DETERMINANTS AND CONSEQUENCES OF GREEN INNOVATION ADOPTION: A STUDY ON ISO 14001 MANUFACTURING FIRMS IN MALAYSIA

FADHILAH MOHD ZAHARI

UNIVERSITI SAINS MALAYSIA
2015

DETERMINANTS AND CONSEQUENCES OF GREEN INNOVATION ADOPTION: A STUDY ON ISO 14001 MANUFACTURING FIRMS IN MALAYSIA

by

FADHILAH MOHD ZAHARI

Thesis submitted in fulfillment of the requirements
for the degree of
Doctor of Philosophy

July 2015

ACKNOWLEDGEMENT

Alhamdulillah. All praise is due to Allah, the ultimate owner of every single knowledge. I am indeed very grateful for His mercy and guidance throughout this PhD journey. It is also a genuine pleasure to express my deep sense of thanks and gratitude to my supervisor, Prof T. Ramayah. Sincerely, I am constantly amazed by his knowledge and patience, his feedback often triggers me to explore more about my research, and his helping hand eases many hurdles that I face from time to time. I owe him more than I can express.

The completion of this thesis also takes along a bucket of love and support from many individuals, especially my husband, Muhammad Adham Edwin, and the three young caliphs, Nur Iman Balqis, Jibril Hadif and Husna Najeeha for being very inspiring. Not to forget my dearest family members, I really appreciate for all the continuous supports and prayers.

My sincere thanks also to the participants and respondents for their cooperation during the data collection. I also owe my appreciation to all the academics and staffs in the School of Management for their kind assistance and encouragement.

Finally, this pursuit of knowledge will not be as fancy as it is without friends who persistently support and inspire me; especially my dearest sisters Ainul, Fardzah, Malini, Suria, Nurul Liyana, Azlyn and many more. I pray that the Almighty grants all of you a blessed life and rewards your kindness.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

DOE	Department of Environment
EMS	Environmental Management System
EMT	Ecological Modernization Theory
EPU	Economic Planning Unit
E&E	Electrical and electronics industry
GTFS	Green Technology Financing Scheme
GI	Green Innovation
KeTTHA	Kementerian Tenaga, Teknologi Hijau dan Air
LCA	Life Cycle Analysis
MPC	Malaysia Productivity Corporation
NGO	Non-Government Organization
NRBV	Natural Resource Based View
OECD	Organization for Economic Co-operation and Development
PEMANDU	The Performance Management & Delivery Unit

PENENTU DAN KESAN PENERIMAAN INOVASI HIJAU: KAJIAN KE ATAS FIRMA PEMBUATAN BERSTATUS ISO 14001 DI MALAYSIA

ABSTRAK

Hakikat bahawa agenda lestari semakin menjadi tumpuan global, Malaysia juga tidak terkecuali. Jesteru itu, aspirasi negara untuk mengimbangi kelestarian dalam pelan pembangunan dan pertumbuhan ekonomi telah mencetuskan minat utama dalam kajian ini. Berdasarkan kepada teori pemodenan ekologi (EMT) yang mencadangkan bahawa inovasi teknologi pencegahan sebagai langkah berkesan untuk mengurangkan kesan buruk perindustrian kepada alam sekitar, kajian ini menetapkan untuk menganalisa faktor penentu dan kesan penerimaan inovasi hijau dalam pembuatan dan proses di kalangan firma pembuatan yang berstatus ISO 14001 di Malaysia. Tidak banyak yang diketahui tentang faktor penentu penerimaan inovasi hijau ini dalam kajian yang sedia ada, walaupun pengetahuan ini memberi kesan yang signifikan ke arah kelestarian alam sekitar. Dengan berbuat demikian, kajian ini menggabungkan kedua-dua perspektif luaran dan dalaman untuk memperkayakan perbincangan mengenai tajuk berkenaan. Kajian ini juga mengenal pasti keupayaan tertentu yang diperlukan sesebuah firma untuk inovasi hijau, yang mana pengetahuan mengenainya setakat ini agak terbatas, bersama penentu lain seperti tekanan institusi dan orientasi firma terhadap alam sekitar. Seterusnya, kajian ini menggabungkan analisa terhadap konteks persekitaran perniagaan sebagai faktor kontingensi dalam menerangkan kepelbagaian kesan penerimaan inovasi hijau terhadap prestasi kemajuan sesebuah firma.

Kaedah mel telah digunakan untuk mengumpul data daripada firma pembuatan berstatus ISO 14001 di Malaysia. Analisis ini dilakukan menggunakan SmartPLS 2.0 untuk mengkaji hipotesis langsung dan kontingensi. Berkenaan faktor penentu, keputusan gagal untuk menyokong hipotesis hubungan antara tekanan institusi dan penerimaan inovasi hijau. Sebaliknya, orientasi firma terhadap alam sekitar dan keupayaan firma menyokong beberapa hubungan, sekali gus mencerminkan kepentingan dasar dalaman yang dilaksanakan melalui pensijilan ISO 14001. Mengenai hasil penerimaan inovasi hijau, analisa mengesahkan implikasi positif inovasi hijau ke atas prestasi alam sekitar, manakala kesan ke atas prestasi ekonomi dan daya saing menunjukkan hasil yang tidak seragam. Begitu juga, peranan faktor kontingensi hanya menyokong beberapa hubungan sahaja. Secara khusus, hanya dimensi ketidakpastian dan konteks persekitaran perniagaan yang kompleks, menunjukkan kesan dalam meningkatkan implikasi inovasi hijau kepada prestasi firma.

Kefahaman yang dikemukakan melalui kajian ini membawa beberapa implikasi kepada perkembangan dari sudut teori dan praktikal, khususnya dalam mempromosikan inovasi hijau di Malaysia. Selain itu, beberapa faktor yang berpotensi untuk dikembangkan pada kajian akan datang telah dikenal pasti dan dicadangkan. Secara keseluruhannya, kajian ini memberi gambaran yang lebih jelas berkenaan faktor penentu dan hasil penerimaan inovasi hijau, yang masih kurang diselidiki dalam kajian semasa.

DETERMINANTS AND CONSEQUENCES OF GREEN INNOVATION ADOPTION: A STUDY ON ISO 14001 MANUFACTURING FIRMS IN MALAYSIA

ABSTRACT

The fact that the sustainability agenda is becoming a central focus globally, Malaysia also is not without exception. Eventually, the country's aspiration to steer a balance in its development plan and economic growth has triggered the main interest in this research. Following the wisdom of ecological modernization theory that suggests the preventive technological innovation as a powerful means to mitigate the detrimental effect of industrialization on the environment, this study sets to examine the determinants and outcomes of green product and process innovation among ISO 14001 manufacturing firms in Malaysia. Little is known about the determinants of green product and process innovation in the existing literature, despite its significant impact towards environmental sustainability. In doing so, the study integrates both external and internal perspective to enrich the discussion. The study also identifies specific firm capabilities for green innovation, which have not well attended so far, along the other determinants such as institutional pressures and environmental orientation. Further, this study incorporates the moderating effect of business environment context in understanding the conflicting results of green innovation on firm performance.

A mail survey approach was used to collect data from ISO 14001 manufacturing firms in Malaysia. The analysis was done using SmartPLS 2.0 to examine the direct and moderating hypotheses. Concerning the determinant factors, results failed to support the

hypothesized relationship between institutional pressures and green innovation adoption. Indeed, firms' environmental orientation and capabilities show some relationships, thus reflects the significance of self regulating policy in ISO 14001 certified firms. On the outcomes part of green innovation adoption, the result strongly affirms the positive implications on environmental performance, while the economic and competitive advantage measures compile mixed findings. Likewise, the moderating relationships were also partially supported. Specifically, only complexity and uncertainty in business environment context has a sound effect in enhancing the implications of green innovation on firm performance.

The insights forwarded through this study brings some implications to both theoretical and practical advancements, particularly in the promotion of green innovation in Malaysia. Besides, several potential avenues for future research were identified and proposed. In short, this research provides a more enriching picture of the determinants and outcomes of green innovation adoption, which remains lacking in the current literature.

Chapter 1 INTRODUCTION

1.0 Introduction

There are warnings of the need to diversify, innovate and change to ensure business sustainability (Sarkar, 2008). The innovation climate in the 21st century requires that environmental management becomes a pervasive organizational philosophy where all individuals are involved in greening companies (Sarkis et al., 2010). While this movement offers a great winning strategy to sustain the business, the impact to the planet's sustainability is even greater. Innovation in a green manner brings various environmental improvements such as reduction in air emissions, resource consumption, and consumption of hazardous materials (e.g., Chiou et al., 2011; Eltayeb, Suhaiza, & Ramayah, 2011; Hall & Wagner, 2012; Klassen & Whybark, 1999; Lee & Kim, 2011; Li, 2014; Zhu, Sarkis, & Lai, 2007). Due to these significant benefits to the environment, such kind of innovation is often termed as green innovation, sustainable innovation or eco innovation (Hordern, Borjesson, & Elmquist, 2008).

Green innovation has evolved against the backdrop of environmental sustainability. Historically, the concern for the environment came into light in the 1960s when people started to realize the impact of human activities on the environment (Sarkis, Zhu, & Lai, 2011). In the early days, the industry has used various control and treatment measures, or those that were generally referred as end-of-pipe treatment system to reduce the pollution. However, this approach is costly and found to be far from adequate (OECD, 2009). Since the Rio Summit in 1992 sparks the sustainability agenda globally, the manufacturing sector has been greatly pressurized. One major concern is that manufacturing industry accounted for a significant part of the world's

consumption of resources and waste generation, which consequently caused detrimental effect to the environment (OECD, 2009; Rashid, Asif, Krajnik & Nicolescu, 2013). Data from OECD (2009) show that the energy consumption of manufacturing industries grew by 61% from 1971 to 2004 and contributes for almost a third of today's global energy usage. In addition, they are responsible for 37% of global carbon dioxide emissions (IEA, 2013). Moreover, the resource scarcity is becoming an imperative issue as the world's population and economic development are growing at an exponential rate, thus, compelling this industry to satisfy the rising demand of the people (Rashid et al., 2013). Owing to these scenarios, the industries began to seek innovative solution to reduce the environmental harms caused along their operations. More recently, the efforts to improve environmental performance have moved towards thinking in terms of life cycles and the industries began to accept larger environmental responsibilities throughout their value chain (OECD, 2009).

There is a consensus among scholars that industries could lessen environmental burden by greening their business operations, such as by adopting green innovations (Adams, 2006; Aragón-Correa, Hurtado-Torres, Sharma, & Garcia-Morales, 2008; Bönte & Dienes, 2013; Carrión-Flores & Innes, 2010; Chan, 2010; Chiou, Chan, Lettice, & Chung, 2011; Claver, López, Molina, & Tarí, 2007; Dangelico & Pujari, 2010; Eiadat, Kelly, Roche, & Eyadat, 2008; Kammerer, 2009; Rehfeld, Rennings, & Ziegler, 2004). Green innovation generally refers to a new practice in management, products or processes that have beneficial effects on the environment (OECD, 2008). The term *green* is often used synonymously with other words such as *environmental*, *eco* and *sustainable*.

A growing body of literatures also suggests that green innovation is an important domain and demands further attention. For instance, Halila (2007) argues that there are at least two main reasons why green innovation is important. From an environmental point of view, he argued that managing the environment is the greatest challenge facing us in the future and the global scenarios for the next decades are not encouraging. Likewise, the economic point of view holds that eco-industry is one of the fastest growing industries in the world. According to Selwyn and Leverett (2006), the global revenues of this industry is estimated to reach 700 billion euros in 2015 and its growth largely depends on the demand from emerging countries where the pace of industrialization of these nations makes it imperative to manage waste in a systematic manner (Sinclair-Desgagné, 2011). Additionally, Borregaard and Dufey (2005) claim that sustainable products provide huge market opportunities for developing countries. Due to the increasing demand in the industrialized nations, these countries have to rely on imports to satisfy their local needs, which offer a prospect for developing country producers to supply sustainable products. There are also evidences that green innovation adoption offers economic benefits such as better profitability, market expansion, and competitive advantages apart from its contribution in reducing the environmental harms (e.g., Chang, 2011; Eltayeb, et al., 2011; Eltayeb, Zailani, & Filho, 2010; Hall & Wagner, 2012; Huang & Wu, 2010; Sambasivan, Bah, & Jo-Ann, 2013).

Despite its central roles, the pervasiveness of green innovation is not yet encouraging. Developing countries, in particular, are still practicing end-of-pipe solutions rather than proactive approaches to reduce the sources of waste and pollution (Anbumozhi & Kanda, 2005; Gonzales, Sakundarini, Ariffin, & Taha, 2010). The

corrective approach such as end-of-pipe solutions has drawbacks in terms of cost and environmental improvement. Conversely, proactive approach prevents the source of environmental impacts from the beginning (e.g., as early as the product development stage); it is indeed the best practice to improve environmental performance (Tukker, Ellen, & Eder, 2000). This could be made possible if firms adopt green innovation pertaining to their products and processes in their business operations.

Surprisingly, the determinants for green product and process innovation have not been adequately addressed in the existing literatures. Rather, the available studies have conceptualized green innovation into many forms, such as environmental management practices (Chiou et al., 2011; De Marchi, 2009; Hofmann et al., 2012; Li, 2014), EMS adoption (Delmas & Toffel, 2008; Halila, 2007; Haslinda & Fuong, 2010; Sambasivan, Bah, & Jo-Ann, 2013; Tan, 2005) and environmental strategy (Banerjeee et al., 2003; Chan, 2010; Colwell & Joshi, 2013; Eiadat et al., 2008; Sharma et al., 2007). Hence, what determines a firm's adoption of green innovation in products and process, as well as the consequences of its adoption are worth an investigation.

The present study is a step into this direction. By examining the determinants and outcomes of adopting green products and process innovations, the study hopes to shed light on some important factors that firms should consider in their environmental efforts. As such, the firms could address the issues accordingly by working on the crucial factors in making the green innovation a successful endeavor. Hence, the firms not only benefits from the competitiveness and economic returns of green innovation, but the benefits could be substantiated to the environment at large because green innovation is a powerful means to mitigate environmental impacts resulting from

industrial activities (Hoffman, 2007; Kammerer, 2009; Tukker et al., 2000). Furthermore, knowing the important issues that surround green innovation adoption helps the policymakers to design appropriate policy as to diffuse the adoption of green innovation to a greater extent (Anex, 2000; Hordern, et al., 2008; Rueda-Manzanares, et al., 2008).

1.1 Defining green innovation

Historically, the term *innovation* originates from the Latin word *novus*, which means "new"; sometimes, it is referred as "new idea, method or device" or "the process of introducing something new" (Rennings, 2000). According to OECD (1997), innovation can be distinguished into three categories:

- Process innovation – which occurs when a given amount of output (goods, services) can be produced with less input.
- Product innovation – improvements to the existing goods (or services) or the development of new goods.
- Organizational innovations- new forms of management, for example, total quality management.

Rennings (2000) argues that the general concept of innovation is too broad and neutral concerning the content of change, and it is open in all directions. While some innovations have specific environmental implications, using the term *innovation* in general does not explicitly differentiate between environmental and non-environmental innovations (Rennings, 2000). Hence, the type of innovation that has particular environmental attributes or implication has often been described in the existing

literatures as green innovation, sustainable innovation, environmental innovation or eco innovation. These terms are used intertwined when referring to environmental sound innovations as to differentiate the concept from conventional innovation (Hordern et al., 2008).

Literatures have compiled a number of definitions for the notion of green innovation. Klemmer et al. (1999) describes eco (green) innovations as "all measures of relevant actors (firms, politicians, union, associations, churches, private households) which develop new ideas, behavior, products and processes, apply or introduce them and contribute to a reduction of environmental burdens or to ecologically specified sustainability targets" (as cited in Rennings, 2000, p.322). According to Little (2005), sustainability-driven innovation refers to the creation of new market space, products and services or processes driven by social, environmental or sustainability issues. European Commission (2007) considers eco innovation as any form of innovation that aims at significant and demonstrable progress toward the goal of sustainable development, in which it uses the natural resources more efficiently and responsibly. Other definitions of green innovation are presented in table 1.1.

Table 1.1
Some definitions of the green innovation concept from previous studies

Author(s)	Green innovation defined (GI)
Li (2014)	• new or modified **processes, techniques, systems and products** to replace wasteful, inefficient energy practices with a strategy for clean energy, energy efficiency, and conservation, so as to avoid or reduce environmental damage
Wong (2013)	• **product** innovation that imposes no or less negative impact on people and the environment throughout the product life cycle • **process** innovation that use environmentally friendly technologies and manufacturing processes to produce goods and provide services that impose no or less negative impact on the people and the environment
Chiou et al. (2011)	• Modification of existing **product** design to reduce any negative impacts on the environment during any stage of product's life cycle • Any adaptation to the manufacturing **process** that reduces the negative impact on the environment during material acquisition, production and delivery implementation of environmental **management**
Nabsiah & Lee (2011)	• Introduction of a more environmentally friendly composition of one or more firm internal **processes** irrespective of the realization of environmental product innovations • reduction of hazardous and excess materials in **product**, improvement of energy efficiency and pollution output, as well as extended use or recycling schemes for obsolete products
Suhaiza, Azlan & Herina (2011)	• Green logistics
Chang (2011)	• Improvement of **products or processes** about energy-saving, pollution-prevention, waste recycling, green product designs, and corporate environmental management in the field of environmental management

Table 1.1. Continued

Dangelico & Pujari (2010)	• **Products** that strive to protect or enhance the natural environment by conserving energy/ resources and reducing or eliminating use of toxic agents, pollution and waste
De Marchi (2009)	• New or **modied processes, techniques, practices, systems and products** to avoid or reduce environmental harms
Kammerer (2009)	• All innovations that have a beneficial effect on the natural environment regardless whether this was the main objective of the innovation
Huang et al. (2009)	• New technical improvement or administrative practices for improving natural environmental performance and competitive advantage of an organization
Wagner (2008)	• Measures of relevant actors which: (i) develop new ideas, behaviour, products and processes, apply or introduce them, and (ii) contribute to a reduction of environmental burdens or to ecologically specified sustainability targets
Horbach (2008)	• Improvement of product and processes in environmental manner
Lin & Ho, Lin et al. (2008)	• Green management practices
Chen (2007), Chen et al. (2006)	• Hardware or software innovation that is related to green products or processes
Henriques & Sadorsky (2007)	• Technical and administrative innovations that reduce environmental harms
Rothenberg & Zyglidopoulus (2007)	• Environmental technologies
Halila (2007)	• Any innovations that contributes to an improved environment as well as a good economic exchange
Pujari (2006)	• Environmental new product development (ENPD)
Ziegler & Rennings (2004)	• New or modified products and processes to avoid or reduce environmental harms

Because green innovation has been interpreted in many ways, this study adopts the OECD's (2008) definition, which takes green innovation as encompassing all innovations that have beneficial effects on the environment, regardless of whether this was the main objective of the innovation. They include process, product and organizational innovations (OECD, 2008). This broad definition not only covers all the concerning aspects mentioned in other literatures; it also highlights that it is the effects rather than the intention that determine whether or not the innovation is green (Halila, 2007). Thus, in many ways, green innovation does not contradict with the broad concept of innovation, but rather form a "subset" of innovation, since it covers the core features of innovation and delivers the extended benefits of innovation to the environment (Wagner, 2008). Green innovation is also used intertwined with other terms such as eco innovation, environmental innovation, environmentally driven innovation and sustainable innovation (Hordern et al., 2008).

Given the fact that green innovation is a marriage of two distinct concepts, it is vital to note that the term include two important measures, namely "greenness" and "newness" (Wong, 2013). The greenness aspect is a relative concept that vary from one firm to another (Zhu et al., 2009). However, the measure of greenness generally falls under three main categories: energy, materials and pollution (Dangelico & Pujari, 2010). As for the second measure, Johanessen et al. (2001) posit that the "newness" dimension entails three important questions, which are "what is new, how new and new to whom?" (p. 21). With regards to question "what is new?", some researchers measure green innovation based on new practices in products, processes and management (Chiou et al., 2011; Huang, Ding, & Kao, 2009; Li, 2014; Theyel, 2000), while some use patent

as proxy to newness in product (e.g., Berrone, Fosfuri, Gelabert, & Gomez-Mejia, 2013; Brunnermeier & Cohen, 2003). On the other hand, "how new?" reflects the degree of newness which is typically classified as radical and incremental (Johanessen et al., 2001). The existing studies in green innovation tend to favour incremental measures (e.g., Chang, 2011; Chiou et al., 2011; Huang et al., 2009; Li, 2014; Wagner, 2008; Wong, 2013) as opposed to more radical measures. Additionally, the issue of "how new?" is closely linked to the question "new to whom?" While these two questions are subjective and relative in nature, scholars argue that "new to whom?" could be investigated in terms of newness to a firm and newness to a market (Garcia & Calantone, 2002; Kotabe & Swan, 1995).

Researchers commonly agree that green innovation warrants attention due to its economic value and environmental contributions (Borregaard & Dufey, 2005; Chang, 2011; Eltayeb, et al., 2011; Halila, 2007; Hall & Wagner, 2012; Huang & Wu, 2010; Sambasivan, Bah, & Jo-Ann, 2013). Past studies managed to delve into various aspects of green innovation ranging from products, processes and organizational innovations. As depicted in table 1.1, studies in green innovation vary along their scope and focus. Despite of this fact, scholars maintain that preventive actions through changes in technologies that are associated with products and production processes should be emphasized for their significant impacts to environmental improvement and sustainability (Dangelico & Pujari, 2010; Milanez & Bührs, 2007; Shrivastava, 1995; Tukker et al., 2000). This is because products and production technologies determine the type of raw materials to be used, production efficiencies, emission from production process, workers' health and safety, public safety and management of waste

(Shrivastava, 1995). Therefore green product and process innovations provide important means to embed the environmental concern right at the beginning as this helps to mitigate the environmental harm along the product's life cycle (Dangelico & Pujari, 2010; Hoffman, 2007; Kammerer, 2009; Milanez & Bührs, 2007; Shrivastava, 1995; Tukker et al., 2000).

1.1.1 Green product innovation

Scholars commonly cited that there is still a great confusion on what constitutes a green product (Dangelico & Pujari, 2010; Ottman, 1997; Peattie, 1995). Although none of the products have zero impact on the environment, green products could be described as those that strive to protect or enhance the natural environment by conserving energy and/or resources and reducing or eliminating the use of toxic agents, pollution, and waste (Ottman et al., 2006). Dwyer (2009) views products that are "green" as those with designs, commercializations, and uses being feasible and economical whilst reducing the generation of pollution at the source, as well as minimizing the risk to human health and the environment. Similarly, a green product also refers to a product that imposes no or less negative impact on people and the environment throughout the product's life cycle (Wong, 2013). While these definitions range from broad to specific environmental impacts, Dangelico and Pujari (2010) conclude that green products have specific focus on three environmental aspects, namely energy, materials and pollution that resulted at different stages of the products' life cycle.

In referring to green product innovation, this study defines it as new practices in product development that involve resource conservation, pollution prevention, waste recycling and eliminating the use of toxic materials (Chen et al., 2006; Ottman et al., 2006). Being a new paradigm that embed the environmental concern as early as the product's development stage, green product innovations are believed to play a significant role in mitigating the environmental impacts resulted throughout the product's total life cycle (Dangelico & Pujari, 2010; Kammerer, 2009; Tukker et al., 2000).

1.1.2 Green process innovation

Green process innovation generally refers to the use of environmentally friendly technologies and manufacturing processes to produce goods and provide services that impose no or less negative impact on the people and the environment (Chen et al., 2006; Wong, 2013; Ziegler & Nogareda, 2009). Such innovation is not just environmentally sound, but also promotes efficiency and productivity as it uses resources during production efficiently and sensibly (Florida, 1996; Kuo, 2007; Roper, 1997). Besides, the scope of green process innovation is generally on the actual manufacturing process itself rather than on the wastes generated (Henriques & Sadorsky, 2007).

Following these principles, the present study defines green process innovation as a new practice in manufacturing processes that lowers environmental harm through the use of environmentally friendly technologies, waste elimination and reduction of resource consumption (Y.-S. Chen et al., 2006; Chiou et al., 2011). It is worth to note that although green product innovation typically induces green process innovation due

to product changes (Bönte & Dienes, 2013), green process innovation could also be introduced without the realization of green product innovation (Rehfeld, Rennings, & Ziegler, 2007; Ziegler & Nogareda, 2009). Therefore, this study considers that the adoption of only a green process innovation is possible as it is accomplished within the firm (Rehfeld et al., 2007).

1.1.3 ISO 14001

The ISO 14001 is a standard that provides specifications for a complete and effective environmental management system (ISO, 2013). It was released in 1996 and was revised in 2004 by the International Organization for Standardization, with a main purpose to improve the environmental and regulatory performance of firms (Inoue, Arimura, & Nakano, 2013). Being certified to this standard implies that a firm or an institution had implemented a formal environmental management system (EMS) that helps to achieve environmental goals by reducing the firm's environmental impacts and by increasing its operating efficiency (Inoue et al., 2013). Although the standard does not guarantee environmental performance in a firm, it generally provides assurance to internal and external stakeholders that environmental impact is being measured and improved in that firm (ISO, 2013).

A number of studies regard that the adoption of ISO 14001 standard as an organizational innovation because it reflects the new management practice that consider natural environment as part of their strategic concern (Antonioli, Mancinelli, & Mazzanti, 2013; Chiou et al., 2011; Goh et al., 2006; Goh & Nabsiah, 2010; Halila, 2007; Li, 2014; Sambasivan et al., 2013; Sambasivan & Fei, 2008; Tan, 2005; Theyel,

2000; Wagner, 2008). Having registered to the standard implies that a firm had implemented the environmental management system (EMS), which the core role is to facilitate the environmental improvement in a firm. As such, EMS often require a firm to make significant changes in their business operation to enable the environmental improvement initiatives; such as developing appropriate policy, training, commitment, planning, controlling and monitoring process (Melnyk, Sroufe, & Calantone, 2003).

Nishitani et al. (2012) contend that the environmental performance among ISO 14001 firms can be explained through the realization of cleaner production approach such as toxic use reduction and design for the environment. This is because EMS develops unique capabilities to deal with environmental issues, the firms will be encouraged to explore more environmental solutions such as by adopting green products and process innovation (Tan, 2005; Wagner, 2008). Moreover, Inoue et al. (2013) provide empirical finding that more environmental technological innovation takes place along the maturity level of ISO 14001 in facilities.

In short, considering the ISO 14001, green product and process innovation in one study addressed the concept of green innovation as forwarded by OECD (2008). Specifically, the ISO 14001 implies the organization innovation category, while green product and process innovation reflects on product and process category, respectively.

1.2 Background of the Study

1.2.1 Environmental issues in Malaysia

Over the last decade, Malaysia has been one of the leading industrial economies in South East Asia. Since its transformation from being agricultural- to industrial-based country, the manufacturing sector plays a significant role to the economic growth of the country (EPU, 2011). Nevertheless, the rise of industrialization in the country has led to various harmful effects on natural resources. More resources have been used for industrial input, generating waste and industrial emissions to the environment. As a result, the country is confronted with serious pollution and natural resources degradation. Malaysia's ecological deficit was reported at 48% in 2001, which is the highest in the Asia Pacific region, and four times larger than in North America (Salim, 2005). Byrd (2008) cautioned that this ecological deficit will continue at unprecedented rate if the rate of urbanization, deforestation, energy consumption, waste production and pollution are not being controlled. Apart from that, the socio-economic development could be affected to a greater extent. Climate change caused by pollution and greenhouse gas (GHG) emission from industries can cause serious health problems, natural disasters such as flood and acid rain, as well as food scarcity. According to Murad et al. (2010), climate change has been the primary concern in Malaysia due to its threat to national food security and export earnings from plantation crops.

Based on the recent report by DOE (2012), the top environmental issues in Malaysia are water pollution, air pollution and solid waste disposal. Water pollution in the country is typically caused by untreated industrial discharge and farming activities

(DOE, 2012). However, a recent water crisis in the country has given an alarming signal that the water also needs to be sustainably managed. This has posed a new challenge for Malaysia to organize on securing, managing and governing towards conserving its water resources (Anis, Robiah & Khadijah, 2013). Besides, air pollution is another hazardous episode for the country, particularly due to the haze from transboundary air pollution. According to DOE (2012), even if the haze caused in the overall air quality drops, the emissions from motor vehicles would enhance the problem further. Data from the World Development Indicator (2014) in figure 1.1 illustrates that Malaysia's carbon dioxide emission rate follows an increasing trend, with a significant jump in the early 1990s due to rapid industrialization that took place. In contrast, other developed nation such as Singapore and Japan, which initially had greater carbon dioxide emission rate, have exhibited a reduction or moderate change pattern. This could be explained by the strict environmental standard and proactive measures to reduce carbon footprint in these countries.

In addition, solid and hazardous waste also appear as one of the critical issues for Malaysia (Devadason & Chenayah, 2010). MGCC (2010) reports that about 17,000 tons of waste were produced daily and this is expected to increase to more than 30,000 tons per day by 2020 due to the growing population. Despite of its large amount, the portion of waste being recycled amounted to only 5% (MGCC, 2010). Due to lack of awareness and some technical constraints, Malaysia and many other developing countries are still practicing the conventional method for end-of-life products, that is to landfill or incinerate the waste. In fact, many companies have resorted to illegal dumping, which polluted rivers and lands (Devadason & Chenayah, 2010). Data from

DOE (2012) revealed that a major portion of waste in Malaysia goes to landfill (Figure 1.2). Apart from being costly, this practice also causes harm to the environment because the exposure of these wastes in landfill emits greenhouse gas (GHG), which in turn, contributes to climate change (DOE, 2010).

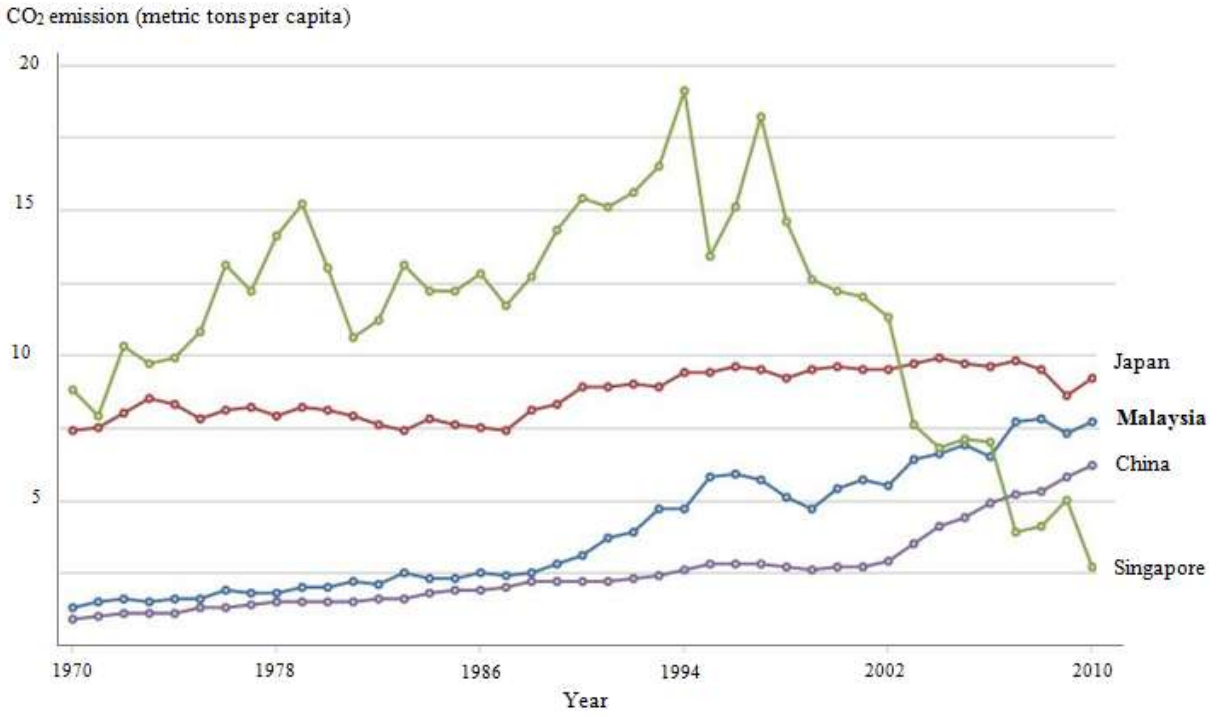

Figure 1.1 Carbon Dioxide (CO2) emissions per capita for selected countries (Source: World Development Indicator)

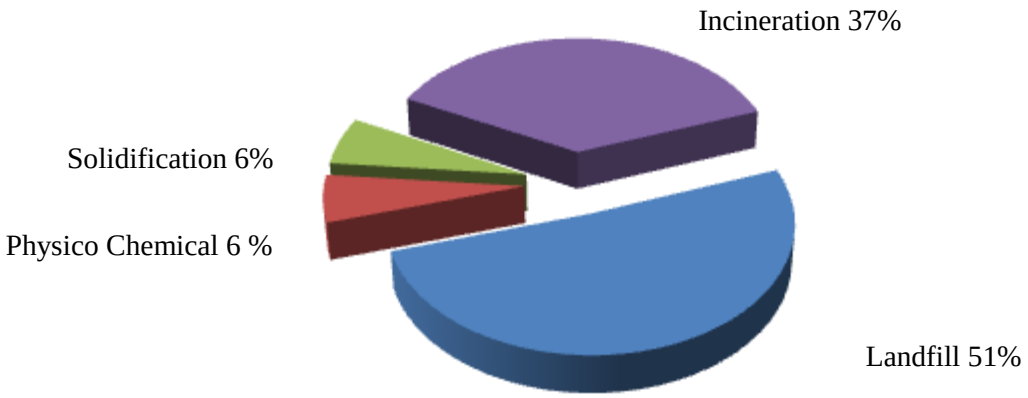

Figure 1.2 Types of Treatment and Disposal of Waste in Malaysia (Source: DOE, 2012)

1.2.2 Manufacturing sector and environmental issues

As the backbone for economic growth of the country, Malaysian manufacturing industry currently contributes about 27% of the gross domestic product (GDP), and exports of manufactured goods account for 72% of Malaysia's total export (EPU, 2011). Despite of its significant role in economic development, the natural environment was also threatened to a greater extent by the industrial activities. In 2012, DOE disclosed that manufacturing industry is one of the major sources of water pollution in the country, which endangered the river ecosystems due to untreated industrial toxic and hazardous wastes such as heavy metals, polyaromatic hydrocarbons (PAH), oil and grease (Hezri & Nordin, 2006). Indeed, failure to comply to industrial effluent regulation was the top offences reported in the year 2013, a double increment compared to the cases compiled in 2012 (DOE, 2014). The report also discloses other cases that violate the environmental regulations, including open burning and black smoke emissions by industries.

Besides, the controversial Lynas plant is another example that highlights how industrial activities could be harmful to human and environment at large. According to Consumer Association of Penang (2014,) the public protest basically stemmed from environmental concern that the environmental impact assessment (EIA) was not conducted for such a critical project, thus, the public feared that the detrimental effects as suffered from the Asian Rare Earth project in Bukit Merah might recur. Although the project was agreed to commence due to its economic benefits to the country (BERNAMA, 2014), people heavily criticized that this reason shall not jeopardize the natural environment and human well being. Consequently, the "Stop Lynas" campaign became the biggest ever environmental issue for the country (Heng, Lee, Foong, & San, 2012). While this conveys a message that environmental awareness is on the rise, it is imperative that firms observe their practices as to avoid boycott or campaign resulting from their negligence on environmental issues.

In addition, there is an urge for manufacturers to embed environmental concerns in their products and practices as global directives are anchored towards environmental sustainability. Among the examples are Kyoto Protocol, Restriction of Use of Hazardous Substances (RoHS), guidelines on Waste Electrical and Electronic Equipment (WEEE) and Eco-design for Energy using Products (EuP). Firms are facing increasing pressure to become responsible and greener. Hence, there is a point to worry for countries that rely much on export, such as Malaysia to keep pace with this transformation as to remain competitive in the global arena (Chen, 2006). Given these challenges, it is imperative for Malaysian manufacturing firms to shift their business

paradigm that incorporates both environmental and economic needs in order to sustain their business.

1.2.3 Achieving ecological and economic sustainability through green innovation

Scholars widely believe that economy and ecology are not necessarily conflicting; rather harmonizing the two is the strategic approach to manage business nowadays (Berger et al., 2001; Jänicke, 2008; Milanez & Bührs, 2007; Murphy & Gouldson, 2000; Zhu, et al., 2012). In this sense, environmental sound practices offer solutions to various environmental problems that originates from products or production process in the industry.

Concomitant with the rising concern of environmental issues, Malaysian firms have also shown growing interest towards sustainable practices. The formal environmental management system (EMS) through ISO 14001 certification is often adopted as the starting point towards greening the business. EMS involves the formal system and database which integrates procedures and processes for the training of personnel, monitoring, summarizing, and reporting of specialized environmental performance information to internal and external stakeholders of the firm (Melnyk, Sroufe, & Calantone, 2003). The system is widely recognized as a powerful tool to manage environmental issues as environmental improvement is being integrated into every aspect of a company's operations (Sroufe, 2003). To date, there are 969 registered ISO 14001 firms in Malaysia since its introduction in 1996 (Standards Malaysia, 2014). The momentum for corporate greening continues with the establishment of the Ministry

of Energy, Green Technology and Water (KeTTHA) in 2009s icommitted to promote an economy that is based on sustainable solutions (DSD, 2011).

Having EMS implemented normally is viewed as a firm's adopting of green innovation (Haslinda & Foung, 2010; Goh et al., 2006; Goh & Nabsiah, 2010; Melnyk et al., 2003; Sambasivan et al., 2013; Sroufe, 2003; Tan, 2005); however, technological changes that take place following the EMS adoption is indeed a significant factor that contributes to better environmental performances (Nishitani et al., 2012). Scholars commonly agree that technological innovation is a powerful means to mitigate environmental impacts resulting from the products and its production processes (Hoffman, 2007; Kammerer, 2009; Tukker et al., 2000). This is because tackling the environmental problems at the source where it originates, such as in the product design, could mitigate the environmental impacts which would be stemmed from disposal and the products used (Kammerer, 2009). On the other hand, poor product design could turn waste issues into serious environmental problems in the future (Lin et al., 2012; Puckett & Smith, 2002).

Table 1.2 describes the comparison between the features of conventional and green products. It is apparent from the table that green products contributes less to environmental harm (CO_2 emission), and so does the use of alternative resources (electric) rather than nonrenewable resources (petrol). This suggests that green innovation could lead to ecological preservation in the long run.

Table 1.2
Comparison of Car Models vs. CO_2 Emission Rate

Type of product	**Conventional**		**Hybrid (eco-friendly)**	
Maker	KIA Rio	Proton Persona	Toyota Prius	Honda Insight
Model	2008 5HB, GS	2009 4 SAL, GLS	2001 4 SAL, Hybrid	2009 5 B, Imase
Fuel	Petrol	Petrol	Petrol / Elec.	Petrol / Elec.
Transmission	Auto	Auto	CVT	CVT
Engine (cc)	1399	1597	1497	1339
CO_2 Level (g/km)	**165**	**160**	**120**	**101**

(Source: Wan Mohamed, 2011)

1.3 Problem statement

The foregoing review suggests that various threats and issues are surrounding the manufacturing industries in Malaysia; hence, it is deemed important to attend to these concerns seriously. One striking report from Kong (2009) mentioned that:

> Malaysia has to go green soon or risk completely using up valuable resources in the country and reducing its natural heritage to nothing (The Star, July 9, 2009, p. N42).

Simultaneously, MPC (2009) raised a concern that despite the obsession in EMS, the preventive approach by means of green innovation is yet to be adopted in Malaysia. This is also supported by Gonzales et al. (2010), who observed that innovation in green product design is still at infancy stage in this country. According to PEMANDU (2014), there are only 293 products with green label, while Malaysia is targeting to achieve 5000 products by the year 2020. In addition, the country is also subject to commitment

in reducing 40% of the carbon emission by the same year (Wo, 2009). Given that those missions are to be realized in a few years to come, there is a great need to encourage the adoption of green innovation among manufacturing firms. Consequently, knowledge on green innovation warrants an investigation.

In view of this prime focus, the researchers so far have not well addressed the determinants of green products and process innovations (Chang, 2011), despite the fact that it is a powerful means to improve the environmental performance (Hoffman, 2007; Kammerer, 2009; Tukker et al., 2000). Moreover, the existing studies tend to discuss the internal and external contributing factors in isolation, thus the complexity and interconnectedness of environmental issues in green innovation is not fully grasped (Child & Tsai, 2005; Clemens & Douglas, 2006; Colwell & Joshi, 2013). Specifically, it is not well known what are the necessary firm capabilities that facilitate green innovation adoption, in response to the institutional forces that exerted to the firms. The researchers call for more investigation on this issue, because the complexity and risky nature of green innovation need to be supported by specific capabilities in order to make the effort successful (De Marchi, 2012; Hofmann et al., 2012; Hordern et al., 2008; Little, 2011). Similarly, the contemporary view suggest that the current perspective of green innovation has to be focused on "how to do it successfully" rather than to debate on "whether it pays to be green" (Eiadat et al., 2008; Orsato, 2006; Wagner, 2007), hence necessitate the investigation of relevant firm capabilities.

Further, the implications of green innovation adoption on firm performance have been inconclusive; which on one hand favorable outcomes were reported (e.g. Chan et al., 2012; Hall & Wagner, 2012; Li, 2014), while on the other hand, the positive

outcomes were not observed (e.g. Gilley, Worrell, Davidson, & El−Jelly, 2000; Margolis & Walsh, 2003; Watson, Klingenberg, Polito, & Geurts, 2004). According to (Claver, López, Molina & Tari, 2007), different operationalization of the term *green innovation* from one study to another could contribute to this inconsistence findings, besides the potential role of contingencies factors in explaining this phenomenon (Reuda-Manzanarez et al., 2008).

Building upon the key drawbacks which are the isolation of the internal and external factors and the inconsistence findings of green innovation outcomes, this research seeks to examine the determinants and consequences of green innovation adoption with regards to product and process innovation. This research argues that the integration of institutional theory and NRBV offer a useful theoretical lens to examine the determinants of green innovation adoption, specifically of institutional pressures, firm environmental orientation and capabilities. However, it is worthy to note that this does not imply that the other theories used in environmental management research are problematic; rather, their applicability vary according to the focus and context of one study to another. In particular, the chosen theories in this study attend to the call on the need to enrich the discussion regarding the determinants of green innovation through the integration of the external driven forces with the firms' internal factors (Child & Tsai, 2005; Clemens & Douglas, 2006; Colwell & Joshi, 2013). This is because, while the institutional theory captures the pressure from external drivers such as regulation, peers influence and trade associations (Colwell & Joshi, 2013; DiMaggio & Powell, 1983), it is particularly silence on the aspects of firms' internal dynamics that explains the capacity to respond to such pressures (Dacin, Goodstein, & Scott, 2002; Greenwood