THE EFFECT OF GREEN INFORMATION SYSTEMS ON ENERGY EFFICIENCY AND LOW CARBON FOOTPRINT: MEDIATING EFFECTS OF GREEN SUPPLY CHAIN INTEGRATION

BY

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ABSTRAK

Revolusi Perindustrian mengubah masyarakat dan juga hubungan dengan alam sekitar dan masyarakat, meningkatkan penggunaan sumber semula jadi seperti bahan api fosil untuk memenuhi kadar pembangunan produk pengenalan baru. Ini telah mencipta produk yang berbahaya daripada proses pembuatan seperti pengeluaran karbon berlebihan, pencemaran dan juga kekurangan sumber semula jadi yang membawa kepada peningkatan harga tenaga global. Akhir-akhir ini, perhatian dan tumpuan terhadap alam sekitar telah mendorong industri pembuatan menerajui peranan yang proaktif terhadap amalan pembuatan lebih hijau dan lebih ke arah persekitaran yang mampan.

Dengan semua isu-isu dan cabaran yang dihadapi ke arah kelestarian alam sekitar, terdapat keperluan untuk meningkatkan kesedaran mengenai kepentingan peranan sistem maklumat dan rangkaian integrasi bekalan dalam memimpin ke arah prestasi alam sekitar yang lebih baik di antara semua syarikat-syarikat pembuatan di Malaysia. Kajian ini dijalankan dengan itu melanjutkan lagi model penyelidikan sistem maklumat hijau dan hijau rantaian bekalan kesan pelaksanaan integrasi ke arah kecekapan tenaga dan kesan karbon rendah firma di Malaysia.

Satu kaji selidik dalam talian ditadbir kepada industri pembuatan di Malaysia. Jumlah 159 data dianalisis dengan menggunakan persamaan struktur model dengan Smart PLS 3.0. Keputusan analisis menunjukkan bahawa sistem maklumat hijau dan hijau integrasi rantaian bekalan memainkan peranan penting ke arah kecekapan tenaga yang lebih baik dan kesan karbon rendah.

ABSTRACT

The Industrial Revolution altered the society and also the relationship with the environment and the society, increasing the natural resources consumption such as the fossil fuels in order to meet the pace of development of new products introduction. This has created harmful products from the manufacturing process such as excess carbon emission, pollution and also depletion of the natural resources which lead to increase energy prices globally. Lately, concern and focus for the environment has motivated the manufacturing industry to lead a proactive role towards greener manufacturing practices and towards more environments sustainable.

With all the issues and challenges facing toward environment sustainability, there was a need to raise the awareness of the important role of information systems and supply chain integration in leading towards better environmental performances among all the manufacturing firms in Malaysia. This study thus carried out to further extend the research model of green information systems and green supply chain integration implementation impact towards energy efficiency and low carbon footprint of firms in Malaysia.

An online survey is administered to manufacturing industry in Malaysia. Total 159 data were analyzed using the structural equation modeling with Smart PLS 3.0. Analytical results demonstrated that green information systems and green supply chain integration play a crucial role towards better energy efficiency and low carbon footprint. This study presents the practical implication for practitioners which underlined a need to greening their supply chain integration and information systems.

CHAPTER 1

INTRODUCTION

1.1 Introduction

The effect of information technology (IT) in environment performance is complicated due to both first and second order effects comprises by IT. Adverse impacts induced by information technology manufacturing, disposal or practice to the environment are known as the first order effect. Green information technology is recognized as to make this effect to become greener in term of environment. On the contrary, business and society' environment sustainability enhancement from the positive information system (IS) usage impact was termed as the second order effect; this known as green information system. Green information system, known as the Green IS, is the combination of Information Technology (IT) and the environment which comprises the positive effect of using Information Systems (IS) to enhance the eco-sustainability of businesses and society (Gholami et al., 2013).

Nowadays, as information technology manufacturers, the firms required to supply to brand firms information technology products that comply the environmental rules and regulations (Karakayali et al., 2007). As a result, information technology manufacturers had applied and fulfilled Restriction of Hazardous Substances (RoHS) to their green supply chain management (GSCM) in order to achieve their customers' requirement (Koh et al., 2012). This motivates the IT manufacturers to implement the green supply chain integration (GSCI) to integrate the firms with their supply chain partners due to these environmental directives.

Green supply chain integration involves engagement of green innovation, including environmentally oriented product designs together with manufacturing processes, essentially meeting the requirements of sustainable development (Tseng et al., 2013).

In line with this topic of the study, the objective is to investigate the effect of Green IS on environmental performance, and how it can be impact to green supply chain integration (GSCI). Environmental performances in aspects of energy efficiency and low carbon footprint will be the focused areas for this study. Many studies have assessed the impact of Green IT on the environmental performances, but few actually have studies the relationship of Green IS and environmental performance through GSCI. This study will concentrated into the integration of information systems for companies in industry from upstream to downstream in supply chain entities and the impact of the both relationships towards the environmental performances.

1.2 Background of the Study

One third of the world's entire energy demand is coming from the manufacturing processes and activities. The industry demand foresees to continue grow due to the populations and living standards expand and rising continually. As society focus on tackle the complicated challenges for climate change, the first most important challenge is aiming for better energy efficiency of the core manufacturing activities. From the survey carried out in year 2011 on Europe countries, majority industry executives which up to 75 percent from total participants strongly agree that energy efficiency played the

most critical factor in the manufacturers cost saving plan. The International Energy Agency (IEA) which based on Paris predicted that a total estimate $3.3 trillion saving in total energy bills by year 2035 when the manufacturers invested in energy efficiency technologies and practices in their core manufacturing activities. Rising energy prices nowadays proved that energy efficiency investment in organizations could be major cost benefit in the long run. Not only the cost benefit served as the major driver of the energy efficiency in the organization, the organization would also be able to enhance their environmental concerned image among the society.

For the time being, majority organizations approach aggressively towards the sustainability in their own supply chain in order to lessen the organizations' environmental negative impact and adhered their organization corporate social responsibility commitments. This supply more motivation for the supply chain organizations to concentrate on energy efficiency practices. For example many organizations begin to replace and change those less-efficient lightning in their manufacturing production area in order to improve their energy efficiency which would significantly help on their cost saving initiatives.

Climate change is known as the major global economy stability threat and it is not only cause by poor energy efficiency but also the carbon footprint creation from the manufacturers. In South Africa, numerous efforts had been made to reduce the fossil fuels usage which contributed largely towards the greenhouse gases emission. Manufacturing organizations also faced large shareholders and customers' attention and pressure to reduce the organization core operations and products carbon footprint. Moreover, not only carbon emissions contributed to the environmental negative impact

such as greenhouse gases, it carriers a great future regulation prospective. Lowering carbon emissions provide business advantage as it most related to energy cost-cutting.

For past few years, concern and pressures on environmental from variety of shareholders have motivated both researchers and practitioners to investigate for more greening solutions on the firms. Parties such as government, institutions or companies in industry and their stakeholders noticed the growth and importance of greening and environmental sustainability. Environmental sustainability has become one of the serious issues for contemporary firms as evidenced by increasing concerns about climate change or natural environment protection among firms' stakeholders (legislators, stakeholders, managers, suppliers, customers and employees) (Kleindorfer et al., 2005).

Recent global United Nation survey at year 2013 to determine the critical issues that foresee will be dominating the future identified sustainable development as the preeminent issue. In the report itself it notes, 'At no time before has the world opinion been as united on a single goal as it is on achieving towards the sustainable development'. The earth's resources are unsustainable, currently and foresee will be creating major environment problems, which is shown in the current development and trend in our general consumption. The urgency to change our current human behavior is a must. Climate revolution, pollution of air, resource depletion are happened every corner of the world and each issue affect a large number people and the earth chronically. The current consumption of the earth's limited resources unable to preserved. Sustainable development is the solution to meet the needs of the present and in the same time without compromising the ability of future generations to meet their own needs' (Brundtland et al., 1987).

The function of the population, technology, and wealth factors the environmental burden nowadays, and controlling these factors is exceptionally challenging. It has more impact upon the earth when the larger the population. In addition, societies desire to affluent lifestyles mainstream. These more affluent individuals consume a large number of resources than less wealthy persons than we could able to tell of. Technology can be the cause of the environmental burden or in the other hand a potential solution for sustainability (Boudreau et al., 2010).

In the same time carbon emissions caused by technology which offers the electricity that society required to have a wealthy lifestyle and then contribute enormously to global warming. On the other hand, potential sustainability resolutions offered by the renewable energy technologies such as the solar or the wind, even each technology contained harmful magnitudes as well. A well-known example is the wind turbines constructions which consume the energy and also materials.

In the information technology (IT) perspective, main environmental issue induced by the equipment disposal such as the toxic products in computers and displays. However, for the last few years, in many countries information system has been demonstrated as the major backer for productivity development. Sustainable business practices need the support from the information systems that operate by the IT.

Global problem will be able to address by through the important means of technology. As the matter of fact establishes one of the biggest chances in the commerce the past is to leveraging environmental friendlier technologies for goods and services production is a momentous effort (Hart et al., 1997). Many business leaders are

connecting sustainability to their implementation of corporate strategy. These business leaders recognize they hold the key responsibility to participate in solving this serious global issues and that their customers also expect them to provide green products and services. IS foreseeing to be the key element is the transition to a sustainable economy and sustainability requires sustainable business practices because of the dominant role of firms in the global economy (Esty et al., 2006).

Role of IT that can contribute towards creating and reducing global environmental issues has started to focus by the information systems community. Majority information system practitioner community efforts and discussion in focusing on creating energy efficient equipment or computer or data centers in order to decrease the direct IT negative environmental impacts. Firms expressed strong motivation to adopt these efforts which can reduce IT costs directly. Evidence from surveys concludes that IS societies are adopting green practices, and directly responding to these incentives. Two different information specialist studies acknowledged that the top inspiration for performing green information technology is related to cost reduction. On the other hand, social acceptance, corporate strategy and environmental concern are identified as the next three top inspirations in the study of New Zealand, U.S., Australian, and New Zealand organizations (Molla et al., 2009).

Primarily information technology (IT) transmits, processes, and then stores information. Green Equipment consumption and energy proficiency is fundamentally concentrated by IT. Fundamentally, Green IT decreases the data centers energy intake by substituting personal computers with energy proficient thin clients. On the other hand, information system incorporate and collaborating software set by via information

technology to support any parties such as individual, group, organizational, or even the common goals. Green information systems applied and design the information systems that help on the sustainable business practices. For example logistic costs reduction and energy intake lessens can be achieved by Green IS with vibrant vehicles routing and management system to evade bad traffic condition. Green IS manages and monitors a firm's operational emissions and waste products effectively and it helps on tracking the environmental information such as energy used or the total carbon footprint (Boudreau et al., 2010).

Green IS possess greater potential than green IT as it able to tackles a much larger area of problem. Green information system make over the complete systems into more ecological compared to decreasing the crucial energy to run the IT. Sustainable development and green information system must not be seen or included as portion of the business operating cost. Both should be viewed as the chances for firms to enhance their profit and output by cost reduction. Bad environmental process inescapably will cause many forms of waste creation for example energy ineffectiveness, emissions, heat are all products of waste that take from financial effectiveness. Total $2.6 billion expenditures spent on waste management in Canada local governments on year 2008. An efficient enterprise represents less waste. Companies that enthusiastically pursue Green IS and link the information systems with their sustainable business initiatives are beneficial for their public, consumers, stakeholders, and future generations.

Information systems played important role in supply chain integration with the developments in information technology, which crucial to organizations executives and managers. Organizations had shown for improving competitiveness with implementation

of information systems for supply chain management. Supply chain integration positions for the co-operation of supply chain members in both intra- and inter-organizational processes (Flynn et al., 2010). Green supply chain integration (GSCI) can be defined as "the cooperation between a firm and its supply chain partners to achieve both intra- and inter-organizational environmental practices" and separate into internal and also external integration. Cross-functional barriers removal, firms' environmental capabilities improvement and employees encouragement to learn about environmental initiatives (Wu et al., 2012) is focus on internal integration. Oppositely, external integration takes in the co-operation between firms' suppliers and customers to manage together for the cross-firm environmental issues (Vachon et al., 2006). In trend with the swift emergence of green consumption and fast developments in green technology, firms must effectively implement GSCI to transform their products, processes and even business models (Nidumolu et al., 2009).

A multi-dimensional approach to analyze the relationships among the supply chain integration, environmental uncertainty and performance is necessitating in many recent studies (Paulraj et al., 2007 and Wong et al., 2011). Supplier, customer and internal integration have been proven to effectively improve environmental performance (Flynn et al., 2010; Lau et al., 2010). The whole effects of each integration required to be examined together due to each of these three types of integration represents an important aspect of supply chain integration (Koufteros et al., 2005; Lee et al., 2007; Wong et al., 2011).

Malaysian government and the public very concern towards the environmental issues, this has become very important topic. In year 1974, The Environmental Quality

Act was established and has been revised a number of times to incorporate 18 sets of regulations to aid the implementation of projects which relating to clean air, sewage and industrial effluent assessment (Rao et al., 2004). Furthermore, a numbers of pressure groups were formulated to monitor the current environmental issues.

In year 2013, Malaysia welcomes the government's Budget 2014 announcement on several green initiatives that will be introduced in the country later part. The green initiatives included the setting up of the National Conservation Trust Fund, the introduction of the National Carbon Reporting Programme, Environmental, Social and Government (ESG) Index, and MyCarbon, investment tax allowance on green technology products, and income tax exemption on green technology services and systems, the establishment of the Malaysian Green Foundation and the government's leadership by example in becoming energy efficient.

According to Bernama on year 2015, Malaysia target to reduce carbon emission up to 40% in terms of emission intensity of GDP (Gross Domestic Product) at year of 2020 compared with the levels in year of 2005. National green technology policy was introduced in July 2009, with the policy stated that the green technology shall be a driver to accelerate the national economy and promote sustainable development. Main objectives included to minimize the growth of energy consumption while improving the economic growth at the same time.

1.3 Problem Statements

Globally, the manufacturing sector seated for the top majority contributor for greenhouse gas emissions compared with any other sector contribution. Manufacturing industry is driven by the energy efficiency since it consumes and emits the greatest number of energy and carbon in the world historically. In year 2010, International Energy Agency (EIA) highlighted that the manufacturing organizations accountable for around 33% of primary energy consumption and 38% for the emission of carbon dioxide worldwide.

Furthermore, new pressure exerted by latest sustainability trend and rising energy price on the manufacturing organizations to reduce their operations energy usage for cost reduction and environmental friendliness. Germany recorded total 100% increase of energy prices from the last 20 years. Energy savings achievements on any manufacturing organizations are predicted from energy efficiency enhancement and supply chain processes through creative energy management approaches. Energy prices foresee to continue increase as the world markets restricted supply together rising energy demand globally.

Environment carbon emissions caused critical impacts on both climate and also society. According to Shaw et al., (2013), supply chain stakeholders from manufacturing industries noticed the attention of climate change and global warming issues. Majority organizations exploring the method to reduce carbon emissions in their organization supply chain process in order to reduce the environment burdens and to achieve cost advantages as well. Besides, government authorities exerted huge pressure on business organizations to reduce their carbon emissions as well.

IT can also be an answer for environmental control and sustainability in general two ways. First, linking environmental sustainability principles into the organization's IT planning and usage to green the IT and subsequently reduce the adverse impacts of IT on the environment performance (Elliot et al., 2011). The fundamental principle of these green IT practices is that IT required being green and itself is a consumer of energy and a source of waste generation. In the other hand, the second way is to leverage IT infrastructure, which can contribute to environmental sustainability and enhance the efficiency of resource use follow by transforming the organization's business processes. In this second way green IT can convert these processes into more environmentally sustainable processes (Watson et al., 2010). A simple example will be using the IT capabilities to enhance carbon productivity by increasing throughout the energy efficiency of structures, transportation systems, and supply chains (Mithas et al., 2010).

The research of the role of IT in environmental management and sustainability is in its initial stages despite the above rationales (Malhotra et al., 2013). Previous information systems (IS) research has been mainly based on opinion pieces, subjective evidence or very exploratory studies (Benitez-Amado et al., 2012). Information system literature required a well theoretical understanding and robust empirical evidence on the role of IT towards the environmental sustainability.

Most information system scholars performed studies that concentrated on direct or the first-order effects of IT. Second order impacts of information technology are dedicated by more IS scholars exceptionally (Watson et al., 2008; Dedrick et al., 2010). Follow by notify both information technology specialists and business administrators,

specialist need to learn and work from their past knowledge about the wider prospective and also the precise Green IS costs.

On the implementation side, green IT or green IS practices may not be adopted even showing a clear economic payoff. The variables frequently are further than the IS range of the related department are the major obstacles. Like instance, IS division budget will not be always charged by the data center energy cost. Building original holder generally make decisions which related to design of building design and utilities and in some occasions by the architect in the event of space is rented and the firm may paid the utility bills. At times when energy cost increasing which create the incentive, chief information officer (CIO) is found difficult to comprehend the largest energy reductions without any direct control.

Furthermore, due the carbon emission is in the much wider firm operations, most CIOs do not have any part in the firm's efforts to decrease energy consumption. IS department's may not have the role and responsibility to obtain indirect or second-order benefits from IS. In other hand, if the company has the Corporate Social Responsibility group rarely has direct operational authority, although they advocate for sustainability, but. The IS department may not focus on the strategically usage of IT to helps on the environment impacts reduction as the division generally concentrated on IT impact and cost throughout the firm.

In Malaysia, despite numerous of the government efforts and emergent public awareness of environmental issues, environmental problems remain to persist. Malaysia still encounters problems of deforestation, pollution of inland and marine waters, high

carbon footprint, overfishing and coral reef destruction, along with air pollution, water pollution and the problem of waste disposal. In react to environmental issues, firms start to adopt environmental management initiatives at global and also local levels, which can be categorized in five levels as follows: defensive compliance, waste minimization or cleaner production, eco-efficiency, design for environment and also green supply chain.

1.4 Objective of the Study

This study intend to develop an extended framework to link it the green IS that affects the environmental performances in the manufacturing industry where the current study proposed the mediating effects of GSCI. There are limited studies in literature as references to extend the firm commitment to reduce the environmental performance on low carbon and energy efficiency. Differing from prior research which focused on overall environmental performances, this study segmented environmental performances into energy efficiency and also the low carbon footprint; it also examine the moderating effect of GSCI between green IS and the environmental performances.

Melville and Watson et al. (2010) argued that only relatively number of studies that concentrated to get the most advantage from using the information systems to enhance the environmental performance and the less adequate IS within the perspective of environmental sustainability. Resolution is to empirically create the relationships between an organization's capability to share information empirically and the extent to the improvement of the organization information system to dedicate on the firm environmental performance is the end goal.

Overall, this study suggest that a manufacturing organization that able to synchronously information sharing in actual time with supplier chain partners together with the green IS implementation is positively affect the manufacturing organization's environmental performance. A theoretical framework that integrates the sharing of information as predecessor to green IS and environmental performance as the last significance is established, with the mediating effect of the GSCI and follow by internet data collection empirically assessment. To the best of our knowledge so far, this is the pioneer study to include all these variables.

The objectives of study are as follows:

1. To investigate the relationship between the green information system and green supply chain integration

2. To examine the effect of the green information system on energy efficiency

3. To examine the effect of the green information system and low carbon footprint

4. To investigate the relationship between the green supply chain integration and energy efficiency

5. To examine the relationship between the green supply chain integration and low carbon footprint

6. To investigate green supply chain integration as a mediating variable on the relationship between green information system and energy efficiency

7. To investigate green supply chain integration as a mediating variable on the relationship between green information system and low carbon footprint.

1.5 Research Questions

In order to attain the said objectives as mentioned above, the objectives are transformed into the research questions as follow:

1. What is the relationship between the green information system and green supply chain integration?
2. What is the effect of the green information system on energy efficiency?
3. What is the effect of the green information system and low carbon footprint?
4. What is the relationship between the green supply chain integration and energy efficiency?
5. What is the relationship between the green supply chain integration and low carbon footprint?
6. Does the presence of green supply chain integration will mediating the relationship between green information system and energy efficiency?
7. Does the presence of green supply chain integration will mediating the relationship between green information system and low carbon footprint?

Based on the data analysis results, this study concludes that the energy efficiency and low carbon footprint of the firm was affected by green supply chain integration together with the green information system.

1.6 Significance of Study

1.6.1 Theoretical Contributions

On the theoretical part, Prajogo et al. (2012) and Qrunfleh et al. (2014) highlighted the impacts and benefits of supply chain integration on the firm performance such as the environmental performance, as the single dimensional construct. Meanwhile, this study developed an extended more comprehensive framework by looking into environmental performances in term of energy efficiency and low carbon footprint specifically, which serve as the multi-dimension constructs. This is valuable contribution due to previous related studies only more focus in overall firm performance. Also, this study introduced green supply chain integration as the mediating factor when this study develop a model of green supply chain integration affecting the relationship between green information system with energy efficiency together with low carbon footprint. This input is valued as previous green information system studies had not adopted this mediating approach to examine the relationships between green information system and environmental performances. Also, our model not only able to assist scholars to understand the integration of the supply chain but also the outcomes of its adoption, particular inside the relationship between the green information system and environmental performances.

1.6.2 Practical Contributions

This study identifies the determinants of the green information systems implementation among the manufacturing companies in Malaysia. With the identification, a firm can choose on whether to leverage their usage of information system and production with

increasing IT and IS usage rate, which can eventually become portion of environmental sustainability solution. The use of information technology and information systems is exploding, reported growing two times faster than the Gross World Product (Siegler et al., 2008) nowadays, and consuming large portions of business' energy costs. In most cases, more than half of this energy waste can be avoided by manufacturing companies by preventing any inefficient technologies, poorly designed systems, or uninformed behaviours in their organizations.

Besides that, this study gives a clear picture of the positive impacts of green IS implementation in organization compared to the environment dangerous impacts. It motivates the implementation as the positive impacts on environment can eventually be part of the operation cost reduction. For example the teleconference operating systems that permit the remote meetings among the employees and contributed to reduction of the operating cost and also the adverse environmental effects related with travel. In the other hand, environmental variables can be monitor and tracked using information systems for example the waste or toxicity creation, emissions, energy effectiveness, and also the carbon footprints; or the firm supply chain systems integration to reduce the energy consumption by improve product routing and transportation (Watson et al., 2008).

This study find an empirical justification to reduce energy consumption in term of energy efficiency has major business impact due to its through bottom line effects and the linking benefits of greenhouse gas (GHG) emissions reduction. Whenever there is a market for such emission with price, these benefits growth. With broader view and better understanding of the entire system, the IS researchers can contribute to the firms by decision making, for example the location and data centre design, selection for the

hardware, system architecture, in order to enhance a combination of environmental performance, operation cost and energy efficiency. Improved implication understanding would be valued on carbon productivity decisions or carbon footprint from an economic and policy view.

This study helps the managers to draw upon our framework and received the valuable information related to manufacturing environment in which the implementation of green information system together with green integration of the supply chains are most successful. Existence of green supply chain integration helps to improve the energy efficiency and low carbon footprint of companies by green information systems. This information are very useful for managers as the businesses around the world are facing high pressure from society, customers, regulators or even competitors to practice sustainable business activities in their core business strategy. Increasing of the public awareness and concern for the environment makes this study important and timely as well. Managers need to understand better the mediating role of the green supply chain integration in order to have successful effect of implementing and adopt the green information system in their organizations.

1.6.3 Social Implication

Organizations can improve further in their energy efficiency and reduce their contribution in carbon footprint towards the environment by the adoption of the green information system. Success green integration of the supply chain could help the manufacturing companies to reduce the negative environment impact from their core activities such the

logistics, production and many more. This led to healthier lifestyle for the Malaysia community and further helps Malaysia to recognize a low carbon economic country.

1.7 Definition of Key Terms

This section further elaborates and explains the key terminologies that have been used for this particular research.

1. Information Technology: Transmits, processes, and then stores information (Boudreau et al., 2008)
2. Information Systems: Integration and cooperating set of software using IT to support any parties such as individual, group, organizational, or even the common goals (Boudreau et al., 2008)
3. Green Information Technology: The study and practice of designing, manufacturing, using and disposing of computer, servers and associated subsystems, efficiently and effectively with minimal or no impact on the environment (Dedrick and Jason, 2010)
4. Green Information Systems: The use of information systems to enhance sustainability across the economy (Dedrick and Jason, 2010)

   The design and implementation of information systems that contribute to sustainable business processes (Boudreau et al., 2008)
5. Green supply chain integration: The cooperation between a firm and its supply chain partners to achieve both intra- and inter-organizational environmental practices (Flynn et al., 2010)

6. Carbon footprint: The amount of the impact social practices have on the environment in terms of the quantity of greenhouse gases generated, measured in tons of carbon dioxide (Yang and Chen, 2014)
7. Energy Efficiency: Way of handling and confining the growth in energy consumption whilst produces more services with same energy input (Therkelsen et al., 2014)

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter will summary the studies that have been published from the past researches. The first part will be the review literatures for the key variables such as the green information system and green supply chain integration follow by other variables for example the environmental performance, sustainability and theory that supporting this research.

2.2 Green Information Systems

By assisting the organization's inner environmental management system, green information systems signify the backbone of environmental management efforts and also meeting the reporting requirements for numerous stakeholders (El-Gayar et al., 2006). Green information system provide the info essential for coordinating with consumers in terms of eco-design, packaging, recycling, production, disposal, transportation and scrap ratio.

In term of integration and also coordination, by using green information systems, information sharing proved to be the crucial enabler for supply chain management (Chandra et al., 2007). The theory of logistical integration consists of the partnership extent in management fundamental informational and material flow throughout the supply chain was suggested by Frohlich and Westbrook (2001). Established on a food industry case study, Hamprecht et al. (2005) debated that the implication of incorporating

environmental controls together with other quality controls, inside the information system that covers all the way through the food supply chain. Green information systems provide the information vital to make conclusions for eco-design, in features of material reuse and energy intake, recycling and recovery.

Zelbst et al (2010) and Green et al (2007) classified the information sharing. Zhu et al. (2008) established the scales operationally cultivate the environmental performance meaning. In the other hand, the green information system classification is derivative from such systems features which established from Esty and Winston (2006).

Real time information synchronized sharing with customer and suppliers are the ability of information sharing (Zelbst et al., 2010). Capability to share the information openly throughout the supply chain partners is talk over by Green et al. (2007), which in a timely manner. All customer and suppliers needed the information to be obtainable on an actual time basis. Commonly, both Green et al. (2007) acknowledged that this information type is offered through some recognized available manufacturing systems.

Information systems are applied to monitor processes to safeguard environmental sustainability are known as the green information systems (Watson et al., 2008; Esty et al., 2006). Energy intake decline, waste creation, environmental information tracing and emissions observing can be executed by this kind of information systems (Esty and Winston, 2006). Moreover, consumers encouraged implementing green choices, growth decision making from the executives related to sustainability issues, support the renewable energy creation and allocation of renewable energy, and the part of information systems detection in energy policy offered by green information system.

2.3 Green Supply Chain Integration

Hart (1995) proposed a natural-resource-based view (NRBV) which suggested that firms should implement product stewardship programs with socially complex features to create the fundamental competencies for sustainable development and same time to implement pollution prevention strategies with casual uncertain characteristics. Referring to NRBV, intra- and inter-organisational environmental practices can be divided from green supply chain management (GSCM); the earlier represents the methods of casual ambiguous resources and the later refers to socially complex resources (Shi et al., 2012). Some of the intra-organisational environmental practices like the well-known total quality environmental management, environmental management systems and also the waste management, are concentrated on usage of the energy, consumption of the material, emissions and waste in linking with in-house processes (Gimenez et al., 2012).

As in differently, inter-organisational environmental practices, for example the environment design, analysis of the life cycle, logistics reversal and green distribution (Wong et al., 2012), are classically referred to as product stewardship programs which accentuate associations between suppliers and customers to mutually handle and manage with cross-organizations environmental issues (Vachon et al., 2008). Social networks were established with an interactive platform between supply chain partners which provided by these practices, and implanted with trust and commitment which inspire knowledge exchange and exchange (Hart et al., 1995). Result, inter-organisational environmental practices have socially complex features and depend on on close co-operation between organizations and supply chain partners (Shi et al., 2012). The

significance of taking appropriate steps is stress in these practices to effectively integrate between the suppliers and customers.

Collaboration among supply chain partners represents by supply chain integration, which in both intra- and inter-organisational procedures (Flynn et al., 2010). According to Flynn et al. (2010) and Shi et al. (2012), the co-operation between an organization and its supply chain partners can be defined as GSCI, in which direct towards both intra- and inter-organisational environmental practices. Generally GSCI can be divided into three different aspects: supplier, customer and internal integration. Supplier integration means that during upstream chain procurement and operations, organizations support suppliers in fulfilling with environmental protection requirements (Lee et al., 2011). In other hand, positive relationships and collaborating with downstream chain consumers to guarantee that marketing, distribution and manufacturing conform to environmental regulations can be define as customer integration (Vachon et al., 2008). Internal integration focuses on improving inter-departmental collaboration, assisting employee involvement in environmental initiatives and evolving environmental abilities (Wu et al., 2012).

Other than the approach to integrate on suppliers and customers side, producers must also integrate internally to enhance intra-organisational environmental practices. An organization's entrepreneurial actions rest on its absorptive capacity which proposed by Cohen and Levinthal (1990), is the ability to explore, adapt and apply valued new knowledge. Zahra and George (2002) established a model which splits absorptive capacity into potential and realized categories based on this perspective. The model principally accentuates the significance of realized absorptive capacity in terms of revolution and exploitation. Gluch et al. (2009) suggested that to strengthen realized