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Sustainable Value Chain Practice Adoption to Improve Strategic Environmentalism in ICT Based Industries

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Abstract

Purpose

This research investigates the current value chain activities grounded on Porter's value chain theory and also examines the drivers of strategic environmentalism that influence sustainable value chain adoption. This study further constructs a prescriptive model to reveal the extent to which Information Communication Technology (ICT) based industries are adopting sustainable value chain practices.

Design/methodology/approach

Data was collected using questionnaire from selected ISO 14000/14001 certified ICT based firms in Malaysia and analyzed using Partial Least Square-Structural Equation Modeling (PLS-SEM).

Findings

Results reveal that the primary activities positively influence sustainable value chain. Moreover, results indicate that support activities significantly influence sustainable value chain adoption in ICT based firms. Results further show that strategic environmentalism drivers have an impact on sustainable value chain adoption.

Research limitations/implications

Data was collected from ICT based industries in Malaysia only. Additionally, this research extends the body of knowledge and offer theoretical implications for ICT based industries in Malaysia and other emerging economies in adopting sustainable value chain activities.

Practical implications

Practically, this study assists ICT based industries to change their current paradigm from the traditional operations to a more holistic approach towards supporting practitioners to simultaneously achieve social responsibility, environmental and economic growth.

Social implications

This study offers social implication for ICT based industries to implement cleaner operations by decreasing CO_2 emission, lessening energy usage, diminish cost incurred, and minimizing usage of natural resources, thereby increasing product recovery and recycle-ability of IT hardware.

Originality/value

This study is one of the first to address the issue related to sustainable value chain in ICT based industry by providing a road-map on how practitioners can implement sustainable initiatives or more significantly, how to infuse these initiatives into their current chain, while concurrently enhancing competitiveness. Furthermore, this research examines the current activities implemented by practitioners towards sustainable value chain adoption and also explores the correlation of the drivers of strategic environmentalism with regard to sustainable value chain.

Keywords: Sustainability development; Sustainable value chain adoption; Strategic environmentalism; Primary value chain activities; Support value chain activities; ICT firms.

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1. Introduction

Strategic environmentalism is a new concept that combines the ideal of ecological protection with industrial goals. Accordingly, Kung *et al*. (2012) cited Taylor (1992) by mentioning that strategic environmentalism refers to the implementation of ecological friendly initiatives throughout the industrial process. Hence, industries need to view environmentalism as a primary element in value chain operations (Taylor, 1992), thus transforming environmental, economic and social related dimensions into competitive benefit. The value chain concept was first presented by Michael Porter in the year 1985, originating from his research on competitive advantage (Porter, 1985). The chain in value chain signifies an interconnected set of value adding financial activities (Feller *et al*., 2006; Fierro *et al*., 2018). In his proposed theory, Porter (1985) argued that competitive advantage cannot be realized by looking at an industry in isolation and that value in industry can be achieved from several detached activities in producing, designing, marketing, and distributing of goods and services.

Accordingly, value chain comprises the collaborative distribution of resources (Handfield *et al*., 1997), within and among respective industries involved in the chain to offer more value added at lesser cost and at a quicker rate than other competing industries (Dekker, 2003; Soosay *et al*., 2012). Respectively, sustainable value chain encompasses the full range of activities that practitioners deploy to bring a product from its formation to end use and disposal (Handfield *et al.,* 1997; Soosay *et al.,* 2012). This includes operations such as design, production, distribution marketing and support to the final customer (Thomas-Francois *et al*., 2017). Likewise, Sustainable Value Chain Adoption (SVCA) refers to the removal of waste and the effective flow of materials, and also involves the collaboration of inter-industry relationships (Rose and Stevels, 2000; Huybrechts *et al.*, 2018). SVCA also includes material sourcing from service providers and suppliers and their impact to the creation of value and the emission of waste (Soosay and Fearne, 2011). Besides, SVCA provide a formal method for involving stakeholders at different phases in the value chain as an effectual catalyst for strategic environmentalism (Darmawan *et al*., 2014).

On the foundation of the aforementioned discussion, this study consider that every area of the value chain comprises the practices of sustainable management aimed at implementing ecological friendly products, as well as minimizing waste, and reducing pollution generated during industrial operations. Therefore, this research defines sustainable value chain as a looped sequence of industrial operations in which environmental friendly initiatives are adopted throughout the complete process, with prominence on reusing, recycling refurbishing to reduce waste. In addition, this research builds upon the concept of sustainability from which sustainable value chain emerges to encompass environmental, economic and social impacts for value chain adoption in Information Communication Technology (ICT) based firms. Therefore, this study is motivated to examine the current sustainable value chain practices implemented in Malaysia ISO 14000/14001 certified ICT based firms.

ICT based firms were selected for this study because nowadays, ICT industries in Malaysia carry out their organizational services by deploying and utilizing resources that are provided by IT infrastructures which consumes electricity thereby emitting CO_2 to the atmosphere that adds to climatic changes, global warming and environmental degradation. In addition, there are fewer studies that have explored sustainable value chain adoption in Malaysia ICT based firm where these ICT industries consumes natural resources that depicts available raw materials and generate electronic hardware wastes which is more waste produced by any other industries that pollutes lands fills and contaminates aquatic lives in rivers. Accordingly, there is need to investigate the current value chain practice in Malaysia ICT based industries to achieve cost saving decrease, energy efficiency, eco-friendly waste management, natural resource conservation and CO_2 emission reduction for a cleaner environment. Moreover, this study fills the gap in knowledge by examining sustainable value chain in ICT based sectors which has not been fully explored by prior studies. Hence, the objectives of this study are;

- To identify the activities to be implemented for sustainable value chain adoption in ICT based firms based on Porter's sustainable value chain theory.
- To identify the drivers that influence strategic environmentalism for sustainable value chain adoption in ICT based firms.
- To construct a prescriptive model based on sustainable value chain activities from Porter's value chain theory and drivers for strategic environmentalism in ICT based firms.
- To validate the constructed prescriptive model using quantitative survey data collected from ICT based firms.

Thus, the organization of this paper is as follows. The theoretical background is presented in Section 2. The prescriptive model and hypotheses development is presented in Section 3 and research methodology has been presented in Section 4. The results and discussion are presented in Section 5 and 6. Next is Section 7 which presents the implications of study. Finally, the conclusion, limitation and future works are presented in Section 8.

2. Theoretical Background

2.1 Overview of Sustainable Value Chain

Value chain practice is a significant aspect in managing industrial operations. Thus, defined as the management of sourcing information, goods, processes, as well as funds from the supplier to the industry and then to the consumer and including disposal of by-products (Thomas-Francois *et al.,* 2017). Arguably, it is the assimilation of crucial operations from consumer through creative suppliers of services, products and information that adds value for end users (Olson, 2014; D'heur, 2015). It recommends value creation for consumers and profits to stakeholders (Soosay *et al*., 2012; Anthony Jr *et al*., 2018). Respectively, practitioners in industries such as ICT based industries are encouraged not to view services and products as merchandises, but instead to focus on adding true value and quality to products (Huybrechts *et al*., 2018). Hence, sustainable value chain aims to optimize resources and focus on stewardship in all activities throughout the entire chain (Thomas-Francois *et al*., 2017).

Correspondingly, sustainable value chains introduce economic, social and environmental issues, often considered in 21st century corporate practice as the triple bottom line (Rabelo *et al*., 2007). Hence, sustainable value chain refers to the management of raw-material and information dissemination as well as collaboration among industries along the chain while taking stakeholder and end user requirements into account for economic, social and environmental goals (Soosay and Fearne, 2011). Sustainable value chain also involves procedures for improving production and environmental performance concurrently to achieve complete socio-economic improvement and better quality of life to consumers (Kung *et al*., 2012). It is the collective deployment of ecological management techniques, technologies and tools that decrease the environmental effects of industrial activities for competitive advantage (Darmawan *et al*., 2014).

2.2 Importance of Sustainable Value Chain

For many years, academicians, government and Non-Governmental Organization (NGOs) have encouraged industries to adopt environmental friendly practice in their operations (Darmawan *et al.,* 2014), delivery of products as well as provide strategic path that will offer them and society with both economic and environmental benefits (Huybrechts *et al.,* 2018). Additionally, the empirical proof concerning the benefits of 'environmental friendly practice' is often anecdotal. Accordingly, Olson (2014) stated that much of prior pro-environmental studies failed to recognize any prospective tradeoffs for environmental friendly practice industries, for instance how they can deduce higher expenses and declining competitive advantage.

Similarly, another commonality for value chain adoption is that traditionally, it emphases on the financial implications that operations such as sourcing, logistics and marketing can have on the pricing and sales power of an industry's product to end users (Olson, 2014). Likewise, in the value chain activities, different stakeholders add value to the product to increase the final product value (Soosay *et al.,* 2012). Accordingly, sustainable value chain addresses every phase from raw materials sourcing to consumer right down to dumping of product package after usage (Fearne *et al*., 2012). Thus, offering increased value to consumers for the minimum possible incurred cost (Pesonen, 2001; Thomas-Francois *et al.,* 2017).

2.3 Related Works

Research in sustainable value chain have been investigated by a few researchers as this area of study is still emerging, thus this sub-section reviews prior studies related to this research. Among these studies Couto *et al.* (2016) researched reverse green value chain by analyzing end users behavior in 28 European countries firms' perspective by employing descriptive analyses and structural equation modeling. The researchers mentioned that European consumers are conscious of the "Green" concept, but are not willing to buy or pay more for these products since the value is unclear. Companies offering green products must therefore think their strategies, especially in terms of value proposition, communication strategies, and eco-labeling. However, their study is more aligned with exploring variables that influence consumer's perception towards value to be derived from green products.

Next, Fearne and Martinez (2012) explored the dimensions of sustainable value chains based on case study method to argue how and why value chain analysis needs to integrate the environmental and social elements of sustainability in attaining sustainable competitive advantage. The authors argued that prior studies mainly focused on economic sustainability and paid inadequate attention to social and environment consequences of firm business process. The limitation of the study is due to the fact that the authors only explored the environmental and social dimension and did not consider the economic factors. Furthermore, Kung *et al.* (2012) examined green value chain to improve environmental performance of manufacturing industries in Taiwan. The authors investigated the correlation between green management and environmental performance based on supply and acquisition of upstream materials, research and development, manufacturing and packaging, marketing, promotion and education, and recycling as activities to improve sustainable value chain operations. However, findings from their study are only applicable to Taiwanese firms.

Additionally, Soosay *et al.* (2012) examined sustainable value chain analysis based on case study of Vine industry in Oxford, UK to present how sustainable value chain analysis can be utilized as a diagnostic tool to identify misalignment between resource allocation and end user preferences. Interestingly, their study integrates value chain analysis and life cycle analysis to define which activities in the chain creates value. The main limitation of the research is that the study focuses on a single country (UK). Thus, the single case study results from wine industry cannot be generalized to other industry in general and different parts of the world. Similarly, Soosay and Fearne (2011) employed sustainable value chain analysis as a medium to improve co-innovation as an approach for achieving sustainable competitive advantage in wine industry in Australia. Thus using sustainable value chain analysis, the researchers identified the need for more effective collaboration between policy makers, industry associations and commercial businesses in order to create a closer alignment between resource allocation, environmental management and consumer value. The authors adopted case study using semi-structured interviews only no statistical data was presented in the study.

Likewise, Tan and Zailani (2009) investigated green value chain for sustainability development towards achieving sustainable competitive advantage in manufacturing firms in Malaysia. The researchers developed a research model that comprises of sustainable development, green value chain, and sustainable competitive advantage. However, no empirical analysis was presented to confirm the developed model. Next, Pesonen (2001) explored environmental management of value chains operations towards improving the entire product life-cycle in industrial process. The author argued that industries should be aware of the environmental aspects of their products within the whole value chain in relation to the life-cycle of their products.

Moreover, the author designed a product life-cycle model that described the relationship between product life-cycle, stakeholders (suppliers, consumers, main contractor, authorities, NGOs, competitors, and employee), and value chains activities (raw material, transport, and waste management). However, the author only concentrated on the environmental dimension of sustainability. In addition, Rose and Stevels (2000) studied application of environmental value chain analysis for product take-back of out-dated systems. The authors further examined the influence of information, profit and product flows between players (producers, government, consumers and recyclers) involved in take back in relation to how these players are affected by internal value chains that impact other external interactions. The limitation of the study is that the research is more centered to return and post-use processing activities.

Hartman and Stafford (1998) researched on initializing enviropreneurial value chain strategy through green alliances in making businesses to be more environmentally responsible. The authors proposed a enviropreneurial value chain activities that comprises of primary activities (inbound logistics, operation, outbound logistics, marketing and sales, services, and post use processing) and support activities (procurement, technology development, human resource management, and corporate infrastructure). However, the author did not carry out any data collection to verify each value chain activities. Lastly, Handfield *et al.* (1997) conducted qualitative method by employing interview to examined green value chain operations in the furniture industry. Based on the interview data the authors developed a taxonomy of eco-friendly best practices to improve value chain operations management. The taxonomy was further extended to develop a group of propositions to improve eco-friendly practices, although no evaluation was carried out to confirm the developed taxonomy measures.

Based on the ten prior studies reviewed in relation to sustainable value chain, there is lack of a study that examined the activities to be implemented for sustainable value chain adoption as well as the drivers that influence environmental practices in improving sustainable value chain adoption. Besides, none of the studies conducted their research in ICT based firms. Hence, this research is motivated to fill the gap in knowledge by constructing a model that present the activities to be implemented for sustainable value chain adoption and drivers that influence strategic environmentalism in ICT based firms.

3 Prescriptive Model and Hypotheses Development

This section aims to accomplish the first and second objectives by identifying the sustainable value chain activities and drivers for strategic environmentalism from prior studies.

3.1 Porter Sustainable Value Chain Theory

According to Porter's (1985) sustainable value chain theory, value chain operations can be further subdivided into primary and support activities as previously adopted by Hartman and Stafford (1998); Kung *et al.* (2012) in their research on green value chain as seen in Figure 1.

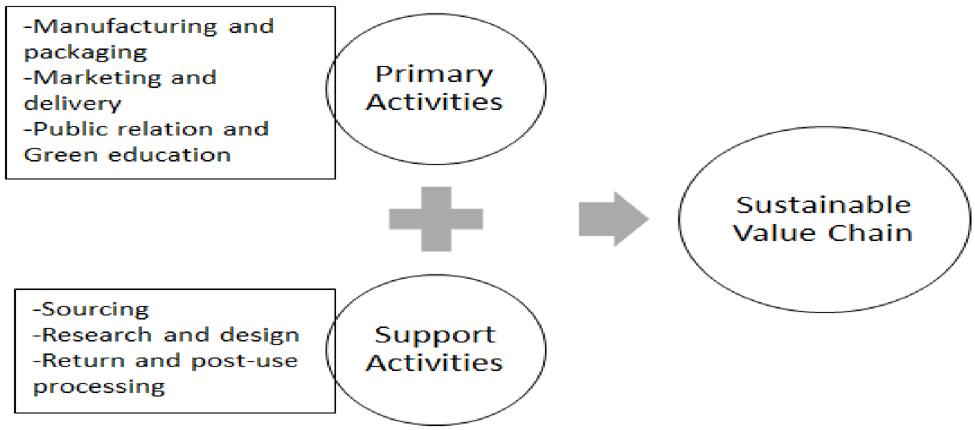

Figure 1 Porter's sustainable value chain theory adapted from (Porter, 1985)

Analogous to Porter's sustainable value chain theory, this study also categorized green manufacturing and packaging, green marketing, and public relation and green education are the primary activities while sourcing, research and development, and returns and post use processing as support activities.

3.1.1 Primary Value Chain Activities

a. Green Manufacturing and Packaging

Green manufacturing refers to procedures which use IT materials and products with moderately low environmental effects, which produce little waste or generates less pollution in ICT industrial operations (Saha, 2014). Green manufacturing encompasses hygienic delivery procedures to encourage negligible waste formation, which enhances energy efficiency thereby lowering electricity utilization (Pichetpongsa and Campeanu, 2011). Likewise, green packaging consist of green logistics in terms of smaller size, better shape, and usage of materials that have less effect on product or service distribution to consumers (Sarkis, 1995; Anthony *et al*., 2018a). Where improved packaging, with rearranged packing shapes, can reduce materials usage, create space in the enterprise warehouse and in the vehicle (trailer), thereby minimizing the quantity of handling needed (Raza *et al*., 2012; Thiruvattal, 2017). Thus it is proposed that;

H1: Green manufacturing and packaging initiatives will have a positive effect on sustainable value chain adoption in ICT based industries.

b. Green Marketing and Delivery

Green marketing and delivery refers to industrial activity, aimed at satisfying consumers demand for green IT product and services (Kung *et al.,* 2012). In addition, green marketing refers to the procedure utilized to predicts, identifies and meets the demands of customer and the society

(Schmidt *et al.,* 2011). Hence, green marketing focus on the acquirement, assembly, sales, usage, and discarding of IT raw materials towards reducing the environmental effect of every link in the value chain (Kung *et al*., 2012). It involves various aspects of promotion, ranging from advertising strategies to corporate operations or corporate culture. Similarly, green delivery characterizes set of IT initiatives that relates to the beliefs and ethics of environmental consideration for IT product pricing and promotion put in place to satisfy the demand of end users and society (Kung *et al*., 2012). Thus it is proposed that;

H2: Green marketing and delivery practice implemented will have a positive effect on sustainable value chain adoption in ICT based industries.

c. Public Relation and Green Education

Public relations and green education involves creating awareness on environmental friendly IT hardware products and services by utilizing communication tools which includes sales staff, green promotions and direct selling of green IT products and services (Kung *et al*., 2012). In industrial environment, green education involved providing eco-friendly awareness for practitioners to aid the discussions of green issues and communication of green messages within the firm (Kung *et al*., 2012). Furthermore, green education underpins green concepts among practitioners during value chain operations, hence making them aware of environmental objectives of the industry. Based on the proceeding arguments, the following hypothesis is made:

H3: Public relation and green education awareness campaign carried out will significantly influence sustainable value chain adoption in ICT based industries.

3.1.2 Support Value Chain Activities

a. Sourcing

Sourcing ensures that procured IT hardware conforms to environmental requirements, where green sourcing refers to the purchasing of IT materials that is in line with environmental friendly standards (Kung *et al*., 2012; Junior *et al*., 2018). Hence, sourcing in industries involves making preference for IT hardware that are recyclable and reusable or have been previously recycled (Schmidt *et al*., 2011). In addition, sourcing considers the environmental performance of IT merchants, thereby integrating ecological friendly principles into value chain operations. Moreover, sourcing involves ecological-friendly procurement practices for IT hardware and selection of IT hardware according to ecological criteria (Handfield *et al*., 1997). Thus it is proposed that;

H4: Sourcing initiatives will have a positive impact on sustainable value chain adoption in ICT based industries.

b. Research and Design

Research and design (R&D) entails initiating set of principles and procedures for practitioners to implement green design activities (Schmidt *et al*., 2009), such that industries possesses the capability to support practitioners in the deployment of value IT services and products (Kung *et al.,* 2012). Besides, R&D in industries involves synthesizing, analyzing and designing ecological friendly services as well as IT products with less energy (Saha, 2014). Accordingly, ICT based industry facilitates practitioners to design efficient IT products with less costs incurred (Pichetpongsa and Campeanu, 2011). Thus, industries aim to design and produce IT products that integrate ecological considerations effectively as well as analytically by modifying the current existing techniques (Mickoleit, 2010). Thus it is hypothesized that;

H5: The research and design practice employed will have a positive effect on sustainable value chain adoption in ICT based industries.

c. Return and Post-use Processing

This activity aims to reduce e-waste by repairing, re-deploying, or disposing, refurbishing, retaining, reusing of outdated IT hardware in an environmentally friendly manner (Loeser *et al*., 2017). According to Mickoleit (2010) discarded IT hardware should be dismantled for reuse or refurbished, whereas disposal of outdated IT hardware should conform to pertinent ecological legislations and regulations. Return initiatives includes striving for recoverability and recyclability of IT hardware as stipulated by The European Waste Electrical and Electronic Equipment (WEEE) directive (Pichetpongsa and Campeanu, 2011) and lastly using biodegradable based materials in place of plastics (Raza *et al*., 2012). Thus it is proposed that;

H6: Return and post-use processing activities will have a positive effect on sustainable value chain adoption in ICT based industries.

Based on the finding from Section 3.1 the derived primary and support activities from the literature includes green manufacturing and packaging, green marketing, and public relation and green education, sourcing, research and development, and returns and post use processing.

3.2 Drivers for Strategic Environmentalism

To accomplish the second objective, it is important to identify the drivers that influence ICT industries to consider the natural environment in their value chain operations. Based on prior studied conducted by Banerjee (2002); Gil *et al.* (2007); Tan and Suhaiza (2009) the author identified four drivers of environmentalism that comprises of social concern, regulatory forces, operational performance and management performance. In addition, value added information is included as a new driver in this study based on previous studies Soosay *et al.* (2012); Couto *et al.* (2016). Accordingly, each of the identified drivers is discussed below.

3.2.1 Social Concern

Social concern or pressure from the society is one of the main forces that persuade practitioners, stake holders and staffs in industries to adopt environmental friendly initiatives (Vykoukal *et al.,* 2011; Jørsfeldt *et al*., 2017). In this respect, Banerjee (2002) mentioned that motivational pressure from consumer groups is a crucial factor in the integration of environmental friendly initiatives into managerial decisions. Gil *et al.* (2007) maintained that the social pressure from these groups such as consumers may have a significant influence on industrial's environmental alignment and policies. Finally, Kranz and Picot (2011) stated that industries operating in polluting sectors such as manufacturing firms are faced with a higher social pressure because the consumers perceive they generate more CO_2 emission when they use IT products. Accordingly, this study formulates the hypothesis that:

H7: Social concern positively influences sustainable value chain practice adoption in ICT based industries.

3.2.2 Regulatory Forces

Regulatory forces aids in enforcing laws that are needed to protect the natural environment (Banerjee, 2002). According to Tan and Suhaiza (2009), the emergent political influence in ecological related problems has resulted in the development of ecological legislations to monitor industrial operations. Respectively, the push or pressure from governmental and NGOs is usually perceived as essential to attain environmental preservative objectives in designing green value IT products with lesser cost and improved quality (Zhu *et al.,* 2013). This is supported by Gil *et al.* (2007); Butler (2011) where the authors reported that the existence of strict regulations is one of the main driving forces for ecological actions. Likewise, Ryoo and Koo (2013) argued that industries try to meet the expectations of competitors as well as interest groups due to regulatory pressure. Accordingly, this study establishes the following hypothesis:

H8: Regulatory forces positively influence sustainable value chain adoption in ICT based industries.

3.2.3 Operational Performance

This includes the prospect of attaining competitive value chain advantage for social, economic and environmental benefits in industries (Tan and Suhaiza, 2009; Anthony *et al*, 2018a). Accordingly, social benefit comprises adopting sustainable value chain initiatives that will lead to improvement of the industry's image (Hervani *et al*., 2005). Thus, economic benefit for sustainable value chain leads to a positive effect on the firm's commercial performance and growth in net sales (Huybrechts *et al*., 2018). Similarly, environmental benefit sustainable value chain can lead to better pollution mitigation and IT recycling strategies, which causes decrease in the ecological accident and fines incurred by industries due to pollution and IT waste discarded (Agrawal *et al*., 2016). Recently, Abareshi and Molla (2013); Anthony Jnr *et al.* (2018) argued that the state of adoption of environmental practice will has a positive impact on the firms' competitive advantage for cost decrease and product diversity. Thus it is proposed that;

H9: Organizational performance will positively determine sustainable value chain adoption in ICT based industries.

3.2.4 Management Performance

This driver relates to the commitment of management towards adopting sustainable practices in their industrial operations (Anthony Jr, 2019) According to Vykoukal *et al.* (2011) management performance is a strong internal administrative force. Hence, management can improve environmentalism by assigning environmental and steward supervisors to be responsible for controlling the industry's sustainable value chain activities (Simpson *et al.,* 2007; Carter and Rogers, 2008). In this respect, Molla *et al.* (2014), whose research examined IT professionals environmental beliefs in relation to sustainable practices adoption in firms confirmed that the attitude of management committee members positively influence if an industry will adopt sustainable practices. Similarly, Ryoo and Koo (2013) also emphasized the role of management in initiating innovative environmentally friendly strategies. Based on the proceeding discussion revised it is proposed that;

H10: Management performance will positively influence sustainable value chain adoption in ICT based industries.

3.2.5 Value Added Information

Kranz and Picot (2011) stated that consumers need credible and clear information to judiciously decide what to purchase and to select IT products with perceived value. Hence consumers' intention to purchase a product can be favorable or unfavorable based on the availability of information reflecting product value (Rose and Stevels, 2000; Singh *et al*., 2016). Accordingly, findings from Couto *et al*. (2016) suggested that the information about a product displayed at shops, advertising or on the internet are the most significant sources of knowledge. Thus, available information on the perceived value to be derived from a product influences the purchase power of a particular product (Butler, 2011; Sarkis *et al.,* 2011). Respectively, information for sustainable value chain, support decision making in the chain on how resource can be effectively allocation based on what customer value and what they do not value (Hassini *et al*., 2012; Soosay *et al*., 2012). Thus it is hypothesized that;

H11: The availability of information on value created to consumers significantly influences sustainable value chain adoption in ICT based industries.

Based on the finding from Section 3.2 the derived drivers that influence strategic environmentalism from the literature include social concern, regulatory forces, operational performance, management performance, and value added information. Thus, in relation to the literature on sustainable value chain activities and drivers for strategic environmentalism the prescriptive model is constructed as shown in Figure 2 to accomplish the third objective.

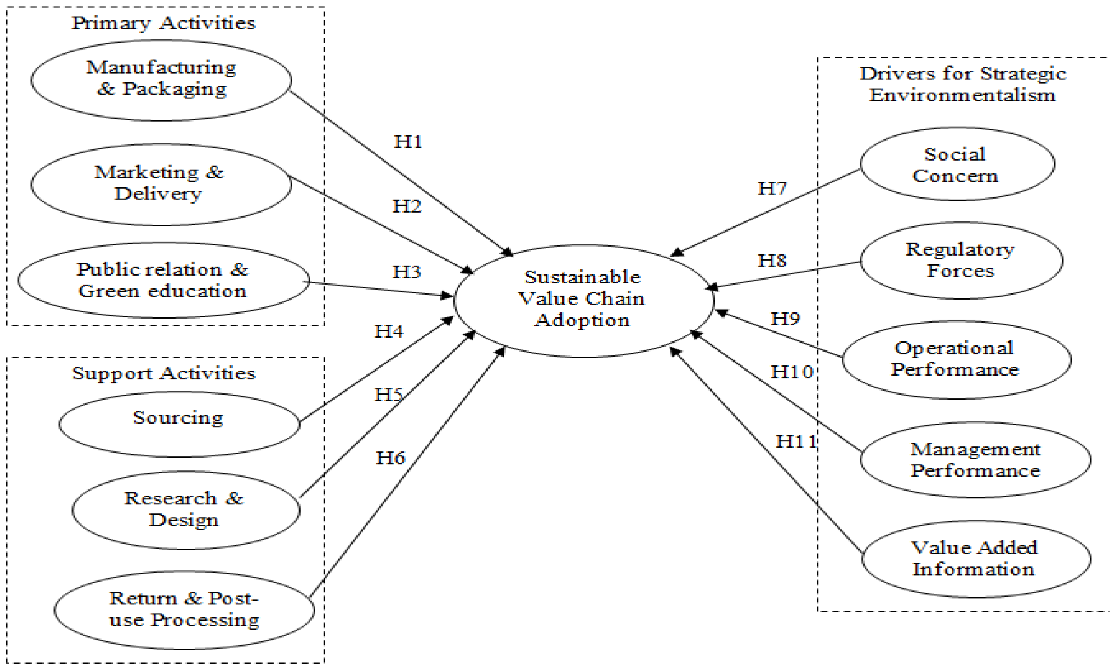

Figure 2 Constructed prescriptive model

Figure 2 shows the constructed prescriptive model which is intended for tangible products or goods in value chain and not for service supply chains. The model aims to evaluate and reveal the extent to which ICT industries are adopting sustainable value chain practices.

4 Research Methodology

4.1 Measure of Constructs

In constructing the scale to validate the constructed prescriptive model, items were adopted from prior studies (see Table 1) for sustainable value chain activities, driver for strategic environmentalism and sustainable value chain adoption. The scale consists of 66 items (see Table 1). The questionnaire comprises of three parts. The first part is the demographic data of the respondents and their respective industry measured using ordinal measurement (see Table 2). The second part measures the rate of sustainable value chain adoption practice. In the second part of the questionnaire, respondents were asked to rate the level of sustainable value chain practice adopted in their industry based on a five-point Likert scale similar to prior studies Zhu *et al*. (2005); Tan and Suhaiza (2009); Couto *et al.* (2016), where "1" means that the sustainable value chain initiative is not fully adopted and "5" means the sustainable value chain initiative its fully adopted. The third part measures the perception of the respondents in relation to how important does the drivers of strategic environmentalism influences sustainable value chain adoption in their respective industry based on a five-point Likert scale analogous to Simpson *et al.* (2007); Zhu *et al*. (2013); Thomas *et al*. (2016), where 1" means not influential and "5" means very influential.

Insert Table 1 Here

As seen in Table 1 some of the construct items are related to ICT industry and other are not, this is due to the fact that the items are derived from literature on sustainable value chain practices conducted from different industrial domain as discussed in Section 2.3.

4.2 Sample and Data Collection

The survey data collections was intended to empirically test the constructed prescriptive model (see Figure 2). Since, the study is mainly for organizational level and less for individual level the population included certified ICT based industries in Malaysia that adopt ISO 14000/14001 as carried out by Chien and Shih (2007); Younis *et al*. (2016) in their research in green supply chain. The samples were gotten from the list in Department of Standards Malaysia website analogous to previous study Tan and Zailani (2009). Thus, ICT industries listed by the Department of Standards Malaysia according to their ISO 14000/14001 rating were included as the population where the samples were selected from. Accordingly, the prospective participants were IT and environmental practitioner in Malaysia ICT based industries. Their contact details were gotten from their company website and emails were sent to them accompanied with a cover letter starting the need for the research. ICT firms in Malaysia were chosen for this study due to the increasing impact of IT on society, economy, and environment, and the management of IT hardware manufacturers as such ICT industries are faced with the challenge of adopting sustainable value chain practice and these has given rise to growing consumption of natural resources, increased CO_2 emissions, increased cost incurred, inflated energy usage and unethical waste management which contributes to environmental degradation and climate changes.

Thus, ICT industries in Malaysia were chosen for this study by employing purposive sampling technique, where only respondents who possess knowledge in sustainable practice in their firms were chosen. Additionally, to ensure content validity of the questionnaire instrument, the items was derived from prior literatures followed by pre-test of the questions refinement carried out to check for typographic wording errors, logical errors and syntax content appropriateness of the questions. However since the items were derived from prior studies pilot test was deemed unnecessary. The item was only pre-tested, where the questions were refined and revised based on the recommendations of three experts (two sustainability academicians and one practitioner) who have more than three years experiences in sustainable life cycle adoption to confirm that each question was suited for the study as previously carried out by Kung *et al.* (2012) in their research on green value chain. The experts checked the English clarity and suitability of the questions in relation to the support and primary activities and drivers for face and content validity. Then, data was collected from January 2017 till April 2017. At the end of the data collection, a total of 994 requests were sent out, and 187 were collected. However, only 157 responses were found complete which could be utilized for further statistical testing which is moderate and is more than samples used in prior similar studies, where Gil *et al*. (2007) utilized 81 samples, Simpson *et al*. (2007) used only 56 useable samples, Chien and Shih (2007) who employed 150 valid samples, Soosay and Fearne (2011) who used 77 survey samples, Kung *et al*. (2012) used 118 questionnaires samples in their study. Likewise Younis *et al*. (2016) used 117 samples.

5 Results

The profile characteristic of the sample is shown in Table 2.

Insert Table 2 Here

In addition, to check for non-bias, since this research used a purposive sampling method non-response bias test by comparing the non-respondents and respondents was not applicable to this study (Ryoo and Koo 2013). Instead, this study followed the recommendation proposed by Lambert and Harrington (1990), an approach to check for non-response bias to examine the possibility of bias where the sample distributions of the early (first 35 respondents) and late respondent (last 35 respondents) groups were compared (Thomas *et al*., 2016) using One way Anova test deployed by Statistical Package for Social Science (SPSS) version 22 similar to prior studies was carried out (Meacham *et al*. 2013; Ryoo and Koo 2013; Anthony Jr, 2019) by considering the industry size.

Insert Table 3 Here

The sample distributions of the two groups as seen in Table 3, indicate that the test is not statistically significant at 5% significance level ($p>0.05$) indicating the absence of bias in the data (Simpson *et al*., 2007; Thomas *et al*., 2016; Anthony *et al*., 2018a).

5.1 Method and Technique

Structural Equation Modeling (SEM) approach is employed for analyzing the data to validate the constructed model as used by Kung *et al.* (2012); Couto *et al.* (2016) in their studies on value chain. SEM is an approach for statistical data analysis that allows for modeling complex cause and effect relationships between variables items. For the data analysis Partial Least Squares (PLS), a SEM technique was utilized. The PLS-SEM technique is primarily focused on the predictive causal testing based on variance. PLS-SEM does not require a large sample size, and PLS can be used for model validation. It can also be used to verify hypothesis (Vykoukal *et al*., 2011). Hence, this study considers PLS-SEM as an appropriate statistical tool for this study. Additionally, the analysis was carried out by SmartPLS 3 software using 5000 sample bootstrapping technique as suggested by (Ryoo and Koo, 2013; Anthony *et al*., 2018a) to determine the significance levels of the path coefficients, weights and loadings for model validation. All statistical tests were measured with one-tailed, *t*-tests at $p<=0.05$ significance.

5.2 Assessment of Measurement Model

Before testing the structural model, the measurement model is tested by to checking reliability and validity. Accordingly, the indicator loading, construct reliability, convergent validity, and discriminant validity was assesses. The construct reliability was confirmed using the

Composite Reliability (CR) coefficient. PLS-SEM prioritizes indicators according to their individual reliability (Hair *et al*., 2012). Thus, composite reliability was employed instead of Cronbach's alpha to analyze the reliability of the constructs, since the previous takes into deliberation indicators that have different loadings (Hair *et al.,* 2011). Thus, results from Table 4 show that all constructs have CR above 0.7, which indicates that the constructs are reliable. Lastly, the mean score of all constructs are higher than 2.5 on a 5 point scale and the standard deviation (SD) value is lesser than 1 showing that the response from the respondents are close.

Insert Table 4 Here

Next the indicator reliability was evaluated based on the benchmark that the loadings should be greater than 0.70, and that every loading less than 0.70 should be eliminated as suggested by Henseler *et al.* (2009). As shown in Table 4, all loadings values are greater than 0.7, hence, no items in the table were eliminated. In addition, Average Variance Extracted (AVE) was utilized as the criterion to test convergent validity, where the AVE values should be higher than 0.5, so that the variable explains more than half of the variance of its indicators (Hair *et al*., 2012; Anthony Jr, 2019). As shown in Table 4, all constructs have an AVE higher than 0.5, meeting this condition (Henseler *et al*., 2009).

Insert Table 5 Here

Furthermore the discriminant validity of the constructs was assessed using two measures: cross-loadings and Fornell-Larcker criteria. The first measure suggests that the square root of AVE should be greater than the correlations between the construct (Fornell and Larcker, 1981). The second criterion entails that the loading of each indicator should be greater than all cross loadings (Chin, 1998). Accordingly, results from Table 5 reveal that the square roots of AVEs (diagonal elements) are higher than the correlation between each pair of constructs (off-diagonal elements). Thus, both measures are fulfilled (Thomas *et al*., 2016). The results of construct reliability, indicator reliability, convergent validity, and discriminant validity of the constructs were satisfactory, indicating that the constructs can be used to validate the constructed prescriptive model (see Figure 2).

5.3 Assessment of Structural Model

The structural model was assessed using percentage of variance R^2 measures and the level of significance of the path coefficients (Hair *et al*., 2011). Accordingly, Table 6 and Figure 3 show the model results. Besides, the significance of the path coefficients or standardized regression weights was assessed by means of a bootstrapping procedure (Henseler *et al.,* 2009) with 5000 iterations of resampling (Chin, 1998) to accept or reject hypotheses (H1-H11) as seen in Figure 2, SmartPLS3 was used to generate path coefficients, R^2 , t-value and p values.

Insert Table 6 Here

Therefore, Table 6 shows the hypotheses test using one-tailed t-test with a significance level of 5% (0.05). According to Hair *et al.* (2011) for the path coefficient to be significant the T-statistics must be equal or larger than 1.65 when using one-tailed. Hence, since there is a positive relationship between the independent variables and dependent variables the author opted for one-tailed test (Chin, 1998). As seen all the values are greater than the 1.65 threshold (see Table 6 and Figure 3). Respectively, results from Table 6 shows the assessment of structural model (H1-H11), where results presenting the R^2 value show how much the variance of the sustainable value chain adoption is being explained by the constructs. Moreover, the path coefficient values are presented, thus ranking of the variables relative statistical importance.

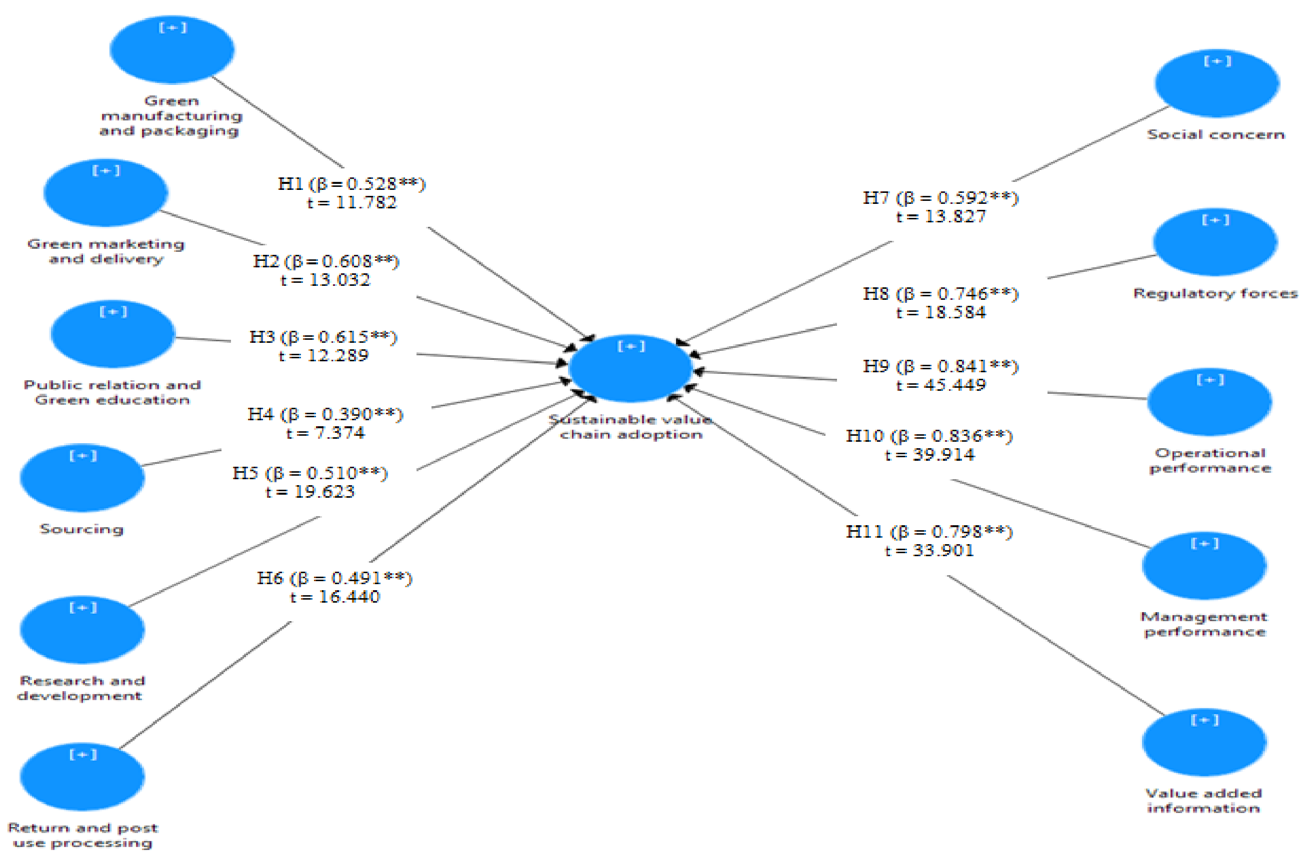

Figure 3 Results of structural model (note: ** significant at 0.05)

Accordingly, results from Table 6 indicate that path coefficient, R^2 (percentage variance) should be >0<1 (Hair *et al.*, 2011; Henseler *et al.*, 2009), where R^2 for (H1) is 0.345 for green manufacturing and packaging signifying that green manufacturing and packaging reasonably explain 34.5% variance of sustainable value chain adoption in ICT based firms in Malaysia. Next, (H2) R^2 is 0.404 (40.4%) for green marketing and delivery, (H3) R^2 is 0.434 (43.4%) for public relation and green education. (H4) is 0.111 (11.1%) for sourcing. (H5) R^2 is 0.435 (43.5%) for R&D, (H6) R^2 is 0.380 (38.0%) for return and post use processing, (H7) R^2 is 0.421 (42.1%) for social concern. (H8) R^2 is 0.746 (74.6%) for regulatory forces. (H9) R^2 is 0.748 (74.8%) for operational performance, (H10) R^2 is 0.737 (73.7%) for management performance and lastly (H11) R^2 is 0.708 (70.8%) for value added information.

In addition, results from Table 6 also suggest that for the path coefficient (standardized regression weights), operational performance has the strongest effect on sustainable value chain adoption in Malaysia ICT based firms at (0.865) revealing that the operational use of IT infrastructure in Malaysia ICT based firms has the potential to support practitioners in Malaysia achieve social, economic and environmental in value chain operation to address increase cost incurred, reduce CO_2 emission, lessen energy usage etc. Next, is management performance (0.859), then value added information (0.841), next is regulatory forces with (0.765), then R&D (0.660), followed by public relation and green education (0.658). Social concern have a value of (0.649) followed by green manufacturing and packaging (0.635), accompanied by return and post use processing (0.616). Next, is green manufacturing and packaging (0.616), and lastly sourcing with (0.333). Hence, the hypothesized path relationship (H1-H11) is statistically significant since all standardized regression weights values are greater than 0.1 (Henseler *et al*., 2009). Thus, it can be concluded that the primary and support activities are important in achieving sustainable value chain adoption in Malaysia ICT based firms and the drivers for strategic environmentalism reasonably predict sustainable value chain adoption in Malaysia ICT based firms.

6 Discussion

As ICT industries transform more physical operations to virtual operations, understanding the significance of sustainable value chain phenomenon becomes imperative. Over the years previous studies have investigated value chain from a broad perspective. The locus of this research is congruent with the proposed Porter’s (1985) value chain theory (see Figure 1). This study fills the research gap by investigating the primary and support activities in accomplishing the first objective of the study and also identified the drivers for environmentalism in Malaysia ICT based firms accomplishing the second objective. The key findings of our study include that the identified primary activities (green manufacturing and packaging, green marketing and delivery, and public relation and green education), support activities (sourcing, research and development, and returns and post use processing) and drivers for environmentalism (social concern, regulatory forces, operational performance, management performance, and value added information) positively influence sustainable value chain adoption in Malaysia ICT based firms. Moreover, a model is developed to accomplish the third objective in examining sustainable value chain adoption for strategic environmentalism in Malaysia ICT based firms.

Next, the developed model is validated to accomplish the fourth objective of the study based on survey data which confirms that the drivers for environmentalism influence sustainable value chain adoption in Malaysia ICT based firms. Besides, results indicates that primary and support activities have an effect on the value chain operations implemented by practitioners in Malaysia ICT based firms as proposed by Porter's (1985) sustainable value chain theory. Findings from this study corroborate prior research (Sarkis, 1995) that indicates a positive influence of green manufacturing and packaging on the firm's adoption of sustainable value chain adoption in Malaysia ICT based firms. A plausible explanation may be that industries aim to attain less cost incurred for IT raw material. This can be lead to gains in production efficiency, reduction of ecological and occupational safety costs, and improved firms' image. In addition, green manufacturing and packaging consist of green logistics in terms of smaller size, better shape, and usage of IT materials that have less effect on product or service distribution. Thus, improved packaging, and rearranged packing shapes, can reduce raw material usage, create space in industrial warehouse and transportation vehicle (trailer), thereby minimizing the quantity of handling needed (Raza *et al*., 2012).

Respectively, results from this study also support prior findings that suggested that green marketing and delivery initiatives influences sustainable value chain adoption in Malaysia ICT based firms. This is analogous with past findings presented by Kung *et al.* (2012), where the authors stated that green marketing and delivery aims to decrease use of non-renewable resources to ensure sustainability, and reduce toxic emissions to the environment. Thus, IT materials utilized should be mainly eco-friendly with little or no residues/wastes. Moreover, findings from this research also confirm that for green marketing and delivery ICT based industries in Malaysia should compare the green metrics of IT (processes, components or materials) and select the one with the least ecological impact, since this would produce services and products with less environmental impacts (Schmidt *et al.*, 2011). Accordingly, this study provides ample support for the importance of initiating green education awareness training and environmental public relation education in the firm's organizational development programs (Kung *et al*., 2012). Such initiatives may help influence industrial community's attitude towards environmentalism for sustainable value chain adoption.

Additionally, this study found that sourcing operations implemented in Malaysia ICT industries was significant in explaining sustainable value chain adoption. This is analogous with prior studies (Schmidt *et al*., 2011; Kung *et al.*, 2012) where the authors argued that most firms adopt environmentally preferable IT hardware purchasing governance policy based on green guidelines adapted when buying IT infrastructures. In addition, Loeser *et al.* (2017) added that sustainable sourcing in any industry should involves the practice of evaluating the green track record of IT and software services vendors by integrating environmental considerations in firms IT purchasing decisions. Furthermore, with regard to research and development, the results also indicate that industries that concurrently pursue a reduced cost method while endeavoring for exceptional product differentiation will never achieve ecological goals (Schmidt *et al*., 2009). As such, ICT based firms in Malaysia will be challenged with diminishing competitiveness and low productivity due to lack of environmental research and development in their current value chain activities adopted in the industry (Pichetpongsa and Campeanu, 2011). Thus, it is imperative to infuse research and development geared towards re-enforcing sustainable vale chain operations.

The survey findings further suggest that returns and post use processing operations contributes to actualizing sustainable value chain in Malaysia ICT based firms. This is similar to results presented by previous studies, where Schmidt *et al.* (2009); Mickoleit (2010) maintained that returns and post use processing of out dated IT hardware provides flexible and audit administrative solution for gathering and re-processing of discarded redundant IT equipment by recycling electronic waste. In addition, Rose and Stevels (2000); Schmidt and Kolbe (2011); Raza *et al.* (2012) believed that returns and post use processing brings about reduction of waste, minimization of CO_2 emissions at a controlled handling cost. The results of this study also offer evidence indicating that social concern or pressure from consumers and stake holders contribute to the firm's adoption of sustainable value chain. Therefore, researchers such as Tan and Suhaiza (2009); Abareshi and Molla (2013) argued that industries should endeavor to accomplish the prospects of their interest groups by adjusting the vale chain demand of products and services.

Likewise, Vykoukal *et al*. (2011); Anthony *et al.* (2017a) concluded that social pressure from consumers is highly effective in inducing industries in adopting eco-friendly practices in Malaysia ICT based firms. The results indicate that industries are currently implementing green technologies and systems to fulfill anticipated or pending changes to governmental and non-governmental environmental policies and regulations. Also, prior study Banerjee (2002) stated that environmental protocols are crucial for the decrease of pollution from discarded IT equipment. Results presented by researchers such as Vykoukal *et al*. (2011); Molla *et al*. (2014) indicated that industrial involvement in environmental protection actions is mainly due to environmental regulations stipulated by government. Thus, confirming that regulatory forces from governmental and NGOs influences sustainable value chain adoption in Malaysia ICT based firms.

Findings from this research also reveal that operational performance positively influences sustainable value chain adoption in Malaysia ICT based firms. Additionally, Tan and Suhaiza, (2009) claimed that the quality of environmental friendly practice implemented in the firm on how IT can be used in reducing energy consumption, lessening CO_2 emission by industries about their daily activity may be a key source of competitive value advantage when they endeavor to gain their clients' loyalty. Besides, Kranz and Picot (2011) mentioned that operational performance from cost savings can be derived by decreasing the utilization of raw materials and power consumed in enhancing business operations may become a significant competitive value advantage for industries. This study thus provides valuable support to literature that management involvement influences sustainable value chain adoption in Malaysia ICT based firms (Carter and Rogers, 2008). Likewise, Ryoo and Koo (2013) found that industries with managers responsible for ecological issues achieve higher levels than industries where there are no environmental managers to oversee sustainable practices. Accordingly, managers view expenses in sustainable value chain as necessary firm investment (Simpson *et al*., 2007). However, this may be influenced by the enthusiasm among industries to commit financial and executive resources towards sustainable value chain (Thomas *et al*., 2016).

Additionally, for Malaysia ICT industries to initiate sustainable value chain, this study suggests that the availability of information about environmentalism influences sustainable practices. Hence, there is need for information to be provided about the environmental friendliness of valued IT products to consumers. Besides, findings from Handfield *et al.* (1997) indicated that practitioners in value chain industries do not perceive environmental issues as directly significant to their jobs. Thus, practitioners often do implement eco-friendly value chain practices. Correspondingly, in resolving this problem, Handfield *et al.* (1997); Anthony *et al.* (2017a) suggested that strategic objective must be to educate practitioners as well as logistics managers on the significance of environmental, social and economic consideration in relation to cost reduction, quality improvement and lead time reduction in ICT industries.

7 Implications of Study

7.1 Theoretical Implications

Sustainable value chain refers to value creation of a product or service designed to reduce environmental effect during its whole life cycle from practitioners sourcing the raw materials for production to disposal by end users (Kung *et al.,* 2012). However, industrial activities are a substantial source of environmental pollution which arises from extreme use of energy, material, water, waste, CO_2 emissions, transport, and harm to biodiversity (Darmawan *et al*., 2014). Hence, to protect societal health and the environment, different environmental rules are being adopted to mitigate industrial related emissions (Huybrechts *et al*., 2018). But, over the years there has been a large number of industry failures related to value chain operations pointing to the need for an environmental driven model, which can be deployed to evaluate the current sustainable practice and further provide guidance to practitioners. Although, several studies have been carried out on value chains, only few studies such as Soosay *et al*. (2012); Olson (2014); Thomas-Francois *et al*. (2017) did examined the impact of value chain activities on the environment. However, these studies did not integrate environmental related issues in a systematic and systemic approach in ICT based industry.

Accordingly, this study is theoretical motivated to explore sustainable value chain activities implemented by practitioners as well as the drivers that influences strategic environmentalism towards sustainable value chain evaluation in ICT based industries. Furthermore, the constructed prescriptive model can be utilized as an analytical tool for supporting the activities of continuous enhancement at all levels level of the chain in ICT industries and other industries. Additionally, the model can be deployed as a roadmap for the allocation of resources, thereby supporting academicians, practitioners and decision makers to recognize areas that need further improvement.

Theoretically, this study explored both sustainable value chain operations and variables as drivers that influence environmentalism for sustainable value chain adoption. Moreover, the items developed in this study (see Table 1) can be used to implement industry based benchmarks of corporate environmentalism for sustainable value chain operations as a diagnostic instrument to examine the degree to which environmental issues have been incorporated in ICT based industries.

7.2 Managerial Implications

This study provides managerial implications for both industrialists and policy makers by opening additional research avenues for sustainable value chain. Accordingly, for managerial implications, this study is motivated to provide managers with insights into how they can improve environmental performance in implementing sustainable value chain in ICT and other industries. Thus, insights from this study support managers to understand the structural relationships between the primary and support activities involved in implementing sustainable value chain for better environmental performance. Therefore, it is useful for industries such as manufacturing, engineering etc. to promote sustainable value chain by sharing successful experience and creating awareness of the environmental benefits. Such campaign can help to lessen the doubts of practitioners about adopting sustainable practice to decrease associated environmental risks. Besides, the constructed model (see Figure 2) provides a starting point for supply chain managers to understand environmentalism for sustainable value chain practice.

While, managers are familiar with the concept of environmental sustainability, findings from this study suggest that IT managers have very different viewpoints of what environmental sustainability really is. Thus, the model developed in this study provides an initial extension and incorporation of all value chain operational perspectives into a social and managerially significant derived conceptualization. The model also suggests an environmentalist case for the managerial adoption and integration into current value chain operations. While, previous research has alluded to economic and social benefits of sustainable value chain, the prescriptive model explicitly accounts for long-term environmental performance. Furthermore, the constructed model also offers IT managers a starting point for what is needed to develop sustainable value chain practices in their firms. The derived items (see Table 1) presented in this study provide IT managers with a tangible and salient understanding of how leading-edge, real-world firms are already implementing sustainable value chain in their enterprise thus supporting managers identify environmental and social initiatives with paramount strategic value.

7.3 Practical Implications

Over the decade, industries are faced with limited information on the sustainable value chain operations to be implementation (Anthony Jr, 209). Hence there is need for a value chain model that provides information on value chain strategies to be adopted in any industry. Hence, this study is motivated to provide practical implications to facilitate management of resources within and between industries in the value chain towards improving the competitiveness of the value chain. Besides, this study provides information on primary and support activities to reduce poor environment operations for sustainable economic advantage. Accordingly, results from this study provide a cross-section of managerial insights of corporate environmentalism. Hence, the environmental drivers examined in this study have the potential of transforming the traditional value chain operations to a more proactive method through improved stakeholder assimilation. Hence, this study practically contributes to the emerging literature in the field by developing drivers for enterprise environmentalism.

In addition, based on Porter's (1985) sustainable value chain theory this study developed a model that can deployed as a predominantly expedient tool for IT managers to pragmatically identify environmental strategies that can have the greatest sustainability impact in their industrial operations. For instance, for the primary and support activities (see Figure 2), managers can examine outbound and inbound logistics activities such as purchasing, packaging, use and return, warehouse wellbeing, and transportation effects which includes CO_2 emissions, energy use, and lastly after-sales service related issues which comprises of reverse logistics issues centering on ecologically waste disposal. Likewise, the drivers of environmentalism provide a self-assessment tool that can facilitate industries to set environmental benchmarks to evaluate their current organizational value chain operations. Thus, by implementing the primary and support activities, ICT industries as well as other industries in Malaysia and beyond can achieve cost saving decrease, energy efficiency, eco-friendly waste management, natural resource conservation and CO_2 emission reduction towards sustainability attainment when they utilize IT infrastructures in facilitating their industrial operations.

8 Conclusion, Limitations and Future works

Recently, Malaysia industries have increased their environmental responsiveness due to pressures from governmental, NGOs and society. Moreover, several of these firms are now adopting international environmental management standards such as ISO14001, ISO14000 and ISO9000. At the same time, industries in Malaysia have sought to implement variety of sustainable value chain practices to improve their environmental performance. But, results from this study reveal that sustainable value chain adoption is influenced mainly by internal operational performance, especially due to the environmental commitment from top management and support from practitioners within the firm. Similarly, green education and environmental awareness of practitioners is one of the initial crucial steps in improving sustainable value chain adoption. However, sustainable value chain is still in its infancy in Malaysia, although, Malaysia firms have recognized the importance, but still lagged in the implementation of sustainable value chain principles into practice.

Nevertheless, results from this study indicate that the impact of implementing sustainable value chain practices in ICT based industries has received a great deal of interest within the

Malaysia context, and therefore undertaking this area was deemed necessary. Accordingly, this study shed light on primary and support activities currently implemented by ICT industries in the Malaysia and the impact of several drivers that motivate these firms to adopt sustainable value chain while continuously endeavoring to improve the environmental performance. Data was collected from selected respondents in Malaysia ICT based industries and was analyzed using PLS-SEM to validate the developed model. Respectively, as with any study, limitations in the research exist, but these limitations also offer directions and opportunities for future studies. First, this study was limited to firms in ICT industry only, and this was due to the realization that ICT industry in any county contributes to the environmental impacts and that IT usage generates CO_2 emission, consumes energy and generates e-waste.

Secondly, the study was limited to Malaysia ICT industries and this study purposefully intended to examine sustainable value chain practices in Malaysia, hence the study's participants operated within Malaysia cultural context. Equally, the analysis and findings of this study should be deliberated with respect to this context. Thirdly, the survey describes the results of an analysis based on 157 samples. Whilst it is still possible to detect significant correlation and make rational assumptions with respect to the hypotheses with a sample of this size, it is required to get more samples for further complex testing. Lastly, this study applied quantitative research methodology by employing survey to collect data, which uses pre-determined measures resulting in numeric data. Thus, there is need to also employ qualitative data collection using interview similar to prior studies (Soosay and Fearne, 2011; Fearne and Martinez, 2012; Soosay *et al*., 2012) to capture a more complete, holistic, and contextual view of the sustainable value chain adoption, contributing to the validity and robustness of the results.

Further studies can extend the developed model to other industries in Malaysia may offer fruitful avenues to understand how the environmental performance of these industries behaves toward sustainable value chain adoption and how they conform with increasing environmental regulations. It can be claimed that this research lays the foundations for future longitudinal research in other Asian-pacific region such as Indonesia, Singapore etc. where ICT industry is booming. Further studies may explore the impact of drivers for environmentalism on sustainable value chain adoption within Asian-pacific regions to assess whether such environmental factors play significant role in improving their sustainable value chain adoption. Furthermore, this work is one of the few to investigate sustainable value chain adoption in Malaysia. Thus, results are still relatively exploratory. Future research can also include control and moderating variables that may influence various constructs in the developed model. Next, a random sample study across industries in Malaysia would be fruitful to get more samples that can provide a broader representation of sustainable value practices. Finally, qualitative research approach will be employed to investigate sustainable value chain adoption using interview to compliment the results from the quantitative survey data and also provide stronger inferences for the model.

References

Abareshi, A. and Molla, A. (2013), "Greening logistics and its impact on environmental performance: an absorptive capacity perspective", *International Journal of Logistics Research and Applications*, Vol. 16 No. 3, pp. 209-226.

Agrawal, S., Singh, R. K. and Murtaza, Q. (2016), "Triple bottom line performance evaluation of reverse logistics", *Competitiveness Review*, Vol. 26 No. 3, pp. 289-310.

Ahn, M., Kang, J. and Hustvedt, G. (2016), "A model of sustainable household technology acceptance", *International journal of consumer studies*, Vol. 40 No. 1, pp. 83-91.

Anthony Jnr, B., Abdul Majid, M. and Romli, A. (2018), "Green information technology adoption towards a sustainability policy agenda for government-based institutions: An administrative perspective", *Journal of Science and Technology Policy Management*.

Anthony Jr, B. (2019), "Green information system integration for environmental performance in organizations: An extension of belief–action–outcome framework and natural resource-based view theory", *Benchmarking: An International Journal*.

Anthony Jr, B., Abdul Majid, M. and Romli, A. (2018), "A collaborative agent based green IS practice assessment tool for environmental sustainability attainment in enterprise data centers", *Journal of Enterprise Information Management*, Vol. *31* No. 5, pp.771-795.

Anthony, B., Abdul Majid, M. and Romli, A. (2018b), "Heterogeneous agent-enabled decision system for evaluating Green IT performance in industrial environments", *Journal of Decision Systems*, Vol. *27* No. 1, pp. 37-62.

Anthony, B., Majid, M. A. and Romli, A. (2018a), "Green IS diffusion in organizations: a model and empirical results from Malaysia", *Environment, Development and Sustainability*.

Banerjee, S. B. (2002), "Corporate environmentalism: The construct and its measurement", *Journal of business research*, Vol. 55 No. 3, pp. 177-191.

Banerjee, S. B., Iyer, E. S., and Kashyap, R. K. (2003), "Corporate environmentalism: antecedents and influence of industry type", *Journal of Marketing*, Vol. *67* No.2, pp. 106-122.

Butler, T. (2011), "Compliance with institutional imperatives on environmental sustainability: Building theory on the role of Green IS", *The Journal of Strategic Information Systems*, Vol. *20* No 1, pp. 6-26.

Carter, C. R. and Rogers, D. S. (2008), "A framework of sustainable supply chain management: moving toward new theory", *International journal of physical distribution and logistics management*, Vol. *38* No. 5, pp. 360-387.

Chien, M. K. and Shih, L. H. (2007), "An empirical study of the implementation of green supply chain management practices in the electrical and electronic industry and their relation to organizational performances", *International Journal of Environmental Science and Technology,* Vol. 4 No. 3, pp. 383-394.

Chin, W. W. (1998), "The partial least squares approach to structural equation modeling", in G. A. E. Marcoulides (Ed.), Modern methods for business research, pp. 295–336.

Couto, J., Tiago, T., Gil, A., Tiago, F. and Faria, S. (2016), "It's hard to be green: Reverse green value chain", *Environmental research*, Vol. 149 No. 1, pp. 302-313.

D'heur, M. (2015), "shared. value. chain: Profitable Growth Through Sustainable Value Creation", in *Sustainable Value Chain Management*, pp. 1-107.

Darmawan, M. A., Putra, M. P. I. F. and Wiguna, B. (2014), "Value chain analysis for green productivity improvement in the natural rubber supply chain: a case study", *Journal of Cleaner Production*, Vol. 85 No. 1, pp. 201-211.

Dekker, H. C. (2003), "Value chain analysis in interfirm relationships: a field study", *Management accounting research*, Vol. 14 No. 1, pp. 1-23.

Fearne, A., Garcia Martinez, M. and Dent, B. (2012), "Dimensions of sustainable value chains: implications for value chain analysis", *Supply Chain Management: An International Journal*, Vol. *17* No. 6, pp. 575-581.

Feller, A., Shunk, D. and Callarman, T. (2006), "Value chains versus supply chains", *BP trends*, pp. 1-7.

Fierro Hernandez, D., & Haddud, A. (2018), "Value creation via supply chain risk management in global fashion organizations outsourcing production to a", *Journal of Global Operations and Strategic Sourcing*.

Fornell, C. and Larcker, D. F. (1981), "Evaluating structural equation models with unobservable variables and measurement error", *Journal of Marketing Research*, Vol. 18 No.1, pp.39–50.

Gil, R. B., Andrés, E. F. and Salinas, E. M. (2007), "The relevance of the environmental factor in corporate strategies: an application to the consumer goods industry", *Journal of Applied Business Research*, Vol. 23 No. 1, pp. 79-94.

Hair, J. F., Ringle, C. M. and Sarstedt, M. (2011), "PLS-SEM: indeed a silver bullet", *Journal of Marketing Theory and Practice*, Vol. 19 No. 2, pp.139–152.

Hair, J. F., Sarstedt, M., Ringle, C. M. and Mena, J. (2012), "An assessment of the use of partial least squares structural equation modeling in marketing research", *Journal of the Academy of Marketing Science*, Vol. 40 No. 3, pp. 414–433.

Handfield, R. B., Walton, S. V., Seegers, L. K. and Melnyk, S. A. (1997), "'Green'value chain practices in the furniture industry", *Journal of Operations Management*, Vol. 15 No. 4, pp. 293-315.

Hartman, C. L. and Stafford, E. R. (1998), "Crafting'enviropreneurial'value chain strategies through green alliances", *Business Horizons*, Vol. 41 No. 2, pp. 62-73.

Hassini, E., Surti, C. and Searcy, C. (2012), "A literature review and a case study of sustainable supply chains with a focus on metrics", *International Journal of Production Economics*, Vol. 140 No. 1, pp. 69-82.

Henseler, J., Ringle, C. M. and Sinkovics, R. R. (2009), "The use of partial least squares path modeling in international marketing", *Advances in International Marketing*, Vol. 20 No. 1, pp. 277–319.

Hervani, A. A., Helms, M. M. and Sarkis, J. (2005), "Performance measurement for green supply chain management", *Benchmarking: An international journal*, Vol. 12 No. 4, pp. 330-353.

Huybrechts, D., Derden, A., Van den Abeele, L., Vander Aa, S. and Smets, T. (2018), "Best available techniques and the value chain perspective", *Journal of Cleaner Production*, Vol. 174 No. 1, pp. 847-856.

Jørsfeldt, L. M., Hvolby, H. H., & Nguyen, V. T. (2016), "Implementing environmental sustainability in logistics operations: a case study", *Strategic Outsourcing: An International Journal*, Vol. 9 No. 2, pp. 98-125.

Junior, B. A., Majid, M. A. and Romli, A. (2018), "Green information technology for sustainability elicitation in government-based organisations: an exploratory case study", *International Journal of Sustainable Society*, Vol. *10* No. 1, pp. 20-41.

Kranz, J. and Picot, A. (2011), "Why are consumers going green? the role of environmental concerns in private green-IS adoption", in *ECIS*, p. 104.

Kung, F. H., Huang, C. L. and Cheng, C. L. (2012), "Assessing the green value chain to improve environmental performance: Evidence from Taiwan's manufacturing industry", *International Journal of Development Issues*, Vol. *11* No. 2, pp. 111-128.

Lambert, D. M. and Harrington, T. C. (1990), "Measuring nonresponse bias in customer service mail surveys", *Journal of Business Logistics*, Vol. 11 No. 2, pp. 5-25.

Meacham, J., Toms, L., Green Jr, K. W. and Bhadauria, V. S. (2013), "Impact of information sharing and green information systems", *Management Research Review*, Vol. 36 No. 5, pp. 478-494.

Molla, A., Abareshi, A. and Cooper, V. (2014), "Green IT beliefs and pro-environmental IT practices among IT professionals", *Information Technology and People*, Vol. 27 No. 2, pp. 129-154.

Pesonen, H. L. (2001), "Environmental Management of Value Chains", *Greener management international*, Vol. 33 No.1, pp. 45-58.

Porter, M.E. (1985), *Competitive Advantage: Creating and Sustaining Superior Performance*, The Free Press, New York, NY.

Rabelo, L., Eskandari, H., Shaalan, T. and Helal, M. (2007), "Value chain analysis using hybrid simulation and AHP", *International Journal of Production Economics*, Vol. *105* No. 2, pp. 536-547.

Rose, C. M. and Stevels, A. (2000), "Applying environmental value chain analysis to product take-back systems", *7th CIRP Life Cycle Engineering, Tokyo, Japan*.

Ryoo, S. Y. and Koo, C. (2013), "Green practices-IS alignment and environmental performance: The mediating effects of coordination", *Information Systems Frontiers*, Vol. 15 No. 5, pp.799-814.

Sarkis, J., Zhu, Q. and Lai, K. H. (2011), "An organizational theoretic review of green supply chain management literature", *International Journal of Production Economics*, Vol. 130 No. 1, pp. 1-15.

Schmidt, N.H. and Kolbe, L.M. (2011), "Towards a contingency model for green IT governance", in *ECIS*, p. 105.

Schmidt, N.H., Erek, K., Kolbe, L.M. and Zarnekow, R. (2009), "Towards a procedural model for sustainable information systems management", *42nd Hawaii International Conference on System Sciences*, pp.1-10.

Simpson, D., Power, D., and Samson, D. (2007), "Greening the automotive supply chain: a relationship perspective", *International Journal of Operations and Production Management*, Vol. 27 No. 1, pp. 28-48.

Singh, R. K., Rastogi, S. and Aggarwal, M. (2016), "Analyzing the factors for implementation of green supply chain management", *Competitiveness Review*, Vol. 26 No. 3, pp. 246-264.

Soosay, C. and Fearne, A. (2011), "Using sustainable value chain analysis as a catalyst for co-innovation in regional development: a case study of South Australian wine from the Riverland", *International Journal of Innovation and Regional Development*, Vol. 3 No. 2, pp. 126-140.

Soosay, C., Fearne, A. and Dent, B. (2012) "Sustainable value chain analysis–a case study of Oxford Landing from "vine to dine"", *Supply Chain Management: An International Journal*, Vol. 17 No. 1, pp. 68-77.

Tan, J. and Zailani, S. (2009), "Green value chain in the context of sustainability development and sustainable competitive advantage", *Global Journal of Environmental Research*, Vol. *3* No. 3, pp. 234-245.

Thiruvattal, E. (2017), "Impact of value co-creation on logistics customers' loyalty", *Journal of Global Operations and Strategic Sourcing*, Vol. 10 No. 3, pp. 334-361.

Thomas, M., Costa, D. and Oliveira, T. (2016), "Assessing the role of IT-enabled process virtualization on green IT adoption", *Information Systems Frontiers*, Vol. 18 No. 4, pp. 693-710.

Thomas-Francois, K., von Massow, M. and Joppe, M. (2017) "Service-oriented, sustainable, local food value chain–A case study", *Annals of Tourism Research*, Vol. *65 No. 1*, pp. 83-96.

Vykoukal, J., Beck, R. and Wolf, M. (2011), "Impact of pressure for environmental sustainability on grid assimilation–empirical results from the financial services industry", *Australasian Journal of Information Systems*, Vol. *17* No. 1, pp. 5-28.

Younis, H., Sundarakani, B. and Vel, P. (2016), "The impact of implementing green supply chain management practices on corporate performance", *Competitiveness Review*, Vol. 26 No. 3, pp. 216-245.

Zhu, Q., Sarkis, J. and Geng, Y. (2005), "Green supply chain management in China: pressures, practices and performance", *International Journal of Operations and Production Management*, Vol. 25 No. 5, pp. 449-468.

Zhu, Q., Sarkis, J. and Lai, K. H. (2013), "Institutional-based antecedents and performance outcomes of internal and external green supply chain management practices", *Journal of Purchasing and Supply Management*, Vol. 19 No. 2, pp. 106-117.

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Table 1 Measures of constructs

Constructs	**Measurement Items**	**Source**
Green manufacturing and packaging	GM1-My industry has integrated environmental issues into our strategic planning process. GM2-In my industry we make every effort to link environmental objectives with our corporate goals.	(Banerjee *et al*., 2003; Schmidt *et al*., 2011).
	GM3- My industry is engaged in developing products and processes that minimize environmental impact.	(Abareshi and Molla, 2013).
	GM4-Environmental protection is the driving force behind my industry's strategies. GM5-Environmental issues are always considered when we develop new products.	(Younis *et al*., 2016).
	GM6- My industry develops products and processes that minimize environmental impact. GM7-We carryout products/package volume reduction and package reuse and refill.	(Zhu *et al*., 2013).
Green marketing and delivery	MD1-We emphasize the environmental aspects of our products and services in our adverts.	(Hartman and Stafford, 1998).
	MD2-Our marketing strategies for our products and services have been considerably influenced by environmental concerns. MD3-In my industry, product-market decisions are always influenced by environmental concerns.	(Banerjee *et al*., 2003).
	MD4-We highlight our commitment to environmental preservation in our corporate adverts. MD5- My industry is engaged in exploring markets for environmental goods and services.	(Schmidt *et al*., 2011; Younis *et al*., 2016).
	MD6-We deploy energy-efficient, reduced-pollution transportation.	(Abareshi and Molla, 2013).
Public relation and Green education	PE1-We have a Green team that carryout environmental education. PE2-We encourage public relations environmental programs for consumers and community. PE3-Our customers are increasingly demanding environmentally friendly products and services.	(Hartman and Stafford, 1998).
	PE4-Our customers feel that environmental protection is an important issue facing the world today. PE5- My industry provides environmental information about a product in product shelf, internet or advertisement mediums.	(Banerjee *et al*., 2003).
Sourcing	SU1-My industry purchase routines are affected by our concern for the environment.	(Schmidt *et al*., 2009).
	SU2-My industry considers the product's impact on the environment when making a decision on products we purchase.	(Schmidt *et al*., 2011).
	SU3-My industry considers the product's price when making a decision on what products we procure. SU4-My industry considers the product's brand when making a decision on what products we purchase.	(Zhu *et al*., 2013; Ahn *et al*., 2016; Couto *et al*., 2016).
	SU5- We monitor IT suppliers' environmental performance in my industry.	(Abareshi and Molla, 2013).
Research and development	RD1-Being environmentally conscious can lead to substantial cost advantages for my industry. RD2- Our industry has realized significant cost savings by initiating ways to improve the environmental quality of our products and processes. RD3-By regularly investing in research and development on cleaner products and processes, our industry can be a leader in the market. RD4- Our industry can achieve lucrative new markets by adopting environmental strategies. RD5- Our industry can increase market share by making our current products more environmentally friendly. RD6-Reducing the environmental impact of our industry's activities will lead to a quality improvement in our products and processes.	(Banerjee *et al*., 2003).
Return and post use processing	RP1-We refill, recycle, reuse and refurbish by-products.	(Zhu *et al*., 2013).
	RP2- My industry carryout waste to energy co-generation.	(Rose and Stevels, 2000).
	RP3- My industry reuse and sell outdated IT infrastructures.	(Zhu *et al*., 2005).
	RP4- My industry carryout waste/pollution reduction.	(Schmidt *et al*., 2011).
	RP5- My industry utilizes renewable or clean energy.	(Ahn *et al*., 2016).
	RP6- My industry utilizes recycled, reusable, durable, biodegradable, nontoxic products.	(Younis *et al*., 2016).
Social concern	SC1-Our customers expect our industry to be environmentally friendly. SC2-All employees in our industry are responsible for developing environmental initiatives.	(Zhu *et al*., 2013).
	SC3-Environmental issues have been integrated into all functional areas of our industry. SC4- My industry has established environmental standards as a performance criterion for all our products and services.	(Younis *et al*., 2016).
Regulatory forces	RF1-Regulation by government agencies influenced my industry's environmental strategy.	(Banerjee *et al*., 2003).
	RF2-Environmental legislation can affect the continued growth of my industry.	(Zhu *et al*., 2005)
	RF3-Stricter environmental regulation is one of the reasons why my industry is concerned about its impact on the natural environment.	Vykoukal *et al*., 2011; Zhu *et al*., 2013).
	RF4-Tougher environmental legislation is required so that only industries that are environmentally responsible will survive and grow.	(Molla *et al*., 2014).
	RF5- My industry's environmental efforts can help shape future environmental legislation. RF6-My industry is faced with strict environmental regulation.	(Chien and Shih, 2007).

Operational performance	OP1-Environmental issues are not very relevant to the major function of my industry. OP2-At my industry, we make a concerted effort to make every employee understand the importance of environmental preservation.	(Banerjee, 2002).
	OP3-We try to promote environmental preservation as major goal across all departments. OP4- My industry has a clear policy statement urging environmental awareness in every area of operations.	(Banerjee *et al*., 2003)
	OP5-Environmental preservation is high priority activity in my industry. OP6-Preserving the environment is a central corporate value in my industry.	(Chien and Shih, 2007)
Management performance	MP1-The top management team in my industry is committed to environmental preservation.	(Molla *et al*., 2014).
	MP2- My industry's environmental efforts receive full support from our top management.	(Banerjee *et al*., 2003).
	MP3- My industry's environmental strategies are driven by the top management team.	(Chien and Shih, 2007).
	MP4-All functional managers in my industry have clear instructions for implementing company environmental goals.	(Ryoo and Koo, 2013).
	MP5- My industry's environmental efforts mainly revolve around compliance with current environmental regulation.	(Banerjee, 2002).
	MP6- My industry must be accountable for the way its actions affect the natural environment.	(Zhu *et al.,* 2005).
Value added information	VI1-If my industry heard that a new sustainable product was available in the store, we would be interested enough to buy it.	(Banerjee, 2002).
	VI2-In my industry environmental issues are always considered when we discuss our strategic plans.	(Couto *et al*., 2016).
	VI3- My industry provides environmental information about a product on the product itself or on a label is important.	(Ahn *et al*., 2016).
Sustainable value chain adoption	SV1-The natural environment does not currently affect my industry's business activity. SV2-The financial wellbeing of my industry does not depend on the state of the natural environment.	(Banerjee, 2002).
	SV3-In my industry, environmental preservation is largely an issue of maintaining a good public image. SV4- My industry's responsibility to its customers, stockholders, and employees is more important than our responsibility toward environmental preservation.	(Banerjee *et al*., 2003).
	SV5- My industry has a responsibility to preserve the environment. SV6- My industry strives for an image of environmental responsibility.	(Kranz and Picot, 2011).

Table 2 Demographic characteristic of survey respondents

Sample Characteristics	Options	Frequency
Gender	Male	87
	Female	70
Age	Below 24	66
	25-54	69
	55-64	18
	Above 65	4
Education	High School	13
	Diploma	14
	Bachelor's Degree	68
	Master's Degree	38
	PhD	24
Current Position	Top management (i.e. President, CEO, Vice President)	9
	Middle Management (i.e. ICT Manager, Environmental Manager)	13
	Supervisory level (i.e. senior officer, officer, coordinator)	45
	Non-managerial (i.e. ICT staff, accountant, assistant, specialist)	78
	Others	12
Working Experience	0-5 Years	52
	6-10 years	47
	11-15	33
	16-20	15
	>20	10
Industry Size	Small (51-100 employees)	35
	Medium (101-300 employees)	60
	Large (301- 5,000 employees)	62
Industry Timing	1-5 Years	34
	6-10 Years	58
	11-20 Years	48
	21 or more	17
	1-5 Years	34
Industry Type	Semi-government	53
	Private company	48
	Foreign or Joint ventures	21
	Government	35

Table 3 one-way ANOVA analysis for non-bias

Industry Size for first 35 datasets					
	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	0.435	3	0.145	0.246	0.863
Within Groups	18.251	31	0.589		
Total	18.686	34			
Industry Size for last 35 datasets					
	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	1.644	3	0.548	0.790	0.508
Within Groups	21.498	31	0.693		
Total	23.143	34			
**. Significant at the 0.05 level (1-tailed), N =35, Sig. (1-tailed) =0.000					

Table 4 Loading and reliability

Variables	Code	Loadings	Composite Reliability (CR)	Cronbach's Alpha (α)	Average Variance Extracted (AVE)	Mean	Standard Deviation
Sourcing	SU1	0.910	0.958	0.945	0.819	3.91	0.749
	SU2	0.931					
	SU3	0.934					
	SU4	0.890					
	SU5	0.859					
Research and development	RD1	0.843	0.954	0.942	0.775	3.95	0.766
	RD2	0.839					
	RD3	0.903					
	RD4	0.868					
	RD5	0.918					
	RD6	0.906					
Return and post use processing	RP1	0.941	0.968	0.960	0.836	3.94	0.776
	RP2	0.858					
	RP3	0.950					
	RP4	0.957					
	RP5	0.913					
	RP6	0.863					
Green manufacturing and packaging	GM1	0.823	0.954	0.944	0.747	3.78	0.762
	GM2	0.830					
	GM3	0.840					
	GM4	0.911					
	GM5	0.897					
	GM6	0.887					
	GM7	0.859					
Green marketing and delivery	MD1	0.810	0.940	0.925	0.724	3.58	0.721
	MD2	0.771					
	MD3	0.842					
	MD4	0.874					
	MD5	0.898					
	MD6	0.904					
Public relation and Green education	PE1	0.859	0.961	0.949	0.831	3.74	0.788
	PE2	0.919					
	PE3	0.941					
	PE4	0.877					
	PE5	0.958					
Social concern	SC1	0.961	0.965	0.951	0.873	3.76	0.774
	SC2	0.969					
	SC3	0.904					
	SC4	0.901					
Regulatory forces	RF1	0.862	0.877	0.932	0.744	3.68	0.746
	RF2	0.816					
	RF3	0.866					
	RF4	0.880					
	RF5	0.857					
	RF6	0.891					
Operational performance	OP1	0.912	0.955	0.713	0.781	3.29	0.911
	OP2	0.916					
	OP3	0.900					
	OP4	0.787					
	OP5	0.927					
	OP6	0.855					
Management performance	MP1	0.785	0.950	0.936	0.759	3.37	0.891
	MP2	0.881					
	MP3	0.899					
	MP4	0.917					
	MP5	0.902					
	MP6	0.836					
Value added information	VI1	0.933	0.960	0.898	0.888	3.15	1.027
	VI2	0.967					
	VI3	0.927					

Sustainable value chain adoption	SV1	0.854	0.926	0.937	0.690	3.52	0.764
	SV2	0.815					
	SV3	0.930					
	SV4	0.955					
	SV5	0.880					
	SV6	0.854					
Note: Loadings>0.7; AVE>0.5; CR and **α** >0.7; Mean: 0.00-2.49 = low, 2.50-3.49 = moderate, 3.50-5.00 = high.							

Table 5 Discriminate validity

#	Constructs	1	2	3	4	5	6	7	8	9	10	11	12
1	Green manufacturing and packaging	**0.864**											
2	Green marketing and delivery	0.704	**0.851**										
3	Management performance	0.436	0.487	**0.871**									
4	Operational performance	0.405	0.53	0.866	**0.884**								
5	Public relation and Green education	0.784	0.818	0.452	0.442	**0.912**							
6	Regulatory forces	0.729	0.784	0.643	0.613	0.853	**0.862**						
7	Research and development	0.748	0.680	0.319	0.287	0.760	0.698	**0.880**					
8	Return and post use processing	0.809	0.673	0.341	0.296	0.786	0.703	0.817	**0.914**				
9	Social concern	0.771	0.799	0.403	0.414	0.840	0.798	0.775	0.782	**0.934**			
10	Sourcing	0.671	0.573	0.214	0.160	0.653	0.595	0.862	0.799	0.657	**0.905**		
11	Sustainable value chain adoption	0.506	0.601	0.854	0.856	0.590	0.736	0.465	0.454	0.562	0.342	**0.831**	
12	Value added information	0.21	0.352	0.745	0.847	0.285	0.427	0.157	0.156	0.256	0.05	0.819	**0.943**

Table 6 Results of hypothesis (H1-H11)

Relationship	Hypothesis	Path coefficient	R^2	β	t-value	P Values	Accept or Reject (at P =<0.05)
Green manufacturing and packaging -> Sustainable value chain adoption	H4	0.587	0.345	0.528	11.782	0.000	Accept
Green marketing and delivery -> Sustainable value chain adoption	H5	0.635	0.404	0.608	13.032	0.000	Accept
Public relation and Green education -> Sustainable value chain adoption	H6	0.658	0.432	0.615	12.289	0.000	Accept
Sourcing-> Sustainable value chain adoption	H1	0.333	0.111	0.390	7.374	0.000	Accept
Research and development -> Sustainable value chain adoption	H2	0.660	0.435	0.510	19.623	0.000	Accept
Return and post use processing -> Sustainable value chain adoption	H3	0.616	0.380	0.491	16.440	0.000	Accept
Social concern -> Sustainable value chain adoption	H7	0.649	0.421	0.592	13.827	0.000	Accept
Regulatory forces -> Sustainable value chain adoption	H8	0.765	0.586	0.746	18.584	0.000	Accept
Operational performance -> Sustainable value chain adoption	H9	0.865	0.748	0.841	45.449	0.000	Accept
Management performance -> Sustainable value chain adoption	H10	0.859	0.737	0.836	39.914	0.000	Accept
Value added information -> Sustainable value chain adoption	H11	0.841	0.708	0.798	33.901	0.000	Accept