and lecturer on green project management at several universities.
F	Respondent F is extremely knowledgeable on various aspects of sustainable design in the construction industry. He has worked in both engineering and architectural fields, and is particularly skillful with interdisciplinary design collaboration for sustainable innovation. His recent projects in consultancy is on drafting design and construction requirements for residential buildings with energy efficiency.
G	Respondent G is with background in transparent project leadership and sustainable project management. He is a chief engineer and is interested in the field of managing project sustainability and has participated in the IPMA Research Conference held in Reykjavik, Iceland on “Project Management and Sustainability”.
H	Respondent H is a professor of engineering project management. His research interest is focused on engineering construction and project management, and he has written several articles and books in these research areas, including the sustainability of project ecosystem applicable to sustainable performance in engineering project management.
I	Respondent I is a senior member of the International Project Management Association (IPMA). With his background in engineering and project management, He is very active for many years, as visiting professor, lecturer

	and researcher with particular interest in sustainability and project management education and training.
J	Respondent J is a project management consultant. He has a profound knowledge in classical Chinese concepts derived from the observation of nature and interactions between man and the environment that links to sustainability with modern systemic and processor-oriented approaches in management consulting. He has made several presentations in IPMA research conferences.
K	Respondent K is an independent international consultant in strategy and project management. She is a PMP and has extensive experience in international cooperation and sustainable development programmes, specialising in programme and project strategy, design and planning, and organisational project management. Her research focus is on the emergence of project sustainable development strategy in the context of corporate sustainability strategy.
L	Respondent L is a professor and course director of a European master programme in project management. He has presented a number of papers on project manager competence in sustainability at international conferences on project management and engineering to describe the evolution of the project management standards as regards to the consideration of sustainability and social responsiveness.

Appendix M: e-Delphi Questionnaire (First Round)

UREC Number: 1571

Managing Project Sustainability: A study of the construction industry in Hong Kong

First Round Discussion

Instructions

Please answer the following open type question. It takes about 15 minutes to complete.
Please send the completed questionnaire back to sender via email at tamc@lsbu.ac.uk.
Thank you for your participation in this research study.

Question

Earlier quantitative study on project managers in the construction industry of Hong Kong shows that no social sustainability impact success criterion was identified significant impacting on project implementation success. Taking a three pillars approach in the field of project management, **"Is there any difference in terms of degree of importance on respective Economic Sustainability Impact, Environmental Sustainability Impact and Social Sustainability Impact impacting on project implementation success of construction project?"** Please explain your view in general (not necessarily for situation in Hong Kong).

Your Response:	

Appendix N: e-Delphi Questionnaire (Second Round)

UREC Number: 1571

Managing Project Sustainability: A study of the construction industry in Hong Kong

Second Round Discussion

Instructions

Please answer the following question. It takes about 10 minutes to complete. Please send the completed questionnaire back to sender via email at tamc@lsbu.ac.uk. Thank you for your participation in this 2nd round Delphi research study.

Question

The following statement is developed from the combined responses of Delphi expert panel on degree of importance of Economic, Environmental and Social sustainability impacts impacting on construction project implementation success.

The **ideal** situation is harmony between the three sustainability impacts (economic, environmental and social) and maintaining multiple interdependencies between these three aspects. If we allow enhancement of just one element, saying on that ground that we are sustainable is the wrong way to go. In **practice**, construction industry needs to take a leading role in environmental sustainability concerning important impact on the natural environment surrounding the construction site and the local communities. Neglecting this aspect will have a negative impact in both the society and economy, and in the whole life on earth. So for sustainable construction project implementation success, it may be necessary to regard the needs of society though industry practitioners put more importance to economic sustainability. The ranking of degree of importance on construction project sustainability impact is: 1) Environmental Sustainability Impact (50%), 2) Economic Sustainability Impact (30%), and 3) Social Sustainability Impact (20%).

If you agree to the above statement, please put "**Yes, I agree.**" in the box on the right. Otherwise, you may modify the statement in the box below.

Your Modified Statement:

Appendix O: e-Delphi Questionnaire (Third Round)

UREC Number: 1571

Managing Project Sustainability: A study of the construction industry in Hong Kong

Third Round Discussion

Instructions

Please answer the following question. It takes about 10 minutes to complete. Please send the completed questionnaire back to sender via email at tamc@lsbu.ac.uk. Thank you for your participation in this 3rd round Delphi research study.

Question

The following statement is developed from 2nd round discussion on the combined responses of Delphi expert panel on degree of importance of Economic, Environmental and Social sustainability impacts impacting on construction project implementation success. The new addition or changes are underlined.

The ideal situation is harmony between the three sustainability impacts (economic, environmental and social) and maintaining multiple interdependencies between these three aspects. However, it is very difficult to achieve a holistic approach to sustainability, because any project activities toward one sustainable objective have potential side effects on the other objectives. Environmental and social costs not being truly internalized is another difficulty. Furthermore, the relative importance of these three aspects is country specific and also relative to the project context. If we allow enhancement of just one element, saying on that ground that we are sustainable is the wrong way to go. In practice, construction industry needs to consider above the others environmental sustainability concerning important impact on the natural environment surrounding the construction site and the local communities. For this reason, neglecting this aspect will have a negative impact in both the society and economy, and in the whole life on earth. So for construction projects achieving implementation success sustainably, it may be necessary to regard the needs of society though industry practitioners put more importance to economic sustainability. The ranking of degree of importance on construction project sustainability impact should be: 1) Environmental Sustainability Impact (45%), 2) Economic Sustainability Impact (30%), and 3) Social Sustainability Impact (25%).

If you agree to the above statement, please put "**Yes, I agree.**" to the box on the right. Otherwise, you may modify the statement in the box below.

Your Modified Statement: