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Toward sustainability in manufacturing : linking green training and green supplier development for sustainable business advantages

Badr Ayesh Alreshidi
University of Toledo

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Toward Sustainability in Manufacturing: Linking Green Training and Green Supplier Development for Sustainable Business Advantages

by

Badr Ayesh Alreshidi

Submitted to the Graduate Faculty as partial fulfillment of the requirements for the Doctor of Philosophy Degree in Manufacturing and Technology Management

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Dr. Jenell L. S. Wittmer, Committee Chair

_____

Dr. Mark R. Gleim, Committee Member

_____

Dr. Euisung Jung, Committee Member

_____

Dr. Mohamed Hefzy, Committee Member

_____

Dr. Patricia R. Komuniecki, Dean

College of Graduate Studies

The University of Toledo

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An Abstract of
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Recently, interest in environmental sustainability has been growing in the business world since it is considered a strategic priority to gain competitive advantage. In addition, there are said to be corresponding risks of choosing to operate unsustainably. It is clear, however, that manufacturing impacts the environment; this is true on a global basis. More than mining, oil and gas, agriculture, or other such activities, manufacturing is accountable for more than 50% of solid waste produced all over the world (Hill, 2004). Manufacturing companies are also responsible for 20.2% of water removal from land; clearly, there are many environmental dangers due to manufacturing (Gavronski, 2012; Shiklomanov, 1999).

Therefore, this research mainly focuses on manufacturing firms and how to manage environmental sustainability (greening) throughout, while also developing green training and green supplier development programs for sustainable competitive advantage. The main objective of this research is to investigate the relationships between the strategic choice of a firm based on their green orientation and relational orientation, green training, green supplier development, and sustainable business advantages, including

green innovation improvement and gaining a sustainable competitive advantage. Specifically, the study explore the relationships between green orientation, relational orientation with supplier, and green training in a manufacturing firm context. Also, the study explore the relationship of internal green training to green supplier development, green innovation, and competitive advantage improvement in a manufacturing firm context. Moreover, the study explore the relationship of green supplier development to green innovation and competitive advantage improvement of a manufacturing firm. Lastly, the study explore the relationship between green innovation improvement and a manufacturing firm's competitive advantage.

All data collected and analyzed at the firm level. A range of United States-based manufacturing firms that operate in various industries were used for the purposes of data collection. The sample of survey respondents was selected from the senior-level representatives of such firms (operations managers, supply chain/purchasing managers, and VPs, as well as CEOs). This study examined 201 respondents from US manufacturing firms and examined the proposed model using Structural Equation Modeling (SEM). The original SEM model showed that 8 out of 9 hypotheses were supported. The empirical results identified that a firm's green orientation positively associate to a firm's green training and green supplier development programs. In addition, it shows that a firm's relational orientation with supplier influences green supplier development programs. Green training and green supplier development is significantly related to green innovation. Also, green supplier development is significant associate to a firm's competitive advantages. There are two-revised models that tested. First path model was for the green supplier development and removed green training. All

the hypotheses in this model were supported. The second model was for green training and remove green supplier development. Removal of the green supplier development path changed the statistical significance of green training to competitive advantage from non-significant to significant. The best fitting model was the one where green training was removed from the model.

I dedicate my dissertation work to my great mother "Refaah", my loving wife "Mona", and my three lovely sons "Abdulah, Abdulrahman, and Ayesh"...

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Chapter 1: Introduction

1. Introduction

Recently, interest in environmental sustainability has been growing in the business world since it is considered a strategic priority to gain competitive advantage. An increasing proportion of firms are recognizing the importance or corporate responsibility, specifically, environmental sustainability as an essential element of business imperatives (Bolme et al, 2014). Instead of being costly, environmental (green) initiatives have become a source of competitiveness (Hart, 1995; Bansal, 2005; Porter & Kramer, 2006; Paulraj, 2011; Hollos et al., 2012). Longoni and Cagliano (2015) assert that results of their study show that "sustainability does not place constraints on organizations but is, on the contrary, a source of inspiration contributing to higher operational, financial and sustainability performance and could also be a source of competitive advantage." Thus, the significance of a company's aspirations environmental aspirations has resulted in elevated importance of green training and green supplier development (Daily, 2002; Daily & Bishop, 2012; Sarkis, et al 2010; Bai & Sarkis, 2010).

Traditionally, governmental organizations have had the sole responsibility of dealing with sustainability issues. Recently, though, the private sector (companies) as well as various social organizations and educational institutions have also started taking on environmental and societal responsibilities (Dubbink, 2003; Arts & Leroy, 2006; Van

Huijstee et al., 2007). It has been recognized that the finite and semi-renewable nature of global resources is becoming increasingly scarce and there is a limited ability of ecosystems to absorb pollutants (Aflaki, 2013; Simon, 1998). However, because of the increasing consumption of these natural resources (e.g., oil, water, fish stocks), there is a future expectation that these resources will become limited and scarce resources. So, the related challenge is how to present the best chance for mitigating threats to the environment and its natural resources. Mainly, there are two fundamental factors that influence the scarcity of these resources: population growth and increasing per capita consumption.

The worldwide population has increased by about 83% since 1970 (Global Financial Data, 2013). It is anticipated that upon reaching the year 2050, the population in cities will be 6.5 billion, from only 3.6 in 2011; this rapid increase in population will occur in emerging economies (Macomber, 2013; Zuzul et al., 2013; Global Financial Data, 2013). This population growth threatens economic sustainability (Thomas Malthus, 1798). Similarly, the purchasing power due to per person income growth and shorter product life cycle has caused the per capita consumption to increase as well (World Bank, 2013). The described behaviors of population growth and increased per capita consumption create challenges to economic and environmental sustainability. Supply of finite resources where there is increased customer demand leads to an increase in the market value of the good, relative to available extraction technologies and substitutes (Simon, 1998). Thus, the related question is determining the role that businesses assume when it comes to the phenomenon of sustainable development.

1.1 Background of the Study

The most popular and well-adopted definition of sustainability is from Brundtland Commission (World Commission on Environment and Development, 1987, p. 8): "development that meets the needs of the present without compromising the ability of future generations to meet their needs." The term 'sustainability' in the triple bottom line (TBL) comprises people, planet, and profit (Elkington, 1994, 1998; Carter & Rogers, 2008), which mean that it is focusing on the balance of the economic, environmental, and social aspects of organizational performance.

In different business literature, the term of "sustainability" has been described as corporate responsibility to the people of different communities, where responsibility refers to the need to eliminate negative effects of business (Baumgartner, 2014; Carpenter & White, 2004). Therefore, businesses under sustainable development have the responsibility to the environment and the society, aside from its own organizational interests. Sustainable development issues present huge challenges but also huge opportunities for businesses. For instance, companies that operate in a sustainable manner have a better chance of enhancing their reputation and image, as well as improving their financial and environmental performance, which, in turn, will improve their competitive advantage (Porter & Kramer, 2006; Paulraj, 2011; Hollos et al*.,* 2012; Longoni, & Cagliano, 2015).

However, there are said to be corresponding risks of choosing to operate for sustainability. Hultman et al. (2010) asserted that there are three types of risks that firms face when they operate unsustainably. First, firms face risks of regulation, economy, and legality from the government and non-government organizations. Second, firms that are

developing new products and services with the goal of achieving sustainability, also face risks related to regulation because of the rapidly changing policies for climate change. Third, firms that operate unsustainably lose profits and cash flows because of climate instability. For example, Cachon et al. (2012) have estimated that manufacturers in the field of automotive in the United States lose capacity of about 1.5%, on the average, on an annual basis because of severity of weather conditions. Thus, any ongoing sustainability movements require companies to strategically move from traditional focus on economic objectives only to a focus on a TBL approach, wherein an organization considers economic, environmental, and social impact of their operations in a simultaneous manner.

Different fields have studied sustainability, including those fields of management, operations management, supply chain, and engineering. Researches in operations management have been inclined to going after the understanding of the effect of individual environmental values, issue awareness, and environmental pressures to the organization and its operations (Angell & Klassen, 1999). An issue that is related to this has enabled the reevaluation of operational focus on environmental aspects and issues related to the training requirements for an organization's manpower, especially in terms of environmental design, recycling, life-cycle analysis, and other proactive measures in relation to ensuring the promotion of the welfare of the environment (Angell & Klassen, 1999). However, specifically looking at it based on the perspective of management, the focus is primarily on ecological sustainability, which pertains to the natural environment. Social and economic responsibilities are only implied (Shrivastava, 1995; Starik & Rands, 1995). Likewise, operations management literature has also generally seen it in

this light, too, with the social aspects being in the peripheral (Sarkis, 2002; Daily & Huang, 2001). Researchers of supply chain management have looked at various related topics and issues, including environmental purchasing (Min & Galle, 1997) and looking at how information is shared between and among different players or actors in a supply chain in a manner related to climate change (Jira & Toffel, 2013). In most fields, the definition of sustainability is similar in that it generally always combines both environmental and economic points. Even CSR conceptualizations and operationalization, however, have considered sustainability from social and environmental points of view. In fact, it's interesting to note that in the engineering literature, the definition includes the three main dimensions of sustainability: the social, environmental, and economic dimensions; and Sikdar (2003) even noted that "organizational sustainability is a wise balance among economic development, environmental stewardship, and social equity."

1.2 Problem Statement

Walley and Taylor (2002; p. 36) have described the term 'greening' as meaning "moving towards ecological or environmental sustainability". It is clear, however, that manufacturing impacts the environment; this is true on a global basis (Gavronski, 2012). In fact, the use of fossil fuels in manufacturing accounts for 15.4% of the total emission, when looking at greenhouse gases of anthropogenic origin (Gavronski, 2012; Olivier et al., 1996). Furthermore, the consumption of energy used in manufacturing represents 22.2% of the entire plant's fuel (Gavronski, 2012; Olivier et al., 1996). More than mining, oil and gas, agriculture, or other such activities, manufacturing is accountable for

more than 50% of solid waste produced all over the world (Hill, 2004). Manufacturing companies are also responsible for 20.2% of water removal from land; clearly, there are many environmental dangers due to manufacturing (Gavronski, 2012; Shiklomanov, 1999).

Therefore, this research mainly focuses on manufacturing firms and how to manage environmental sustainability (greening) throughout, while also developing green training and green supplier development programs. It is important for firms that make a commitment to environmental sustainability (greening) to pay attention to their internal operations and their supply chain as well. The human factor plays a critical role in the implementation of green initiatives, whether on the leadership level or at the direct employee level.

On the other hand, supplier management is also important. For example, Wal-Mart found that about 88% of its carbon footprint is controlled by its suppliers. To this end, green training and supplier development programs for the purpose of greening are important for firms that seek to green their operations and promote environmental sustainability (greening). There are core practices of supplier development, which are direct representations of the involvement of a buyer in creating and improving the skills or its suppliers (Krause, 1999). These practices encompass the direct investments of buyers in assets (e.g., human or physical) for their supplier, as well as the combined actions of both the supplier and the buyer in the scenario (Krause, 1999; Dyer, 1996; Joshi & Stump, 1999). Investigation into internal green training and green supplier development programs together is rare in the research literature, creating a gap, especially

in regards to how an organization can effectively manage such programs (Bai & Sarkis, 2010; Daily & Bishop, 2012; Sarkis et al, 2010).

1.3 Research Objective

The main objective of this research is to investigate the relationships between the strategic choice of a firm based on their green orientation and relational orientation, green (environmental) training, green supplier development, and sustainable business advantages, including green innovation improvement and competitive advantage improvement. Specifically, the study explores the relationships between green orientation, relational orientation, and green (environmental) training in a manufacturing firm context. Also, the study explores the relationship of internal green training to green supplier development, green innovation, and competitive advantage improvement in a manufacturing firm context. Moreover, the study explores the relationship of green supplier development to green innovation and competitive advantage improvement of a manufacturing firm. Lastly, the study explores the relationship between green innovation improvement and a manufacturing firm's competitive advantage.

1.4 Research Questions

In line with the objectives of the research, the overarching or general research question of the study is: How can a manufacturing firm develop capabilities through green employee training and green supplier development programs in order to improve its green innovation and gain a sustainable competitive advantage?

The following specific research questions were asked on the firm-level:

1. What are key antecedents of green training and green supplier development programs in manufacturing firm context?
2. How does a firm's internal green training impact green innovation and competitive advantage improvement in manufacturing firm context?
3. How does a firm's internal green training impact green supplier development in manufacturing firm context?
4. How does green supplier development play a part in a manufacturing firm's green innovation and competitive advantage improvement?

1.5 Significance of the Study

It is important to invest in the management, training, and development of workforce (human resource) and in order to attain effective operations and environmental management (Angell and Klassen, 1999; Daily & Huang, 2001; Kitazawa & Sarkis, 2000; Sarkis, 2001; Sarkies et al. 2010). However, this field remains to be a significant topic, yet under-explored in research (Jabbour et al., 2008; Sarkies et al. 2010). With majority of existing studies focusing on issues and concerns found at the mid-level of environmental operations management (firm/supply chain), there has been lesser attention to issues in employees (e.g., human resource training and management) and environmental tools. Also, it is important for firms to invest in their suppliers in order to implement environmental sustainability successfully. Therefore, this study focus in integrating internal workforce green training and green supplier development to gain

green bossiness advantages including green innovation and competitive advantage improvement.

This study adds significant information to both practice and theory related to operations management and human resources management (HRM). First, it adds to existing literature on issues of environmental operations management and green HR management. It studies the relationship between green supplier development and green training and how these impact green innovation as well as a manufacturing firm's competitive advantage. Second, it examines the strategic choice of the manufacturing firm toward green training and green supplier development by studying green orientation and relational orientation with supplier. Third, the study is one of the first to explore possible relationships that may exist between environmental supply chain issues, HR factors, and green innovation in a manufacturing firm context. Finally, practitioners in the manufacturing sector will find important implications for them in this study.

Chapter 2: Theoretical Framework and Hypotheses

2.1 Theoretical foundations

This study examines the issue of environmental sustainability in manufacturing as a resource of competitive advantage. The main idea in this study is that an increased focus of a manufacturing firm on green orientation, green training, and on greening the supply chain will lead to sustainable business advantages, which include green innovation and competitive advantage improvement. Thus, Natural Resources-Based View (NRBV) View based on The Resource-Based View (RBV) is used as the main theoretical base to explain the effect of greening initiatives on competitive advantage in the manufacturing context. Also, the study use Strategic Choice Theory and Social Capital Theory in order to understand how a firm creates a green initiative orientation and relational orientation with its supplier, as well as Knowledge-Based View (KBV) to understand how green training helps to transfer knowledge to the supply chain.

2.1.1. RBV and Natural Resource-Base View (NRBV). Some firms are able to gain a sustainable competitive advantage and earn higher returns, and Barney (1991) shows that a Resource-Based View (RBV) can explain and predict this specific advantage. RBV states that a firm's resources have different parts, and one part allows them to achieve competitive advantage, and another part leads to excellent long-term performance. Hart (1995) has added to this, suggesting a Natural-Resource-Based view (NRBV) based on both Wernerfelt (1984) and Barney's (1991) interpretations of RBV.

A firm can gain competitive advantage through its resource position, but resources are only as effective as their outcome (Barney, 1991). In other words, the resources are only competitively beneficial for a firm if they lead to above-average returns and if they can be categorized as valuable, rare, and unable to be substituted (Wernerfelt, 1984; Barney, 1991). It is necessary for the resources to be unique, as that ensures the competitive advantage, since other firms will not likely be able to obtain the same competitive ground unless they, too, locate such resources. It is this idea that RBV uses when referring to competitive leverage.

According to RBV, a firm's sustainable impact can be shown to be such a resource; that is to say, the way a firm pursues a goal of sustainability can be seen as valuable, rare, and unique (Laufer, 2003). Therefore, firms must exercise significant effort in order to implement sustainable initiatives so that they can ensure these unique and non-substitutable resources. Hart (1995) is even more specific, arguing that a firm's resources must raise "barriers to imitation" (Rumelt, 1984), meaning they should be resources that cannot be easily reproduced or cannot be reproduced at all. This description of resources also notes that resources are the basic units of analysis and can include both physical and financial resources, too, as well as any skills and specialized organizational process that employees bring to the firm. According to Barney (1991) and Dierickx and Cool (1989), valuable resources must not just be non-substitutable, but they must also contribute to a firm's competitive strategy. Furthermore, strategic resources must be specific to a firm (Barney, 1991; Reed & DeFillippi, 1990), meaning they cannot be branded or otherwise identified, thus making them difficult to transfer or trade. If they are resources that can be widely distributed, they lose their value, and the firm loses its

competitive advantage. Perhaps most importantly, such resources must also be difficult to replicate or otherwise imitate; for this to happen, they may be resources that are not clearly seen as resources (i.e. tacit or causally ambiguous), or, additionally, they could also be socially complex (Teece, 1987; Winter, 1987). If a resource is tacit, it means that it is not something physical or obvious; instead, it might be skill-based, relying primarily on employees' skills. These resources are silent, or "invisible," and are not resources that can be bought; instead, they rely on people's experience (Itami, 1987; Polanyi, 1962). Similarly, socially complex resources also rely on people; the difference between socially complex resources and tacit resources is that socially complex resources depend upon large numbers of people or teams and cannot be realized by individuals alone (Hart 1995).

In some cases, RBV theory has been applied specifically to manufacturing firms (Schroeder et al, 2002; Hart, 1995; Barney, 1986 and 1991; Teece, 1986), looking particularly at the strategies that manufacturing firms use; through this, RBV theory has been used in order to support the development of manufacturing and operational capabilities and resources (Marsillac, 2010). For example, Schroeder et al (2002) applied RBV to the development of internal knowledge within a firm.

Where RBV was lacking, the Natural-Resource-Based View (NRBV) was developed by Hart (1995), based on the RBV, in order to address the idea of resources more completely. The NRBV emphasizes environment in regards to sustainability and competitive advantage, noting environment as an important strategical resource (Hart, 1995).

Hart (1995) has suggested an NRBV of the firm based on the RBV theory (Barney, 1991; Wernerfelt, 1984). The NRBV extends the RBV theory by emphasizing that there may be limitations to the impact of the environment to an organization's potential for attaining sustainable competitive advantage. This suggests that organizations, which manage their roles in terms of their impact to the environment, may generate higher levels of sustainable competitive advantage (Hart, 1995). Hart's NRBV theory considers and combines environmentally interconnected strategies with the resource management and development aspects of a firm. These interconnected strategies involve the following: (a) prevention, minimization and preferable elimination of pollution, (b) proper product supervision, emphasizing a comprehensive "womb to tomb" or "cradle to grave" product perspective, and (c) the minimization of environmental impacts from firm production (Hart, 1995). A summary of Hart's conceptual framework can be found in Table 2.1.

Table 2.1:
Strategic capabilities

Strategic Capability	Environment-based Driving Force	Key Resource	Competitive Advantage
Pollution Prevention	Minimization of waste, effluents, and emissions	Continuous improvement	Lower costs
Product Stewardship	Minimization of product cost in life-cycle	Stakeholder integration	Preempt competitors
Sustainable Development	Minimization of burden on the organization for long-term maintenance and preservation of the environment	Shared vision	Future position

Source: Hart (1995)

In line with greening the supply chain, NRBV dictates that considering the environment is important in order to get into greening the supply chain. Guang Shi, Lenny Koh, Baldwin, and Cucchiella (2012) explored role of NRBV when greening the supply chain. In their study, the authors have found that intra- and inter-organizational constructs related to practices that promote the welfare of the environment play significant roles in the successful implementation of a green supply chain that uses natural resources (Guang et al., 2012). However, Guang et al. (2012), in their study, did not explore the green supply chain based on the NRBV perspective with the incorporating performance and management measures, which include human resource management. The extensive exploration of NRBV of the supply chain has yet to be synthesized in a coherent and comprehensive manner.

This study will use the NRBV because the initiatives related to this perspective represent a set of capabilities socially-based, which can ultimately result in sustainable competitive advantage. It is therefore important for these firms to focus on the development of its resource capacity to improve its ability to respond to external forces, and ultimately result in the organization's superior performance (Sarkis et al., 2010). Nevertheless, even with the study of Hart (1995) that logically illustrated how corporate environmental strategy and the NRBV are associated with each other, the concept of association between the two constructs lacked empirical support. In line with the lack of empirical support for the association, Klassen and Whybark (1999) explored two types of independent variables of environmental technology related to sustainable development in the supply chain: pollution prevention technologies and pollution control technologies. Klassen and Whybark (1999) have found that manufacturing firms that are working for

controlling pollution (e.g., end-of-pipe solutions) are more likely to cause negative implications on their performance. On the other hand, manufacturing firms that were working for technologies that prevent pollution are more likely to improve their performance measures of flexibility, quality, speed, and cost. Similarly, Vachon and Klassen (2007) were able to establish the implication of performing logistical and technological integration, and supply reduction in developing an environmental partnership and cooperation with suppliers. Nevertheless, Vachon and Klassen (2007) did not establish the specific types of sustainable supply chain management practices that generate tacit (causally ambiguous) knowledge. Based on this, the researcher in this proposed study claims that it is important to combine NRBV along with the knowledge-based view (KBV) theories to provide greater clarity on the hypothesized relationships.

2.1.2. Knowledge-based view (KBV). Grant's (1996) KBV model mainly focused on the concept of knowledge as the most strategically significant concept among the different resources that a manufacturing firm' has; thus, extending the RBV and NRVB, because knowledge is central to different research topics, especially in terms of organizational learning, technological management, and cognitive management (Grant 1996). A firm's strategic resources are predominantly described as knowledge-based and as such are far less tangible than the more traditionally referenced firm resources such as equipment, technology and capital assets. However, intangible knowledge resources are certainly also applied to develop unique applications of these traditional resources.

The RBV of a manufacturing organization acknowledges that its resources and capabilities must be transferable within the company as it is a critical predictor for their

capability for sustainable competitive advantage. The efficiency with which knowledge can be transferred depends upon knowledge's potential for aggregation (Maurer, Bartsch, & Ebers, 2011; Tang, 2011). Knowledge transfer includes the processes of transmitting and receiving information (Tang, 2011). Knowledge aggregation, may be enhanced, once knowledge can be expressed in terms of common language (Maurer et al., 2011).

The management literature has clearly distinguished and discriminated between the manner and the details of capturing, acquiring, and differentiating subjective against objective knowledge, implicit or tacit against explicit knowledge, personal against prepositional knowledge, and procedural versus declarative knowledge (Ellis, 2015; Vahdat, Smith, & Amiri, 2014). Scholars identified tacit knowledge, and explored the different theories and known information about explicit knowledge (Hau, Kim, Lee, & Kim, 2013; Kothari, Rudman, Dobbins, Rouse, Sibbald, & Edwards, 2012). Explicit knowledge is identified through the means of communication used; on the other hand, tacit knowledge is determined based on the manner by which it is applied (Hau et al., 2013).

There are four facets of integrating specialized knowledge within an organization in order to promote competitive advantage: (a) rules and directives, (b) sequencing, (c) routines, and (d) group problem solving and decision-making (Grant, 1995). Rules refer to the standards, which regulate interactions between individuals. Direction is a form of communication between specialists and a large number of specialists and/or non-specialists. This form of integration typically utilizes impersonal approaches (Grant, 1995). Sequencing is the easiest facet of knowledge integration with the maintenance of communication and continuous coordination. This is accomplished by coordinating time-

sequenced production activities for specialists so that their inputs happen independently through time slots (Grant, 1995). Routine refers to a relatively complex behavioral pattern that is initiated through a small number of signals or choices for an individual to act in an automatic manner as a recognizable unit (Winter, 1986). Group problem solving and decision-making refer to a situation that calls for high-level interaction and non-standardized coordination that has a positive correlation with complexity and task uncertainty (Grant, 1996). This form tends to take a more formal role in communication and action.

In relation to this proposed research, KBV theory is used to support the hypotheses that developing internal green training will positively impact the effective transfer of sustainability or green knowledge to the firm's suppliers. Specifically, KBV provides support to the claim that the establishment of such relationship between a manufacturing firm and a supplier in the supply chain can promote positive supplier development develop in terms of their green abilities and skills.

2.1.3. Strategic Choice Theory. Strategic Choice Theory was originally developed to address the shortcomings of the classic contingency theory (Child, 1972). Strategic Choice Theory is based on the assumption that a firm is able to achieve high organizational efficiency and performance by proper implementation of strategies within appropriate contexts (Wagner & Bode, 2008). Strategic Choice Theory (Child, 1972) provides the rationale for adopting proactive strategies to address critical issues such as sustainability environmental preservation (e.g., greening practices). The theory assumes that managers adopt the perspective of strategic choices particularly in dealing with

issues that are external to the organization (Child, 1972, 1997). Furthermore, according to the theory organizations have the choice to formulate and implement strategies, especially to address environmental challenges that in turn help achieve effective or favorable organizational outcomes.

Based on the Strategic Choice Theory, both the environment and the structure possess the meanings and actions of individuals. Under the theory, managers of a firm are perceived to be performing a proactive role wherein they make their choices independently, while their actions serve as energizing forces that shape the organizational world (Astley & Van de Ven, 1983). Hence, within the context of sustainable development, Strategic Choice Theory implies that the proactive response of top leadership results in a high level of commitment to green initiatives and relational orientation over time. Therefore, the important factor that must be considered based on Strategic Choice Theory is translating managerial perceptions into strategic commitments that the organizations and its employees must sustain in order to address obvious and emerging stakeholders' pressures (Jørgensen & Jørgensen, 2009). In summary, proactive responses to green issues allow firms to meet emerging market opportunities and, in turn, ensure competitive advantage (Andersson and Bateman, 2000; Sharma, 2000).

Under the SCT, Child (1972) argued that firms are free to choose strategically from available options when developing a process or structure. On the other hand, strategic decision-makers experience a degree of constraint based on contextual factors (Wagner & Bode 2008). From a strategic choice perspective, aligning the resources of a firm with its organizational context may be perceived as a primary and important task for the firm's strategic decision makers. These decision makers must always consider any

potential environmental threats and opportunities as they evaluate the alternatives they have, in order to arrive at the most appropriate and strategically fit choice for the constantly changing environment (Miles & Snow 1978, Venkatraman & Camillus 1984). Therefore, there is a need for organizations to reconsider and reposition itself relative to the issues they would want to address based on the strategic choice theory (Ketchen & Hult 2007). Accomplishing this will enable companies to improve in terms of adaptability to the demands of the organizational environment, as seen in the orientation of the strategies they implement which called strategic orientation (Ponomarov, 2012).

2.1.4. Social Capital theory (SCT). Social Capital Theory emphasizes on the valuable role of social relationship between individuals, groups, and organizations and, the collective beneficial outcomes of these relationships (Granovetter, 1992). Social capital refers to something akin to public relations, the goodwill available to people; any information or influence an individual has affects social capital (Adler&Kwon, 2002). Clearly, social capital can be considered an asset one that shows the importance of trust and cooperation, within a community, or company ((Leana & Van Buren, 1999, Jacobs, 1961). The effects of social capital are transferred through information, influence, and solidarity that are accessible to an individual (Adler & Kwon, 2003). Social capita is also defined as the totality of the actual and ideal resources within a social unit (e.g., organization, entity, group of people) derived from the network of relationships that the unit and its members possess (Nahapiet & Ghoshal, 1998).

Based on Granovetter's (1992) distinction of structural and relational embeddedness, and the cognitive aspects or operational management, it was argued that social capital has three dimensions that are interrelated and co-existent: cognitive (shared language), relational (e.g., trust), and structural (e.g., network configuration). The cognitive dimension of social capital (also known as cognitive capital) refers to shared objectives, purpose, values, and vision between individuals or members of a social unit (Tsai & Ghoshal, 1998). This cognitive capital allows these individuals to them understand the information and classify it into perceptual categories (Augoustinos & Walker, 1995). In the context of supply chain, cognitive capital allows for the development of similar understandings and ideologies, which both the supplier and the customer of the supply chain use for coordinating and sharing of information and perceptions (De Carolis & Saparito, 2006). The next dimension, relational social capital, which also refers to the trust relationships (Nahapiet & Ghoshal, 1998), is an important element of any relationship (Anderson & Narus, 1990). Hence, relational dimension or trust between supplier and customer in the supply chain is an important aspect in order for their relationship to be successful or effective. The third dimension, structural dimension (also known as structural capital) refers to the set-up of the relationships or associations between individuals and members of the different social (Nahapiet & Ghoshal, 1998).

Majority of literature on management have provided significant information on the different aspects of social capital, which is usually explored relative to the different organizational performance outcomes (Adler & Kwon, 2002; Payne et al., 2011). Social capital and its dimensions have performance implications at an organizational and inter-

organizational level. Nahapiet and Ghoshal (1998) proposed that social capital facilitates the creation of intellectual capital in organizations. Tsai and Ghoshal (1998) propose social interactions and trust to be manifestations of the structural and relational dimensions respectively of social capital. These two dimensions were shown to have an impact on resource sharing and product innovation. Social capital is said to play a more prominent role in the context of strategic alliances (Krause et al., 2007). Research has shown that the three dimensions of social capital improve alliance outcomes by enabling resourcing sharing in the form of knowledge, technology and values (Dyer & Singh, 1998; Kogut & Zander, 1992; Szulanski, 1996; Inkpen & Tsang, 2005).

In line with the development of a sustainable or green supply chain, the social capital theory highlights the importance of strong trust, commitment, relationship configuration, and similar understandings and ideologies. These must be present between supplier and customer in order to promote successful attainment of common objectives. Without these aspects of social capital, supplier sustainability and competitive advantage of the firm as a customer cannot be realized.

2.2 Theoretical model

Combining various construct and sub-construct definitions, a conceptual model has been developed to elucidate the theoretical propositions noted above. In this section, construct and sub-construct definitions are provided. Additionally, a more detailed conceptual model with hypothetical paths (Figure 2-2) is presented. Figure 2-1 represents the proposed research model, constructs and anticipated relationships among them. In the proposed research model, the core focus is on green training and green supplier

development in manufacturing firms' context. Green orientation and relational orientation with supplier identified as a key antecedents to internal green training and green supplier development. In addition, the green training implementation of a firm is proposed to have a direct influence on green supplier development. The green training is proposed to directly influence the manufacturing firms' green innovation and competitive advantage improvement. Also, green supplier development that implemented by a manufacturing firm is proposed to directly influence overall the manufacturing firm's green innovation and competitive advantage performance.

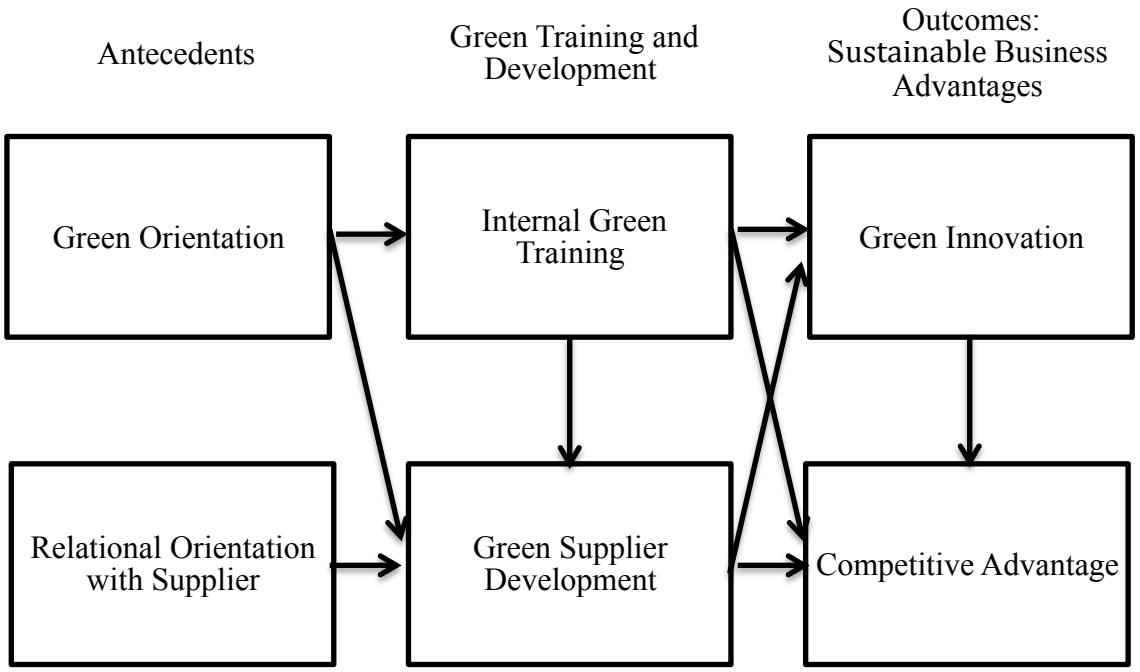

Figure: 2-1: Theoretical Model

2.2.1. Constructs development and definitions. Based on the proposed theoretical model in Figure 2-1, listed below are the constructs to be included in this proposed study. The discussion that follows provides details on the different constructs.

- **Green Orientation**
- **Relational Orientation with Supplier**
- **Green Training**
- **Green Supplier Development**
- **Green Innovation**
- **Manufacturing Firm's Competitive advantage**

From the proposed theoretical model and the list of constructs, green training and green supplier development are suggested to be the critical aspect for the manufacturing firms' green innovation and competitive advantages improvement. However, it must be noted that in the proposed framework, the relationships between green training and development (e.g., internal green training and green supplier development) and green business advantages (e.g., green innovation and competitive advantage) occur within the framework of the organization and the industry in which the manufacturing firm operates.

Green Orientation refers to the extent to which a firm recognizes the importance of environmental issues within its business operations (Banerjee et al., 2003; Huang, 2012; Menon & Menon, 1997).

Relational Orientation with Supplier refers to the extent to which a firm's tendency to develop and use of relational ties with suppliers based on the relational dimension of social capital theory (Claycomb & Frankwick, 2004; Handfield et al., 2000; Liker & Choi, 2004; Mahapatra et al., 2012; Peterson et al., 2005).

The construct of *Green Training* is defined as the planned and systematic programs and efforts to modify or develop environmental-related knowledge, skills and attitudes through learning experiences toward environmental conservation effectiveness (Aquinis & Kraiger, 2009; Daily & Huang, 2001; Daily & Bishop, 2012; Garavan, 1997; Sarkis et al. 2010; Teixeira et al. 2012).

The construct of *Green Supplier Development* is defined as the extent to which the manufacturing firm undertakes environmental sustainability activities that involves direct interaction between the firm and its key suppliers in order to measure and improve the products or services they receive from their suppliers (Blome, et al. 2014; Bai & Sarkis, 2010; Krause & Ellram, 1997; Krause, 1999; Krause et al., 2000; Prahinski & Benton, 2004; Modi & Mabert, 2007; Li, et al. 2012).

Green Innovation is defined as the extent of which a firm's production, production process, service or management or business methods is novel to the organization (developing or adopting it) wherein the results are: reduced risk to the environment, decreased pollution level, and minimization of other unwanted effects of the resources used for innovating (including energy use) compared to relevant

alternatives.(Cheng, et al. 2014; Horbach, 2008; Kammerer, 2009; Kemp & Pearson, 2008; Speirs et al. 2008).

Manufacturing Firm's Competitive Advantage improvement construct is defined as the ability of a firm to outperform its competitors by virtue of its attributed acquired through competitive strategies that competitors are unable to acquire and therefore fail to derive competitive advantage (Porter 1980; Barney 1991; Christensen &Fahey 1984, Li et al. 2012; Chang, 2011).

Table 2.2:
Summary of constructs definitions and related literature

Constructs	**Definition**	**Related Literature**
Green Orientation	The extent to which a firm recognizes the importance of environmental issues within its business operations	Banerjee, 2002; Banerjee et al., 2003; Huang, 2012; Menon & Menon, 1997;
Relational Orientation with Supplier	The extent to which a firm's tendency to develop and use of relational ties with suppliers based on the relational dimension of social capital theory	Claycomb & Frankwick, 2004; Handfield et al., 2000; Liker & Choi, 2004; Mahapatra et al., 2012; Peterson et al., 2005
Green Training	Planned and systematic programs and efforts to modify or develop environmental-related knowledge, skills and attitudes through learning experiences toward environmental conservation effectiveness	Aquinis & Kraiger, 2009; Daily & Huang, 2001; Daily & Bishop, 2012; Garavan, 1997; Sarkis et al. 2010; Teixeira et al. 2012
Green supplier development	The extent to which the manufacturing firm undertakes environmental sustainability activities that involves direct interaction between the firm and its key suppliers in order to measure and improve the products or services they receive from their suppliers	Blome, C., et al. 2014; Bai & Sarkis, 2010; Krause & Ellram, 1997; Krause, 1999; Krause et al., 2000; Prahinski & Benton, 2004; Modi & Mabert, 2007; Li, et al. 2012;

Green Innovation	The extent of which a firm's production, production process, service or management or business methods is novel to the organization (developing or adopting it) wherein the results are: reduced risk to the environment, decreased pollution level, and minimization of other unwanted effects of the resources used for innovating (including energy use) compared to relevant alternatives.	Cheng, et al. 2014; Horbach, 2008; Kammerer, 2009; Kemp & Pearson, 2008; Speirs et al. 2008
Competitive Advantage	The ability of a firm to outperform its competitors by virtue of its attributes acquired through competitive strategies that competitors are unable to acquire and therefore fail to derive competitive advantage.	Porter 1980; Barney 1991; Christensen &Fahey 1984, Li et al. 2012; Chang, 2011

***2.2.1.1. Green Orientation*.** In recent years, companies are exploring various ways to become more environmentally sustainable (Hart, 1995). Traditionally, business strategies were primarily formulated to drive profit. However, many modern companies now are more focused on environmental concerns and therefore are adopting innovative strategies to address them (Gladwin et al., 1995; Shrivastava, 1995). Firms can achieve a competitive advantage over their competitors by devising and implementing sustainable development strategies that address environmental concerns (Porter & van der Linde, 1995; Hart, 1997). In view of evolving consumer demands, modern companies have realized the benefits of becoming environmentally conscious. To achieve competitive advantage, companies must adapt to changing consumer and societal demands for greener products and processes. Thus, companies can gain significant business advantage from incorporating environmentally sustainable strategies.

In realization of the importance of environmental sustainability, more and more

companies are addresing environmental concerns within their operations (Angell & Klassen, 1999; Cobrbett & Klassen, 2006). To successfully assimilate these emerging trends towards environmental sustainability, managers need to clearly recognize the importance of environmental issues within their business operations (Huang, 2012; Menon & Menon, 1997). According to Banerjee (2002), this managerial commitment to environmental sustainability issue can be called a company's green (environmental) orientation. In the study of Hong, Kwon, and Roh (2009), it was found that the strategies for green orientation within a specific firm are based on (a) the consideration of previous green practices, if there are any, (b) implementation of innovative programs for contemporary environmental improvement, and (c) commitment to practicing acts of environmental preservation. A firm's environmental orientation is reinforced by practices of innovation related to practices between and within the organization, which include activities for development of products and services, supply chain network creation and coordination, and realization of relevant organizational outcomes (Hong et al., 2009). For the purpose of this research, green orientation is defined as the extent to which a firm recognizes the importance of the green issues of its business operations (Banerjee, 2002; Huang, 2012; Menon & Menon, 1997).

It is important to note that there are two different levels of green orientation. Banerjee (2002) identifies these two levels as internal and external green orientation. In this research, the construct of green orientation is analyzed in terms of two sub-constructs: (a) internal green orientation and (b) external green orientation. The summary definitions of the green or environmental orientation sub-constructs are provided in Table 2.3.

a) Internal Green Orientation. Internal green orientation refers to the alignment of company objectives and environmental sustainability principles within an organization. Mission statement, company culture, and other internal aspects of an organization can be oriented towards the cause of environmental sustainability. According to Banerjee (2002), companies' internal environmental orientation is reflected in their internal values, standards of ethical behavior, and commitments regarding environmentally conducive operational activities. Internal green orientation plays an important role in determining the nature of companies' environmental activities (Shrivastava, 1995). Companies' internal green orientation is typically reflected in companies' environmental statements, environmental missions, or annual reports (Banerjee et al., 2003). In this research, internal green orientation is defined as the extent to which the company adheres to its values, confirms to ethical behavior, and observes its environmental preservation commitment as reflected in its activities (Banerjee, 2002; Banerjee et al., 2003, Huang, 2012; Shrivastava, 1995).

b) External Green Orientation. External green orientation, on the other hand, refers to a company's environmental strategies and activities in the context of its stakeholders or corporate executives (Banerjee, 2002; Banerjee et al., 2003). As Banerjee (2002) suggested, companies' external green orientation is mainly reflected in the interactions with their external stakeholders in matters concerning ecological issues. In particular, to successfully address environmental concerns emanating from external sources, companies need to precisely understand the importance of environmental sustainability, the ecological impacts of their operations, and external stakeholders'

environmental needs (Banerjee, 2002; Banerjee et al., 2003). Kim Youn, and Roh (2011) conducted a study on the external green orientation. Kim et al. (2011) found that green orientation within the supply chain (external environmental orientation) translates into enhanced organizational performance within the supply chain as reflected in the trust and information sharing practices between the companies and their suppliers. In this proposed study, external green orientation is defined as the extent to which a company perceives the importance of environmental sustainability and the need to address the ecological requirements of their external stakeholders (Banerjee, 2002; Banerjee et al., 2003; Huang, 2012).

Table 2.3:
Definitions of green orientation sub-constructs

Sub-construct	Definition	Reference
Internal Green Orientation	The extent to which the company adheres to its values, confirms to ethical behavior, and observes its environmental preservation commitment as reflected in its activities	Banerjee, 2002; Banerjee et al., 2003; Huang, 2012; Shrivastava, 1995
External Green Orientation	The extent to which a company perceives the importance of environmental sustainability and the need to address the ecological requirements of their external stakeholders	Banerjee, 2002;Banerjee et al., 2003; Huang, 2012;

2.2.1.2. Relational Orientation (RO) with Supplier. A company's success or failure with regards to environmental efforts often hinges on their relationships with

suppliers. A manufacturing company does not always control all aspects of production. Rather, they sell products that were made elsewhere. In this research relational orientation with supplier adapted from Mahapatra et al. (2012), which refers to the "manufacturing's (buyer) tendency to develop and use relational ties with suppliers and is based on the organizational relational capital dimension of social capital theory" (Nahapiet & Ghoshal, 1998).

Important relational dimensions include trust, commitment, and reinforcement of strong relationship from the top management (Claycomb & Frankwick, 2004; Liker & Choi, 2004) as well as shared vision (Li et al. 2006). In other words, relational orientation is characterized in terms of trust present within different actors in a relationship and senior management support for a strong relationship as well as commitment and joint-problem solving (Mahapatra et al., 2012). Trust and commitment are two important elements or sub-constructs of relational orientation with supplier. The strong relationship that develops between manufacturing firm (e.g., buyer or customer) and the suppliers is one that includes trust, and commitment (Claycomb & Frankwick, 2004; Liker & Choi, 2004), which in turn, helps to build superior relational capital (Jap & Anderson, 2007; Kanter, 1994).

Companies must trust that the other party has their interests in mind if they wish to optimize their business interactions. Several studies have shown that trust is often a necessity in order for planning and asset-specific commitment to be successful in a collaborative environment (Dyer et al., 1998; Handfield et al., 2000; Peterson et al., 2005). Part of the reasoning for this is that the exchange process between parties is more involved when trust exists in the relationship (Ring & Van de Ven, 1992; Johnston et al.,

2004). Specifically, researchers (e.t. Krause et al. 2007) has shown how individual and organizational trust are essential parts of relational capital. Liu et al. (2009) agreed with this idea and, in fact, treated trust as a "relational mechanism measure." Trust is the readiness of an organization to be vulnerable to the actions of its partners anticipating that the partner will carry out a specific action essential to the trustor, regardless of the capability to observe or manage the behavior and activities of the said other party (Mayer et al., 1995). It is the willingness to rely on an exchange partner in whom one has confidence (Moorman et al., 1993). In a trusting relationship, partners are seen as consistent, competent, honest, fair, responsible, helpful, and benevolent (Morgan & Hunt, 1994).

A study found that commitment is important in business transactions. More specifically, they found that one party's level of commitment to a cause or project typically impacts how they view the other party (Anderson & Weitz, 1992). In addition, Krause (1999) also found this connection, in relation to buying firms and suppliers, noting the positive influence that the perception of commitment can have on the buying firm's commitment to a supplier. This perception of commitment is even more crucial than the perception of the level of communication (Prahinski & Benton, 2004). As defined in Table 2.4, relationships between suppliers, manufacturers, and other business members can be optimized by incorporating trust and commitment, as sub-constructs of relational orientation of manufacturing firms with supplier, when conducting business.

Joint-problem solving refers to the extent of willingness of both the manufacturing firm (e.g., buyer or customer) to work together with the suppliers in their supply chain in order to address or solve the problems that they encounter in relation to

sustainable development (Handfield et al., 2000; Mahapatra et al., 2012; Peterson et al., 2005). Wagner, and Svensson (2014) did a study on relationships between manufacturers and suppliers for effective supply chain performance. An increased joint actions lead to understanding of supplier's green strengths and weaknesses which can enable buyer firms to better adapt any change needs in a shorter time (Foerstl et al., 2010). Lusch and Brown (1996) asserted that when partners firms jointly work together and try to solve shared problems, they would be able to achieve superior performance benefits. Research revealed that stakeholders and sources (e.g., suppliers) should be recognized and perceived to be interconnected, where resources are used in activities for a business network causing resource residuals may be recovered and reused by other actors in the business network (Wagner & Svensson, 2014). In Table 2.4, the description of each sub-construct for relational orientation of manufacturing firms with supplier.

Table 2.4:
Definitions of construct of relational orientation wit supplier

construct	Definition	References
Relational Orientation with Supplier	The extent to which a firm's tendency to develop and use of relational ties with suppliers based on the relational dimension of social capital theory	Claycomb & Frankwick, 2004; Handfield et al., 2000; Liker & Choi, 2004; Mahapatra et al., 2012; Peterson et al., 2005).

2.2.1.3. Green Training. Authors believe that training is an important aspect of human resource management in order to facilitate a company's advancement in its competitive stance relative to other similar players in their industry (Sarkis et al. 2010). According to Aquinis and Kraiger (2009), training is a systematic approach toward

development and learning with a goal of improving the effectiveness of an individual, their group, and their organization (Goldstein & Ford 2002). In another study, training is defined as a planned and systematic effort to change and improve an individual's or group's knowledge, skills, and attitudes by means of undergoing learning experiences in order to attain an effective performance for a given set of tasks and activities (Garavan, 1997). Moreover, development refers to activities that are essential to the acquisition of new information or skill that will enable the growth of the organization, its members, and its suppliers and customers (Aquinis & Kraiger, 2009).

Aquinis and Kraiger (2009) listed the different benefits of training to be characterized as one of three forms: (a) individual level, (b) organizational level, and (c) societal level. At the individual level, the different favorable effects of training include innovation and tacit skills, improvement of adaptability, betterment of skill in the technical and self-management aspects of organizational performance, and improved ability to adjust to cultural diversity. Other indirect benefits include: team's task coordination, improved planning skills, better communication, and employee empowerment (Aquinis & Kraiger, 2009). At the organizational level, training leads to improved overall performance as reflected in the organization's operating revenue per employee, productivity, effectiveness, and overall profitability. Other improvements at the organizational level include decreased costs, and enhanced product or service quantity and quality (Aquinis & Kraiger, 2009). At the societal level, many countries adopt policies at a national level in order to influence the development and implementation of training programs for the overall improvement of its human resource pool, which in turn promotes better economic advantage (Aquinis & Kraiger, 2009).

With the current focus on sustainable development and environment-friendly practices, there is a pressure to follow greening processes in the different firms. A potential respond to this is to improve the knowledge and ability of the firm and its members in order to promote a culture of green or environmental concern (Sarkis et al., 2010). At the same time developing the key supplier's employees through conducting green training/education, communicating frequently about related-green practices, and involving supplier in eliminating non-value adding activities and green products/process development is important to the efficiency of sustainability. Such employee education and training programs are particularly important, because the employees' familiarity with green practices will enable more effective implementation of sustainable development in their respective firms; thus, increasing the competitive advantage of the said firm (Min & Galle, 2001). Focusing on both, internal green training and green supplier development, expected to improve the firm's capabilities in green innovation and sustainable competitive advantage. Hence, green or environmental training is defined as an organized and systematic effort to develop a program for the modification and development of green-related knowledge, skills, and behavior by means of imparting lessons through experiences toward environmental issues (Aquinis & Kraiger, 2009; Daily & Bishop, 2012; Daily & Huang, 2001; Garavan, 1997; Sarkis et al. 2010; Teixeira et al., 2012). In manufacturing firms, green training mainly focus on training for eco-design, training in Life Cycle Assessment (LCA), training in recycling or reusing, and training in waste elimination.). In Table 2.5, the description of construct of green training is provided.

Table 2.5:
Definitions of construct of green training

Construct	Definition	References
Green Training	An organized and systematic effort to develop a programs for the modification and development of environmental-related knowledge, skills, and attitudes through learning experiences toward environmental issues	Aquinis & Kraiger, 2009; Daily & Bishop, 2012; Daily & Huang, 2001; Garavan, 1997; Sarkis et al. 2010; Teixeira et al., 2012

2.2.1.4. Green Supplier Development. In this study, green supplier development programs are referred to as a firm's effort, as buyers or customers, to determine and enhance the products or services they acquire from suppliers for service providers based on concepts of environmental sustainability (green) (Bai & Sarkis, 2010; Krause, 1999; Krause, et al. 2000; Li, et al. 2012). There are core practices of supplier development, which represents the direct involvement of the buying company in developing its suppliers (Krause, 1999).

Krause (1999) mentioned direct involvement practices of the buying company in developing its suppliers. These practices include direct investments in physical or human assets of a particular supplier, the buyer's expectation of supplier performance improvement, and the joint action between both parties (Ahmed, & Hendry, 2012; Dyer, 1996; Joshi & Stump, 1999, Li et al., 2012). Also, when knowledge transfer activities are increased from buyer firm to the supplier (e.g., training or problem solving assistance), the employees naturally improve both their skills and their productivity, thereby improving a supplier's performance (Modi & Mabert, 2007). Green supplier development helps the supplier improve their greening capabilities and performances.

In this study, green supplier development construct is defined as the extent to which the buying firm in their efforts undertaken of environmental sustainability activities that involving direct interaction and investment between the buying firms and suppliers to measure and improve the products or services they receive from their suppliers in terms of environmental sustainability (green). These activities could include supplier employees' training regarding the different environmental issues that concerns the society. Another possible activity is training suppliers in stakeholder expectations, green manufacturing and awareness. Moreover, buyers may also provide their suppliers with technological advice on improving their environmental responsibility (e.g. processes, project management), and conducting training and education programs for supplier personnel (Bai & Sarkis, 2010).). In Table 2.6, the description of construct of green supplier development is provided.

Table 2.6:
Definitions of construct of green supplier development

Construct	Definition	References
Green Supplier Development	The extent to which the manufacturing firm in their efforts undertaken of environmental sustainability activities that involving direct interaction and investment between the buying firms and suppliers to measure and improve the products or services they receive from their suppliers in terms of environmental sustainability (green).	Blome, et al. 2014; Bai & Sarkis, 2010; Krause & Ellram, 1997; Krause, 1999; Krause et al., 2000; Prahinski & Benton, 2004; Modi & Mabert, 2007; Li, et al. 2012

2.2.1.5. Green Innovation. Some scholars referred to innovative programs in relation to environmental management as eco-innovation or green innovation (Carrillo-Hermosilla et al., 2010; Chen et al., 2006; Chen, 2008). Green innovation is described as the development of products, services, of methods that are new to an organization, provided that the results within the product's or service's life cycle lead to the reduction of environmental risk, pollution and other negative impacts of resources used in relation to other alternatives (Chen et al., 2006; Chen, 2008; Kemp & Pearson, 2008). With the pressures of practicing environmental sustainability activities, manufacturing firms and service providers are pushed to develop their own effective green innovation program and integrate it to a company's management programs (Carrillo-Hermosilla et al., 2010; Dangelico & Pujari, 2010).

Green innovation can be classified into three main categories: green product innovation; green process innovation; and green managerial innovation (Chen et al., 2006; Chen, 2008; Christensen, 2011; Damanpour et al., 2009; Klassen & Whybank, 1999). It is important to implement these programs in an integrated manner, promoting a systematic view, in order to ensure its effectiveness (Damanpour et al., 2009; Chou et al., 2012; Xing et al., 2013). Accordingly, knowing how different types of green innovation complement each other is critical for firms to effectively implement their entire innovation programs. Despite of implementing a systematic and holistic view of green innovation programs, previous studies have mostly focused on individual development of these programs (Pujari, 2006; Anttonen et al., 2013). Green product innovation (Maxwell et al., 2006) was usually treated separately from green innovation of services (Chou et al., 2012; Xing et al., 2013), green technological innovation (Moore & Ausley, 2004; Tseng

et al., 2013), and green innovation related to policies (Rehfeld et al., 2007; Shin et al., 2008). Table 2.5 presents the summary of definitions of the three sub-constructs of green innovation improvements.

Green process innovation. A green process innovation represents the introduction of new elements to a firm's system for developing green products and services (Negny et al., 2012). Moreover, such innovation involve the enhancement of or addition to (e.g., smokestack scrubbers) existing processes to minimize negative impact of the company's operations to the environment (e.g., prevention of environmental degradation) (Rennings, 2000). Hence, green process innovation involves implementation of modifications to an organization's operation in order to realize a significant improvement to its environmental impacts (Negny et al., 2012). Generally, green process innovation refers to the improvement of existing production processes or creation and implementation of improved production processes to reduce environmental impact.

Green product innovation. A green product innovation refers to the act of introducing a modification to a component of a product or the complete addition or replacement of a new or significantly improved product in order to reduce negative impact to the environment regarding their characteristics (Pujari, 2006). Usually, green product innovation is initiated because of the discovery or development of a new or advanced eco technology that may reduce product life cycles, and increase product competition (Carrillo-Hermosilla et al., 2010). The analysis of a product's involves all aspects of a product, from its creation to its consumptions and disposal (Christensen, 2011; Pujari et al., 2004). Therefore, the purpose of green product innovations is to

reduce the environmental impacts during a product's entire life cycle (Christensen, 2011). Generally, green product innovation refers to the improvement in products characteristics such as improvements in technical components and materials that aims to reduce environmental impacts during an eco-product's entire life cycle.

Green managerial innovation. Green managerial innovation refers to the improvement of the management practices of an organization to adopt an eco-friendly view of implementing the firm's business (Chen et al., 2006; Chen, 2008). It includes redefining the process of managing the firm's operation to ensure that there is efficient implementation of green practices inside and outside the company (Chen et al., 2006; Chen, 2008). Therefore, these innovations in management practices can improve the overall performance of the organization by reinforcing relevant and needed modification that will lead to a reduction in the environmental impact of the organization while reducing costs for administering and operating the company (Cruz et al., 2006). Generally, green managerial innovation refer to the improvement and upgrading of the management practices of an organization to adopt an eco-friendly view of implementing the firm's business and upgrading the organization's management processes through a new and eco method. In Table 2.7, the description of sub-constructs of green innovation is provided.

Table 2.7:

Definitions of sub-constructs of green innovation

Sub-construct	Definition	References
Green Process Innovation	Improvement of existing production processes or creation and implementation of improved production processes to reduce	Carrillo-Hermosilla et al., 2010; Chen, 2008; Pujari, 2006

	environmental impact.	
Green Product Innovation	The improvement in products characteristics such as improvements in technical components and materials that aims to reduce environmental impacts during an eco-product's entire life cycle.	Carrillo-Hermosilla et al., 2010; Christensen, 2011; Chen, 2008; Pujari, 2006
Green Managerial Innovation	The improvement and upgrading of the management practices of an organization to adopt an eco-friendly view of implementing the firm's business and upgrading the organization's management processes through a new and eco method	Chen et al., 2006; Chen, 2008; Cruz et al., 2006

2.2.1.6. Competitive Advantage. Competitive advantage refers to the extent to which a firm has the ability to outperform its competitors and competitors unable to acquire the benefit that the company obtains by means of its competitive strategies (Barney 1991; Chang, 2011; Christensen & Fahey 1984, Li et al. 2012; Porter 1980). Competitive advantage is potential points differentiation between an organization and its competitors and not directly controllable by management, but are an outcome of critical management decisions (Tracey et al., 1999). It is related to which business strategy that a company employs (Porter 1980; Barney 1991). Moreover, researchers identified some important competitive advantage items: price/cost, quality, delivery, flexibility (Tracey, 1999; White, 1996; Roth & Miller, 1990; Koufterson, 1995). Moreover, expanding works suggest that time-based competition also important item of competitive advantage (Handfield & Pannesi, 1995; Kessler & Chakrobarti, 1996; Vesey, 1991).

This study defines corporate competitive advantage as the state wherein the

company occupies some positions where the competitors cannot copy its successful strategy and the company can gain the sustainable benefits from this successful strategy (Barney, 1991; Coyne, 1986; Porter, 1985). Competitive advantage improvement is an important objective of green orientation to link the manufacturing firm's green strategies with its overall corporate competitive strategy (Dyer, 1996; Wagner et al., 2005). Therefore, buyer competitive advantage improvement should be an indicator of the effectiveness of green training and green supplier development as well as green innovation improvement.

In terms of the measuring competitive advantage gained from green processes or sustainable development, Chen et al. (2006) used the following eight items: (a) low cost compared to other competitors; (b) the quality of the products or services; (c) the company is more capable of R&D and than the competitors; (d) the company has better managerial capability than the competitors; (e) the company's profitability is better; (f) the growth of the company exceeds that of the competitors; (g) the company is the first mover in some important fields and occupies the important position; (h) the corporate image of the company is better than that of the competitors. Moreover, scholars have identified different measurable items that may determine the competitive advantage of manufacturing or service firm that pursues a green venture: product sales increase, product cost, quality, responsiveness to changes in the market, enhanced corporate image, and the capability of R&D as a competitive advantage items **(**Li et al, 2012; Chang, 2011)**.** In Table 2.8, the description of construct of competitive advantage is provided.

Table 2.8:
Definitions of construct of competitive advantage

Construct	Definition	References
Competitive advantage	The extent to which a firm has the ability to outperform its competitors and competitors unable to acquire the benefit that the company obtains by means of its competitive strategies	Barney 1991; Chang, 2011; Christensen &Fahey 1984, Coyne, 1986; Porter 1980; Porter, 1985; Li et al. 2012;

2.3. Hypotheses development

Based on the theoretical framework development process described above, constructs and sub-constructs definitions, and the overall conceptual model, the various hypotheses for this study are presented below. This dissertation begins with the nine hypothetical postulates shown in Figure 2-2. For a theoretical base, SCT, NRBV, and KBV theories are predominantly used to support all hypotheses 1 to 9. Strategic Choice theory is predominantly used to support hypotheses 1, 2, and 3 with subset of NRBV and Social Capital Theory, while KBV and NRBV used to support hypotheses 4 -9.

Based on the literature stream provided, Strategic Choice Theory (SCT), and Natural Resources-Based View (NRBV), it is hypothesized that the firms' green orientation is positively related to their adapting of a green (environmental) training for its staff to catch up with its directions and orientation.

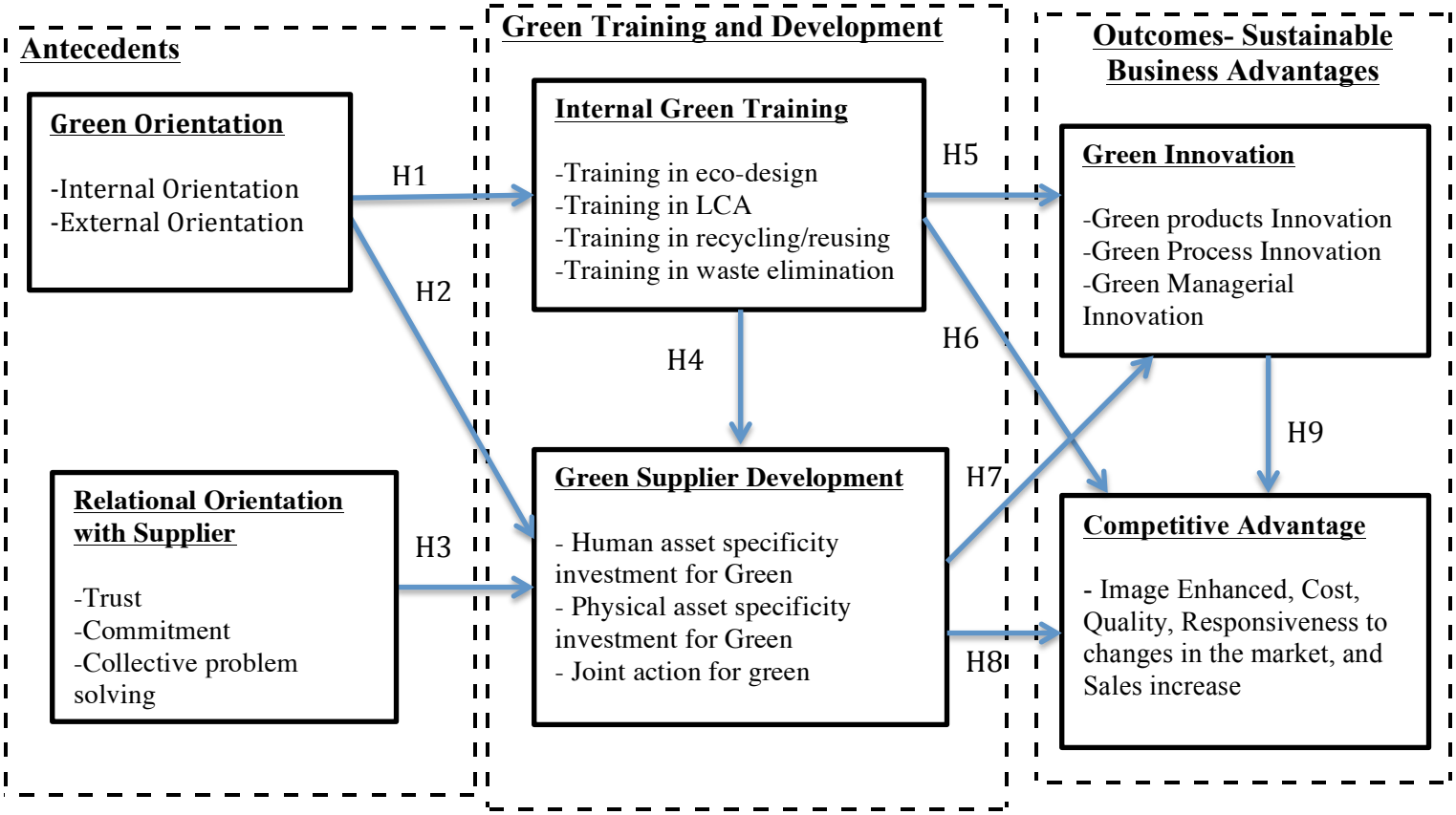

Figure 2-2: Theoretical Model (Detailed)

Most of manufacturing firms have been recognized their impact on environment, and are beginning to recognize that successful firms emphasize the prevention and avoidance of negative environmental impacts, whereas less successful firms implement reactionary environmental controls (Klassen, 2000). In the operations strategy, authors identified competitive priorities as cost, delivery, flexibility and quality (Hayes & Wheelwright, 1984). Recently, researchers suggest that environmental and social sustainability should be included among these priorities (Jimenez & Lorente, 2001; Jabbour et al., 2012; Longoni, & Cagliano, 2015; Porter & Kramer, 2006). Longoni and

Cagliano (2015) reported that with the introduction of environmental and social sustainability priorities are introduced, companies integrate them into traditional operations strategies rather than developing new approaches to competition. Moreover, Longni and Cagliano (2015) have found based on the results of their study that sustainability does not place constraints on organizations. Instead, a source of inspiration contributing to higher operational and sustainability performance and could also be a source of enhanced financial performance leading to competitive advantage. Hypothesis 1 is proposed on the basis of the following assumption. Environmentally oriented companies will adopt environmentally sustainable strategies, which in turn will be reflected in their internal green employees training programs. Furthermore, green orientation of the company will also be emphasized through development of partnership with green suppliers that will support, provide and implement positive environmental initiatives/practices.

Therefore, ***Hypothesis 1 is proposed****: Firms' green orientation is positively related to their implementation of green training.*

Based on the literature stream provided, Strategic Choice Theory (SCT), and Natural Resources-Based View (NRBV), it is hypothesized that the firms' green orientation is positively related to their green supplier development programs. For effective environmental management, manufacturing firms need to regularly interact with external stakeholders in particular that include all their supply chain partners (Polonsky et

al, 1998). The manufacturing firms typically select a small number of key suppliers and engage with those selected suppliers in improving their environmentally sustainable efforts (Watts & Hahn, 1993), which implies green supplier development.

When compared to internal green training that it is more firm-specific, green supplier development has an inter-organizational scope (Vachon & Klassen, 2006). Green supplier development interacts with green training insofar that it adds activities with suppliers that encourage and enable green performance such as (a) developing instead of terminating suppliers in case of improvable green performance, (b) visiting supplier plants and helping them to improve environmental performance, (c) timely and frequent communication on green performance matters, and (d) acknowledging green supplier performance e.g. through awards, and close collaboration with suppliers on green matters (Bolme et al, 2014; Krause & Scannell, 2002). In addition, Huang (2012) found that green orientation positively impact green supply chain design that including green supply base design.

Therefore, ***Hypothesis 2 is proposed:*** *Firms' green orientation is positively related to their implementation of green supplier development programs.*

Based on the literature stream provided, Strategic Choice Theory (SCT), and Natural Resources-Based View (NRBV) and Social Capital Theory, it is hypothesized that the firms' relational orientation is positively related to the implementation of green supplier development programs. Relational orientation is a strategic choice that influences the operating environment of the exchange and it limits the number of suppliers to interact with (Mahapatra et al., 2012). Relational orientation is very

important in terms of supplier development where it makes supplier development proactive, systematic and normative and it supports strong inter-firm routines (Mahapatra et al., 2012). Wagner and Johnson (2004) asserted that close supplier relationship could be a prerequisite to successful supplier development programs in manufacturing firms. Relational Orientation is critical for building a unique relationship in a supply chain. Therefore, a buyer's orientation to develop trust and commitment through relational ties and top management support are important to GSDP.

Therefore, ***Hypothesis 3 is proposed:*** *Firms' relational orientation with supplier is positively related to their implementation of green supplier development programs.*

Based on the literature stream provided and Knowledge-Based View (NBV), it is hypothesized that the firms' internal green training is positively related to their implementation of green supplier development programs. Environmental awareness and knowledge facilitate the implementation of efficient environmental training programs (Daily et al., 2007). According to Modi and Mabert (2007), the emphasis of KBV is on tacit knowledge, because using the skills and practical knowledge of organizational members, tacit knowledge is closely related with production processes and activities. This then raises relevant issues regarding tacit knowledge transfer both within and between organizations (Grant, 1996). The transfer of tacit knowledge or know-how can be extremely difficult and time consuming because it resides within the individuals, can only be observed through application, and acquired through practice (Grant, 1996). Tacit knowledge can be transferred through organizational routines. Specifically, in the event

that the assets of a manufacturing firm are assembled in an integrated manner involving individuals and groups, these activities constitute organizational routines and processes (Teece et al., 1997). For example, the Toyota Supplier Support Center (TSSC) provides on-site assistance to help suppliers implement the Toyota Production System (TPS) and fix quality problem through joint problem solving (Dyer & Nobeoka, 2000); Honda of America Manufacturing assists suppliers improve their processes through activities such as root cause analysis (MacDuffie & Helper, 1997). Green training and green supplier development may therefore result in specific, socially created capabilities for the company that are complex, but at the same time unique. Applying the tenets of NRBV, these capabilities can pave the way for incorporating green operations that in turn ultimately result in a sustainable competitive advantage for all partners.

Therefore, ***Hypothesis 4 is proposed:*** *Firms' green training implementation is positively related to their green supplier development programs implementation.*

To examine the performance impacts of green training and green supplier development, the NRBV is perceived as the basis, because these initiatives represent a set of socially-created as well as path-dependent capabilities that can ultimately result in sustainable competitive advantage (Blome et al 2014). Even though KBV can be created through train employees and supplier green development, it is important that firms develop resources and capabilities that can help them to respond to these forces and ultimately result in superior performance (Sarkis et al., 2010). Accordingly, it is

perceived that it is important to combine NRBV along with the knowledge-based view theories to provide greater clarity on the hypothesized relationships.

Based on the literature stream provided, NRBV, and KBV, it is hypothesized that the firms' green training implementation is positively related to their green innovation. Cramer and Roes (1993) call for both management and employees to actively collaborate on environmental issues and goals, and the training process by which they are achieved. In manufacturing firms, training at all levels is vital for successful environmental programs (Daily & Huang, 2001; Ramus, 1997; Cramer & Roes, 1993; Garavan, 1997; Perron et al., 2005). Daily & Huang, (2001) asserts the importance of green training for managers and employees, which in turn develop the firms' environmental performance. Also, Yoxon (1996) recognizes the need for training managers to aid in environmental decisions. Training is a critical function to develop innovation in firms. Therefore, it is strongly believed that green training in eco-design, LCA, recycling/reusing, and waste elimination will lead to green innovation improvement. This will help firms to improve their green innovation that gained by training their workforce.

Therefore, ***Hypothesis 5 is proposed:*** *Firms' green training implementation is positively related to their green innovation.*

Based on the literature stream provided, NRBV, and KBV, it is hypothesized that the firms' green training implementation is positively related to their competitive advantage. There is empirical support that firms with higher levels of sustainability

experience will gain competitive advantages (Campbell, 2007; Russo & Fouts, 1997). Green (environmental) training lead to lower production costs and safer work environment for employees (Daily & Huang, 2001; Ramus, 1997; Cramer & Roes, 1993). Moreover, KBV theory supports the claim that developing internal green training will positively impact the effective transfer of sustainability or green knowledge to the firm's suppliers, which is essential to competitive advantage. Such employee education and training programs are particularly important, because the employees' familiarity with green practices will enable more effective implementation of sustainable development in their respective firms; thus, increasing the competitive advantage of the said firm (Min & Galle, 2001).

Therefore, ***Hypothesis 6 is proposed****: Firms' green training implementation is positively related to their competitive advantage.*

Based on the literature stream provided, NRBV, and KBV, it is hypothesized that the firms' green supplier development programs implementation is positively related to firms' green innovation. Rao (2002) acknowledged that initiatives towards developing green suppliers in fact lead to environmentally sustainable suppliers and more green innovations. However, other studies have found that such integration could negatively impact performance; for instance by increasing development time and costs (Ittner & Larcker, 1997; Ragatz et al., 2002; Das et al., 2006). In this study, it is expected that the implementation of green supplier development programs will lead to improve the manufacturing firms' green innovation.

Therefore, ***Hypothesis 7 is proposed:*** *Green supplier development program implemented by manufacturing firms is positively related to the manufacturing firms' green innovation.*

Based on the literature stream provided, NRBV, and KBV, it is hypothesized that the firms' green supplier development programs implementation is positively related to firms' competitive advantage. Studies have shown that working closely with suppliers can enhance competitiveness as suppliers can provide critical information for the business (Chiou, et al. 2011). For example, Rao (2002) noted that in Taiwan some of the leading organizations have enhanced their competitiveness in the global market, improved their product quality and, reduced production cost through implementation of effective partnering systems with suppliers. In the past few years, one key success factor for green supply chain management has been partnering with suppliers who have met environmental standards thereby reducing the cost of regulatory non-compliance ((Chiou, et al. 2011; Sarkis, 1999). Several large and medium sized enterprises have worked with their suppliers not only to ensure compliance with environmental regulations, but also to organize other environmental services for their suppliers, such as providing environmental technical advice. Companies have also involved their suppliers in the early stages of product development process (Handheld & Nichols, 1999; Rao, 2002; Rao & Holt, 2005). This has led to improved product quality, reduced production costs and, enhanced competitiveness in the market. This study specifically focuses on greening the supplier, which has not been adequately addressed in the previous studies.

Therefore, ***Hypothesis 8 is proposed:*** *Green supplier development program*

implemented by manufacturing firms is positively related to the manufacturing firms' competitive advantage.

Based on the literature stream provided, NRBV, and KBV, it is hypothesized that the firms' green innovation is positively related to their competitive advantage. Innovation is one of the key forces to increase corporate competitive advantage (Porter & Van Der Linde, 1995). According to Brown (1992) innovation can be a powerful method of gaining a sustainable competitive advantage in both growing and matured market. With environmental regulations becoming more stringent, it is now necessary to consider the entire product life cycle in making product and design process decisions. Green products and processes not only reduce the environmental footprints, but they can also increase company's competitive advantage (Porter & Van Der Linde, 1995). Chen et al. (2006) conducted a survey in the information and electronics industry to explore how green product and process innovations affect competitive advantage. However, there is further need to provide more empirical evidence supporting green innovation and competitive advantage, across different industries and countries.
Therefore, ***Hypothesis 9 is proposed:*** *Firms' green innovation is positively related to their competitive advantage.*

Chapter 3: Methodology

The main objective of this research is to investigate the relationships between the strategic choice of a firm based on their green orientation and relational orientation, green training, green supplier development, and the green business advantage, including green innovation and competitive advantage. In line with the purpose, there are four research questions for the study, with nine corresponding hypotheses, as illustrated in Figure 2-2. Chapter 3 provides details of the procedures that will be used for testing nine theoretical hypotheses presented in the previous chapter.

3.1. Structural Equation Modeling

Methodologically, the study employed Structural Equation Modeling (SEM) to test the proposed theoretical model. SEM is a technique used to explain the nature of relationships between multiple variables using a series of multiple regression equations and testing the validity in the process of theory building. SEM has been used as a basis for theory development and testing within supply chain and operations management as well as other related disciplines (Wallenburg & Weber 2005). SEM has been incorporated into several specialized software packages such as AMOS, LISREL etc. In this study, AMOS will be used for structural equation modeling in this research.

Mainly, SEM has two parts to it – measurement model and structural model

(Anderson & Gerbing, 1988). In the measurement model part of SEM, measured variables are connected to latent variables in order to validate the measurement instrument (Byrne, 2001). In the structural model part of SEM, relationships between latent variables are examined (Joreskog & Sorbom, 1977). As part of assessing the structural model, overall model fit will be examined and at the same time individual relationships (i.e. parameter estimates) between variables as specified by the research hypotheses will be examined. Model fit will be assessed by the following model fit indices – Goodness of Fit (GFI), Adjusted Goodness of Fit (AGFI), Root Mean Square Residual (RMR), Normed Fit Index (NFI) and Comparative Fit Index (CFI).

3.2 Research Design

A survey methodology was employed to gather the data necessary for testing the nine hypotheses presented in the previous chapter. Surveys are appropriate for gathering a large number of responses in a comparatively cost- effective way (Kerlinger & Lee 2000), as well as allows for the quantification of responses and statistical testing for the validity of the obtained results, and the accuracy of survey data depends on the quality of the sampling procedures employed. Dillman (2000) proposed a theoretically-sound framework for such procedures, and it will be used in this research. More specifically, an Internet-based survey methodology was followed based on such comparative advantages as easier access to the target group of respondents, greater efficiency, cost-effectiveness, and the interactive dynamics between the respondents and the questionnaire (Dillman 2000; Dillman 2007).

3.3. Data Collection and Sampling Frame

All data was collected and analyzed at the firm level. A range of United States-based manufacturing firms that operate in various industries was used for the purposes of data collection. The sample of survey respondents was selected from the senior-level representatives of such firms (operations managers, supply chain/purchasing managers, and VPs). In particular, the following job titles were deemed to be suitable for this survey – Operations manager, supply chain/ purchasing manager, Environment manager, purchasing director, supply chain director, VP of manufacturing, VP of Purchasing, VP of supply chain, VP of operations, VP of sustainability, CEO and President.

3.4. Constructs Measurement

The constructs used in this research have been tested empirically in the extant literature. Therefore, the first step in developing the set of appropriate measures was to review the scales that were previously used in similar studies and, context. The scales used here for measuring green orientation, relational orientation with supplier, green training, green supplier development, green innovation, and competitive advantage were adapted from previous studies with some necessary modifications.

Green Orientation

Green orientation was operationalized in terms of both internal green orientation and external green orientation. The following statements describe typically the extent to which your company recognizes the importance of the environmental issues of its business operations from both internal and external perspectives. It is adapted from Huaug (2012); Banerjee (2002 & 2003). All items are proposed to be measured on a Seven-point Likert-like scale.

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree

Internal Green Orientation	1	2	3	4	5	6	7
Our Firm…							
…Has clear policies promoting environmental awareness in all functional area.	o	o	o	o	o	o	o
…Identifies protection of the natural environment as a high-priority activity.	o	o	o	o	o	o	o
…Takes initiatives to ensure that employees realize the importance of natural environment protection.	o	o	o	o	o	o	o
…Identifies environmental protection as its corporate responsibility.	o	o	o	o	o	o	o
External Green Orientation	1	2	3	4	5	6	7
Our firm…							
…Realizes the impact of environmental sustainability on their financial well-being.	o	o	o	o	o	o	o
…Understands that its survival is contingent on the protection of the natural environment.	o	o	o	o	o	o	o
…Recognizes the importance to address the environment requirements of the external stakeholders.	o	o	o	o	o	o	o
…Clearly recognizes the environmental requirements of the external stakeholders.	o	o	o	o	o	o	o
…Clearly recognizes environmental footprints of their operations.	o	o	o	o	o	o	o

Relational orientation with Supplier

The following statements describe typically the extent to which a firm's tendency to develop and use of relational ties with suppliers based on the relational dimension of social capital theory. It has been adapted from Mahapatra et al. (2012) and contains 4 items.

Relational orientation with Supplier	1	2	3	4	5	6	7
In your relationship with the key supplier, the degree of mutual trust is high	o	o	o	o	o	o	o
In your relationship with the key supplier, commitment of the top management to relationship development is high	o	o	o	o	o	o	o
In your relationship with the key supplier, support of the top management to relationship development is high	o	o	o	o	o	o	o
In your relationship with the key supplier, collective problem-solving with the supplier is high	o	o	o	o	o	o	o

Green Training

The following statements describe typically the extent to which your company implements planned and systematic efforts and programs to modify or develop green-related knowledge, skills and attitudes through learning experiences toward environmental issues. It is adapted from Daily, et al. (2012) and Sarkis et al. (2010) and contains 7 items.

Green Training In Our Firm…	1	2	3	4	5	6	7
…Employees are frequently provided with training on methodologies and procedures for eco-design, LCA, Recycling/reusing of materials, and disposal of production waste.	o	o	o	o	o	o	o
…Sufficient amount of trainings on environmental issues are provided to the employees.	o	o	o	o	o	o	o
…Every employee in this facility has the opportunity to receive training on environmental issues.	o	o	o	o	o	o	o
…I am content with the environmental training for employees at our facility.	o	o	o	o	o	o	o
…The employees are training regularly on environmental issues.	o	o	o	o	o	o	o
…The employees use their environmental training effectively.	o	o	o	o	o	o	o
…Employees have several chances of using their environmental training.	o	o	o	o	o	o	o

Green Supplier Development

The following statements describe typically the extent to which your company in their efforts undertaken of environmental sustainability activities that involving direct interaction between the firm and its key suppliers to measure and improve the products or services they receive from their suppliers in terms of environmental sustainability. It is adapted from Blome et al. (2014) and Krause (1999) and contains 7 items.

Green Supplier Development **Our firm…**	1	2	3	4	5	6	7
…Communicates with its suppliers timely and regularly on sustainability related issues.	o	o	o	o	o	o	o
…Engages in close cooperation with a limited number of suppliers for the greening of our supply chain.	o	o	o	o	o	o	o
…choses to develop instead of abandoning suppliers if they fail to meet environmental standards.	o	o	o	o	o	o	o
…Personnel visit the premises of the suppliers to help them better their sustainable practices.	o	o	o	o	o	o	o
…. Provide the supplier's employees with environmental training (i.e. Eco-design, Recycling/Reuse, and LCA).	o	o	o	o	o	o	o
… Involve with the supplier in eliminating non-value added activities existing in their process.	o	o	o	o	o	o	o
… Engages the supplier to participate in our green product design and development process.	o	o	o	o	o	o	o

3.82

4.45

o1.59

Green Innovation. The following statements describe typically your company's green innovation. It is adapted from Cheng, (2014). Green process innovation contains 4 items, green product innovation has 7 items, and green managerial innovation contains 4 items.

Green process innovation ***Rate your firm relative to your major competitors over the last three years on the extent to which…***	1	2	3	4	5	6	7
Our firm frequently innovatively updates manufacturing processes to protect against contaminations.	o	o	o	o	o	o	o
Our firm frequently innovatively updates manufacturing processes to adhere to the environmental law standards.	o	o	o	o	o	o	o
Our firm frequently utilizes innovative technologies in manufacturing processes to conserve energy.	o	o	o	o	o	o	o
Our firm frequently innovatively updates manufacturing equipment in manufacturing processes to reduce energy use.	o	o	o	o	o	o	o
Green product innovation ***Rate your firm relative to your major competitors over the last three years on the extent to which…***	1	2	3	4	5	6	7
Our firm frequently emphasizes on developing new eco-products using innovative technologies to improve their package.	o	o	o	o	o	o	o
Our firm frequently emphasizes on developing new eco-products using innovative technologies to reduce construction complications.	o	o	o	o	o	o	o
Our firm frequently emphasizes on developing new eco-products using innovative							

technologies to enable easy component recycling.	o	o	o	o	o	o	o
Our firm frequently emphasizes on developing new eco-products using innovative technologies to enable easy decomposition of their materials.	o	o	o	o	o	o	o
Our firm frequently emphasizes on developing new eco-products using innovative technologies to utilize natural materials.	o	o	o	o	o	o	o
Our firm frequently emphasizes on developing new eco-products through innovative technologies to reduce waste related damage as much as possible.	o	o	o	o	o	o	o
Our firm frequently emphasizes on developing new eco-products through innovative technologies to conserve maximum energy as possible.	o	o	o	o	o	o	o
Green managerial innovation	1	2	3	4	5	6	7
Rate your firm relative to your major competitors over the last three years on the extent to which…							
Our firm's management frequently redefine operation and production processes to ensure internal efficiency that can help to implement green practices	o	o	o	o	o	o	o
Our firm's management frequently re-designing and improving product or service to obtain new environmental criteria or directives	o	o	o	o	o	o	o
Our firm's management frequently uses novel management systems to manage eco-innovation.	o	o	o	o	o	o	o
Our firm's management frequently collects information on eco- innovation trends.	o	o	o	o	o	o	o

Competitive advantage

The following statements describe typically the improvement of competitive advantage objectives. It is adapted from Li, et al. (2012) and Chang, (2011) and contains 7 items.

Competitive advantage improvement	1	2	3	4	5	6	7
Rate your firm relative to your major competitors over the last three years on the extent to which…							
Our product sales have been increased.	o	o	o	o	o	o	o
Our product cost has been reduced.	o	o	o	o	o	o	o
Our product or services quality has been improved.	o	o	o	o	o	o	o
Our products can be produced faster than before.	o	o	o	o	o	o	o
Our capability of responsiveness to changes in the market has been improved.	o	o	o	o	o	o	o
The corporate image of the company is better than that of the competitors.	o	o	o	o	o	o	o
The company is more capable of R&D than the competitors.	o	o	o	o	o	o	o

Chapter 4

Data Analysis, Large Scale Survey and Instrument Validation

As discussed in previous chapters, this study focuses on manufacturing firm. In particular, the following job titles were deemed to be suitable for this survey – Operations manager, supply chain/ purchasing manager, Environment manager, purchasing director, supply chain director, VP of manufacturing, VP of Purchasing, VP of supply chain, VP of operations, VP of sustainability, CEO and President. Organizational members with these job titles are aware of their firms' strategies, processes, and outcomes.

Chapter 4 discusses the results from the survey. Demographic information about the respondents is presented in addition to the discussion regarding the validity of and reliability of the survey instrument. Explorative Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) are also discussed in this chapter. Chapter 5 focuses on path analysis using structural equation modeling (SEM) and two-revised models are presented.

4.1 Sample Demographics

4.1.1. Respondents by job title.

There were 201 respondents included in the analyses. Of these respondents, 38.8% (n=78) were CEOs, 10% (n=20) were VPs, 21% (n=43) were Directors and 30% (n=60) were managers.

Table 4.1:
Demographics. Job Title

	Frequency	Percent
CEO	78	38.8
VP	20	10.0
Director	43	21.4
Manager	60	29.9
Total	201	100.0

4.1.2. Respondents by job function.

The three most common job functions were Manufacturing (n=71, 35%), Executive (n=55, 27%), and Engineer (n=37, 18%).

Table 4.2.
Demographics. Job Function.

	Frequency	Percent
Executive	55	27.4
Engineer	37	18.4
QA	8	4.0
Design	4	2.0
Purchasing	10	5.0
Manufacturing	71	35.3
Sales	4	2.0
Logistics	4	2.0
Other	8	4.0
Total	201	100.0

4.1.3. Respondents by number of years at the Firm.

Almost half of the respondents were at their firm between 3 and 10 years (n=94, 47%), with another 26% at the firm 10-15 years (n=52). Thirty-five respondents were at their firm 15-20 years (17%).

Table 4.3.
Demographics. Years at the Firm.

	Frequency	Percent
<3	6	3.0
3-10	94	46.8
10-15	52	25.9
15-20	35	17.4
>20	14	7.0
Total	201	100.0

4.1.4. Firm size by number of employees.

Only a small percentage of the respondents were from companies <250 people (16%). The majority of respondents were from a company with 501-1,000 employees (44%) with 20% at companies with 251-500 and >1,000.

Table 4.4:
Demographics. Number of employees.

	Frequency	Percent
<100	12	6.0
101-250	20	10.0
251-500	41	20.4
501-1000	88	43.8
>1000	40	19.9
Total	201	100.0

4.1.5. Firms by annual revenues (in millions of $).

Almost half of the companies had an annual revenue between 101 million and 500 million dollars (49%). Nineteen percent of the companies had an annual revenue greater than 500 million and 16% had an annual revenue of 51-100 million. The remaining companies had an annual revenue less than 50 million.

Table 4.5:
Demographics. Annual Revenue (millions)

	Frequency	Percent
<10	14	7.0
10-50	18	9.0
51-100	32	15.9
101-500	98	48.8
>500	39	19.4
Total	201	100.0

4.1.6. Firms by age.

Most of the firms were well-established, with less than 5% of firms less than 5 years old. Thirty-five percent of firms were ≥21 years old with another 26% 16-20 years old. The remaining firms were between 6-15 years old.

Table 4.6:
Demographics. Firm age.

	Frequency	Percent
<=1	1	.5
2-5	8	4.0
6-10	31	15.4
11-15	38	18.9
16-20	52	25.9
>=21	71	35.3
Total	201	100.0

4.1.7. Firms by the Standard Industrial Classification (SIC) code.

The firm classification shows that 36% of the firms are Industrial machinery and equipment with 14% of the firms doing Fabricated Metal Products.

Table 4.7:
Demographics. SIC code.

	Frequency	Percent
Rubber and miscellaneous plastic products	27	13.4
Fabricated Metal Products	28	13.9
Industrial machinery and equipment	73	36.3
Electronic and other electric equipment	20	10
Transportation equipment	15	7.5
Instruments and Related Products	16	8
Other	22	10.9
Total	201	100

4.2. Large Scale Instrument Validation.

Validity and reliability of measurement instruments are the key factors in any empirical study (Bagozzi, 1980; Bagozzi and Phillips, 1982). Reliability of a measurement instrument indicates consistency. Internal consistency is measured by Cronbach's alpha with ≥0.70 as the accepted cut off. Validity of a measurement instrument can be assessed in terms of content validity, convergent validity and discriminant validity (Bagozzi, 1980; Bagozzi and Phillips, 1982). Content validity is generally assessed by a comprehensive review of literature (Nunnaly, 1978) and this was checked in previous chapter. Convergent validity is refers to the extent to which indicators of a construct share variance in common (Hair et al 2006; Campbell, 1960). That means the scale is measuring the intended concept (Hair et al 2006; Campbell, 1960). Discriminant validity indicates that one construct is distinct from another construct and that measure a phenomenon that other measures do not (Hair et al 2006; Campbell, 1960).

Exploratory factor analysis (EFA) was used to determine whether intercorrelated variables fall under more general, underlying variables (i.e. factors). EFA initially assesses the convergent validity (Raubenheimer, 2004). The main intent of a factor analysis is to reduce the dimensionality. EFA uses correlation matrices to examine the intercorrelations between the variables and to determine whether a group of variables correlate with each other rather than variables outside the group (Tucker and MacCallum, 1997). Generally, factors are retained if the Eigenvalue ≥ 1.0 and items are retained in factors if the factor loading is ≥ 0.5. Factor loadings of 0.35 are also considered acceptable and significant for sample sizes of 250 and up (Hair et al. 2006). Factors can be named to reflect the types of items in the factors. Construct validity is tested with the Kaiser–Meyer–Olkin (KMO) and Bartlett's test of sphericity ($p<0.05$) (Bartlett 1954; Yang, et al. 2009).).

A separate EFA was run for each of the 9 constructs. A single EFA was initially run, but it was not practical given the multitude of items and because many of the items were highly intercorrelated, meaning with a single factor analysis, items would load on more than a single factor (i.e. there was not good discriminant validity).

Confirmatory Factor Analysis (CFA) is theory driven and the models will be built based on the results from the EFA (Roberts, 1999). CFA produces both an unstandardized and standardized solution. The unstandardized values represent the slopes of regressing the response (Y) on the factor (X), while the standardized loadings are the slopes in a correlation matrix (i.e., the item correlation with a factor). Higher factor loadings indicate a better fit of the variable to the factor. Conventionally, a factor loading >0.40 is needed to retain the item (Roberts, 1999).

The nine factors were subjected to a confirmatory factor analysis. In CFA models, the first item in a factor is fixed to 1 (and the factor mean is fixed at 0). Therefore, in the unstandardized solution, that result will be '1' and not have an estimated value. However, that item will have an estimated value in the standardized solution.

Discriminant and convergent validity will be examined for the CFA model with all 9 factors; discriminant and convergent validity can only be assessed with CFA models that have 3 or more factors. Convergent validity is the average variance extracted (AVE), which measures the amount of variance captured by the construct in relation to the amount of variance attributable to measurement error (Hair et al., 2011). Convergent validity is judged to be adequate when average variance extracted equals or exceeds 0.50 (i.e. when the variance captured by the construct exceeds the variance due to measurement error). Discriminant validity addresses the concept that each of the factors in the model are different from the other factors within the model. Variables should relate more strongly to their own factor than to another factor. Two primary methods exist for determining discriminant validity during an EFA. The first method is to examine the pattern matrix. Variables should load significantly only on one factor. If "cross-loadings" do exist (variable loads on multiple factors), then the cross-loadings should differ by more than 0.2. The second method is to examine the factor correlation matrix. Correlations between factors should not exceed 0.7.

The fit of the CFA model will be assessed using the chi-square (a p value>0.05 indicates a good fit), comparative fit index (CFI; ≥0.90), Tucker-Lewis index (TLI; ≥0.90), the CMIN/DF and the root mean square error of approximation (RMSEA; ≤0.05).

The CFI and TLI should be as close to 1.0 as possible. The CMIN/DF should be less than 3. The chi-square is sensitive to sample size and is not always the best measure of a good-fitting model (Bian, 2011). Factors will be dropped until the fit and validity are acceptable.

4.3. Large Scale Instrument Validation Results.

The nine factors were part of the large scale instrument validation- Internal Green Orientation, External Green Orientation, Relational Orientation with Supplier, Green Training, Green Supplier Development, Green Processes Innovation, Green Product Innovation, Green Managerial Innovation, and Competitive Advantage.

4.3.1. Green Orientation

4.3.1. a. Internal Green Orientation.

Table 4.8, shows a satisfactory KMO statistic (0.84) and Bartlett's test of sphericity (p<0.000), for the variables of IGO. All four items are substantially loaded onto the variable, with loadings between 0.791 and 0.836. The Cronbach's Alpha coefficient (0.89) suggests good internal consistency (Reliability).

Table 4.8:
Internal Green Orientation: EFA and reliability

	Factor
IGO1	0.836
IGO2	0.813
IGO3	0.791
IGO4	0.836
Bartlett's test of Sphericity	446.19(6), P<0.001
KMO	0.84
Alpha	0.89
% variance	67.13

4.3.1.b. External Green Orientation

External Green Orientation showed a single factor solution with a satisfactory KMO (0.87) and Bartlett's test ($p<0.001$). The alpha was 0.90 indicating very good reliability and the factor loadings ranged from 0.768 to 0.833.

Table 4.9:
External Green Orientation: EFA and reliability

	Factor
EGO1	0.833
EGO2	0.768
EGO3	0.827
EGO4	0.782
EGO5	0.832
Bartlett's test of Sphericity	606.49(10), $p<0.001$
KMO	0.87
Alpha	0.90
% variance	72.27

A CFA was run using Green Orientation as a higher order construct (Table 4.10). This model, while showing an acceptable fit, is not a usable model. The standardized estimate from EGO to the higher order factor of Green orientation is greater than 1 (1.045), probably due to the very high correlation between IGO and EGO. So, it has been removed. The SEM model will only use IGO rather than a higher order factor.

Table 4.10:
Estimates from CFA with Green Orientation

			B	S.E.	P	B
IGO	<---	GreenOrientation	1.00			0.98
EGO	<---	GreenOrientation	1.00			1.05
IGO1	<---	IGO	1.00			0.83
IGO2	<---	IGO	1.01	0.07	***	0.83
IGO3	<---	IGO	0.98	0.07	***	0.81
IGO4	<---	IGO	0.89	0.06	***	0.81
EGO1	<---	EGO	1.00			0.82
EGO2	<---	EGO	1.08	0.08	***	0.79
EGO3	<---	EGO	0.98	0.07	***	0.85
EGO4	<---	EGO	0.99	0.08	***	0.76
EGO5	<---	EGO	0.97	0.07	***	0.82
$\chi^2(26)=51.97$, p=0.002, CFI=0.98, TLI=0.98, RMSEA=0.07, CMIN/DF=1.99						

B=unstandardized beta, b=standardized beta; ***p<0.001

4.2. Relational Orientation (RO) with Supplier.

A single factor solution emerged for the Relational Orientation with Supplier construct. The KMO (0.75) and Barlett's test (p<0.001) indicated a satisfactory model. The alpha was 0.76 indicating good reliability. The factor loadings ranged from 0.561 to 0.741.

Table 4.11:
Relational Orientation with Supplier: EFA and reliability

	Factor
RO1	0.561
RO2	0.663
RO3	0.685
RO4	0.741
Bartlett's test of Sphericity	187.67(6), p<0.001
KMO	0.75
Alpha	0.76
% variance	58

A CFA was run for Relational Orientation with supplier construct (Table 4.12). This model showed an acceptable fit: $\chi^2(2)=5.85$, p=0.054, CFI=0.98, TLI=0.94, RMSEA=0.098, and CMIN/DF=2.93. The standardized estimates from this model are shown in Table 4.12.

Table 4.12:

Estimates from CFA Relational Orientation with Supplier

			B	S.E.	P	b
RO1	<---	RO	1.00			0.56
RO2	<---	RO	1.39	0.22	***	0.66
RO3	<---	RO	1.31	0.20	***	0.69
RO4	<---	RO	1.31	0.20	***	0.74

B=unstandardized beta, b=standardized beta; ***p<0.001

4.3. Green Training.

Table 4.13. Shows a satisfactory KMO statistic (0.93) and Bartlett's test of sphericity (p<0.000), for the variables of Green Training. All seven items are substantially loaded onto the factor, with loadings between 0.788 and 0.868. The Cronbach's Alpha coefficient (0.94) suggests good internal consistency (Reliability).

Table 4.13:
Green Training: EFA and reliability

	Factor
GT1	0.860
GT2	0.788
GT3	0.856
GT4	0.796

GT5	0.868
GT6	0.812
GT7	0.801
Bartlett's test of Sphericity	1081.45(21), p<0.001
KMO	0.93
Alpha	0.94
% variance	72.77

The estimates from the CFA model with Green Training are shown in Table 4.14. The model shows a good fit, the standardized beta estimates are all >0.79 and significant at p<0.001.

Table 4.14:
Estimates from CFA Green Training

			B	S.E.	P	B
GT1	<---	GT	1.00			0.86
GT2	<---	GT	0.85	0.06	***	0.79
GT3	<---	GT	0.95	0.06	***	0.86
GT4	<---	GT	0.86	0.06	***	0.80
GT5	<---	GT	1.00	0.06	***	0.87
GT6	<---	GT	0.90	0.06	***	0.81
GT7	<---	GT	0.87	0.06	***	0.80
$\chi^2(14)=33.80$, p=0.002, CFI=0.98, TLI=0.97, RMSEA=0.08, CMIN/DF=2.42						

B=unstandardized beta, b=standardized beta; ***p<0.001

4.4. Green Supplier Development

A single factor solution emerged for the Green Supplier Development construct. The KMO (0.93) and Barlett's test (p<0.001) indicated a satisfactory model. The alpha was 0.93. The factor loadings ranged from 0.732 to 0.837.

Table 4.15:
Green Supplier Development: EFA and reliability

	Factor
GSD1	0.787
GSD2	0.732
GSD3	0.796
GSD4	0.828
GSD5	0.837
GSD6	0.815
GSD7	0.801
Bartlett's test of Sphericity	923.20(21), p<0.001
KMO	0.93
Alpha	0.93
% variance	69.12

The estimates from the CFA for the Green Supplier Development latent factor are shown in Table 4.16. The model shows an acceptable fit, the p–values are all <0.001 and the standardized betas are between 0.73 and 0.84.

Table 4.16:
Estimates from CFA Green Supplier Development

			B	S.E.	P	b
GSD1	<---	GSD	1.00			0.79
GSD2	<---	GSD	0.94	0.09	***	0.73
GSD3	<---	GSD	0.96	0.08	***	0.80
GSD4	<---	GSD	1.09	0.08	***	0.83
GSD5	<---	GSD	1.24	0.10	***	0.84
GSD6	<---	GSD	1.10	0.09	***	0.82
GSD7	<---	GSD	1.03	0.08	***	0.80
$\chi^2(14)=19.29$, p=0.15, CFI=0.99, TLI=0.99, RMSEA=0.04, CMIN/DF=1.38						

B=unstandardized beta, b=standardized beta; ***p<0.001

4.5. Green Innovation

Three sub-constructs of green innovation were analyzed, green process innovation, green product innovation, and green managerial innovation.

4.5.1. Green Process Innovation

A single factor solution emerged for the Green Process Innovation construct. The KMO (0.81) and Barlett's test ($p<0.001$) indicated a satisfactory model. The alpha was 0.83. The factor loadings ranged from 0.680 to 0.787.

Table 4.17:
Green Process Innovation: EFA and reliability

	Factor
GPTI1	0.787
GPTI2	0.680
GPTI3	0.718
GPTI4	0.771
Bartlett's test of Sphericity	280.63(6), $p<0.001$
KMO	0.81
Alpha	0.83
% variance	65.94

4.5.2. Green Product Innovation

Table 4.18, shows a satisfactory KMO statistic (0.90) and Bartlett's test of sphericity ($p<0.000$), for the variables of Green Product Innovation. All six items are substantially loaded onto the factor, with loadings between 0.730 and 0.811. The Cronbach's Alpha coefficient (0.89) suggests good internal consistency.

Table 4.18:
Green Product Innovation: EFA and reliability

	Factor
GPRI1	0.753
GPRI2	0.773
GPRI3	0.761
GPRI4	0.752
GPRI5	0.811
GPRI6	0.730
Bartlett's test of Sphericity	611.91(15), p<0.001
KMO	0.90
Alpha	0.89
% variance	65.22

4.5.3. Green Managerial Innovation

Green Managerial Innovation showed a single factor solution with a satisfactory KMO (0.82) and Bartlett's test (p<0.001). The alpha was 0.87 and the factor loadings ranged from 0.725 to 0.883.

Table 4.19:
Green Managerial Innovation: EFA and reliability

	Factor
GMI1	0.760
GMI2	0.725
GMI3	0.775
GMI4	0.883
Bartlett's test of Sphericity	376.83(6), p<0.001
KMO	0.82
Alpha	0.87
% variance	71.3

Green Innovation was modeled as a higher order factor with three latent factors loading onto it: Green Managerial Innovation (GM), Green Product Innovation (GPR), and Green Process Innovation (GPT). As seen in Table 4.20, two of the factors showed a loading of 1 or more on the higher order factor, indicating that this is not a good model. So, they have been removed.

Table 4.20:
CFA with Green Innovation

			B	S.E.	P	b
GM	<---	GreenInnovation	1.00			1.00
GPR	<---	GreenInnovation	0.99	0.09	***	1.04
GPT	<---	GreenInnovation	0.97	0.08	***	0.97
GPRI7	<---	GPR	1.00			0.71
GPRI6	<---	GPR	1.02	0.10	***	0.71
GPRI5	<---	GPR	1.17	0.10	***	0.82
GPRI4	<---	GPR	1.09	0.10	***	0.77
GPRI3	<---	GPR	1.09	0.10	***	0.76
GPRI2	<---	GPR	1.18	0.11	***	0.78
GPRI1	<---	GPR	1.14	0.11	***	0.75
GPTI4	<---	GPT	1.00			0.76
GPTI3	<---	GPT	0.92	0.09	***	0.73
GPTI2	<---	GPT	0.88	0.09	***	0.71
GPTI1	<---	GPT	0.97	0.09	***	0.77
GMI1	<---	GM	1.00			0.78
GMI2	<---	GM	1.07	0.09	***	0.77
GMI3	<---	GM	1.06	0.09	***	0.77
GMI4	<---	GM	1.11	0.08	***	0.84
$\chi^2(87)=134.88$, p=0.001, CFI=0.98, TLI=0.97, RMSEA=0.05, CMIN/DF=1.55						

B=unstandardized beta, b=standardized beta; ***p<0.001

4.6. Competitive Advantage

Competitive Advantage showed a single factor solution with a satisfactory KMO (0.89) and Bartlett's test ($p<0.001$). The alpha was 0.86 and the factor loadings ranged from 0.526 to 0.823.

Table 4.21:
Competitive Advantage: EFA and reliability

	Factor
CA1	0.779
CA2	0.526
CA3	0.735
CA4	0.637
CA5	0.618
CA6	0.823
CA7	0.708
Bartlett's test of Sphericity	560.60(21), $p<0.001$
KMO	0.89
Alpha	0.86
% variance	55.43

Competitive Advantage items were subjected to a CFA (Table 4.22). The model showed an acceptable fit and the standardized beta values ranged from 0.53 to 0.82, all $p<0.001$.

Table 4.22:

CFA with Competitive Advantage

			B	S.E.	P	b
CA1	<---	CAa	1.00			0.78
CA2	<---	CAa	0.82	0.11	***	0.53
CA3	<---	CAa	0.88	0.08	***	0.74
CA4	<---	CAa	0.84	0.09	***	0.64
CA5	<---	CAa	0.75	0.09	***	0.62

CA6	<---	CAa	1.12	0.09	***	0.82
CA7	<---	CAa	0.90	0.09	***	0.71

$\chi^2(14)=25.09$, p=0.03, CFI=0.98, TLI=0.97, RMSEA=0.06, CMIN/DF=1.79

B=unstandardized beta, b=standardized beta; ***p<0.001

The estimates from the CFA are shown in Table 4.23. All of the factor loadings are acceptable (>0.40) and the p-values are all <0.001. In addition, the model shows an acceptable fit, with CFI and TIL>0.90 and RMSEA <0.08. However, the correlations between the factors is high (Table 4.24.), all of them >0.85.

Table 4.23:

Estimates from CFA

			B	S.E.	P	b
IGO4	<---	IGO	1.00			0.79
IGO3	<---	IGO	1.12	0.09	***	0.81
IGO2	<---	IGO	1.15	0.08	***	0.84
IGO1	<---	IGO	1.15	0.08	***	0.83
EGO5	<---	EGO	1.00			0.81
EGO4	<---	EGO	1.01	0.08	***	0.76
EGO3	<---	EGO	1.01	0.07	***	0.85
EGO2	<---	EGO	1.13	0.08	***	0.80
EGO1	<---	EGO	1.03	0.08	***	0.82
RO4	<---	RO	1.00			0.69
RO3	<---	RO	1.12	0.12	***	0.71
RO2	<---	RO	1.09	0.13	***	0.63
RO1	<---	RO	0.92	0.11	***	0.62
GPRI7	<---	GPR	1.00			0.71
GPRI6	<---	GPR	1.03	0.10	***	0.72
GPRI5	<---	GPR	1.16	0.10	***	0.81
GPRI4	<---	GPR	1.11	0.10	***	0.78
GPRI3	<---	GPR	1.09	0.10	***	0.76
GPRI2	<---	GPR	1.19	0.11	***	0.79
GPRI1	<---	GPR	1.14	0.11	***	0.75
GSD6	<---	GSD	1.00			0.82
GSD5	<---	GSD	1.12	0.08	***	0.83
GSD4	<---	GSD	0.99	0.07	***	0.83
GSD3	<---	GSD	0.86	0.07	***	0.79
GSD2	<---	GSD	0.87	0.07	***	0.75

GSD1	<---	GSD	0.92	0.07	***	0.80
GPTI4	<---	GPT	1.00			0.75
GPTI3	<---	GPT	0.93	0.09	***	0.72
GPTI2	<---	GPT	0.91	0.09	***	0.71
GPTI1	<---	GPT	1.00	0.09	***	0.77
GT6	<---	GT	1.00			0.81
GT5	<---	GT	1.11	0.08	***	0.86
GT4	<---	GT	0.97	0.07	***	0.79
GT3	<---	GT	1.08	0.07	***	0.87
GT2	<---	GT	0.98	0.07	***	0.81
GT1	<---	GT	1.10	0.08	***	0.84
GMI1	<---	GM	1.00			0.78
GMI2	<---	GM	1.04	0.09	***	0.75
GMI3	<---	GM	1.07	0.09	***	0.77
GMI4	<---	GM	1.13	0.08	***	0.85
CA1	<---	CA	1.00			0.76
CA2	<---	CA	0.85	0.11	***	0.53
CA3	<---	CA	0.87	0.08	***	0.71
CA4	<---	CA	0.93	0.09	***	0.69
CA5	<---	CA	0.78	0.09	***	0.63
CA6	<---	CA	1.11	0.09	***	0.80
GT7	<---	GT	0.97	0.07	***	0.80
GSD7	<---	GSD	0.93	0.07	***	0.80
CA7	<---	CA	0.93	0.09	***	0.71

$\chi^2(1091)=1873.83$, $p<0.001$, CFI=0.91, TLI=0.90, RMSEA=0.06, CMIN/DF=1.71

B=unstandardized beta, b=standardized beta; ***p<0.001

Table 4.24:
Correlations between factors from CFA

			Estimate
IGO	<-->	EGO	1.024
IGO	<-->	RO	.899
IGO	<-->	GPR	.918
IGO	<-->	GSD	.881
IGO	<-->	GPT	.905
IGO	<-->	GT	.877
IGO	<-->	GM	.900
CA	<-->	IGO	.845
EGO	<-->	RO	.903
EGO	<-->	GPR	.906

			Estimate
EGO	<-->	GSD	.865
EGO	<-->	GPT	.878
EGOa	<-->	GT	.844
EGOa	<-->	GM	.892
CA	<-->	EGO	.821
ROa	<-->	GPR	.968
ROa	<-->	GSD	.949
ROa	<-->	GPT	1.028
ROa	<-->	GT	.938
CA	<-->	RO	.935
GPR	<-->	GSD	.984
GPR	<-->	GPT	1.007
GPR	<-->	GT	.951
GPR	<-->	GM	1.038
CA	<-->	GPR	.937
GSD	<-->	GPT	.912
GSD	<-->	GT	.958
GSD	<-->	GM	.980
CA	<-->	GSD	.927
GPT	<-->	GT	.878
GPT	<-->	GM	.967
CA	<-->	GPT	.943
GT	<-->	GM	.957
CA	<-->	GT	.863
CA	<-->	GM	.933
RO	<-->	GM	.953

Discriminant and convergent reliability for the CFA are shown in Table 4.24. For all of the variables, the AVE is greater than 0.50 except RO and CA. But AVE is less than the Maximum Shared Variance (MSV), and the Average Shared Squared Variance (ASV).

Table 4.25:
Validity and reliability of CFA model

	CR	AVE	MSV	ASV
RO	0.759	0.442	1.057	0.898
IGO	0.890	0.669	1.049	0.823
EGO	0.903	0.652	1.049	0.798
GPR	0.905	0.576	1.077	0.930
GSD	0.926	0.641	0.968	0.870
GPT	0.829	0.548	1.057	0.886
GT	0.938	0.683	0.918	0.827
GM	0.868	0.622	1.077	0.909
CA	0.867	0.486	0.889	0.813

Chapter 5

Hypothesis Testing and Results

In chapter 5, the structural (path) model assessed and hypotheses tested. In addition, there are 2 revised model were discussed in this chapter. Model number 1 focuses on Green Supplier Development and removed Green Training. Model number 2 focuses on Green Training and removed Green Supplier Development. In addition to that, comparisons between models are discussed in this chapter.

5.1. Results of the structural model

Composite variables were created from the latent factors by taking the average of the items that comprised the factor. The composite variables were then used in the SEM models. Due to the multicollinearity of the variables and the fact that the higher order models were not acceptable, the Green Product Innovation factor was used rather than the Green Innovation higher order factor and Internal Green Orientation was used rather than the Green Orientation higher order factor.

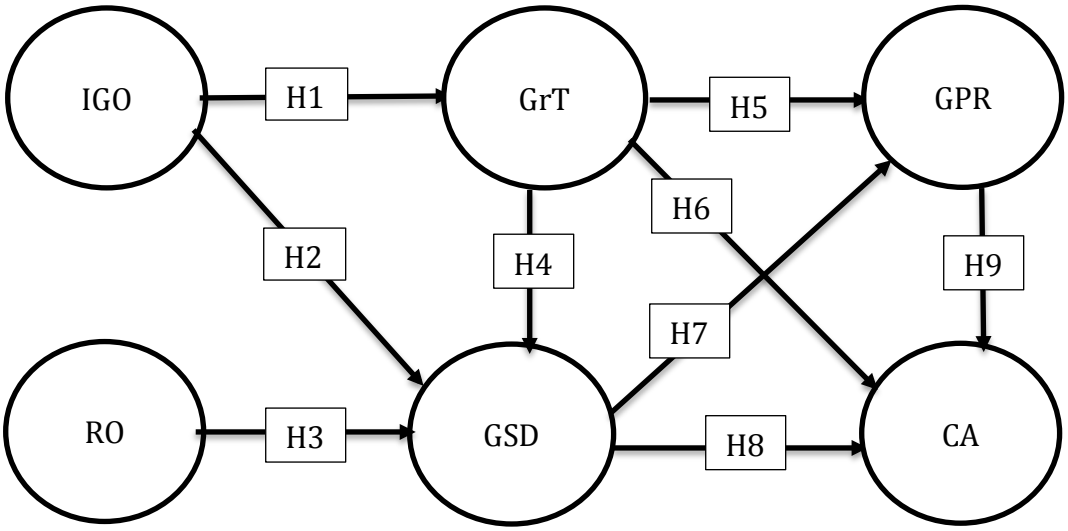

Figure 5-1: Theoretical Model, GrT=green training, IGO=internal green orientation, GSD=green supplier development, CA=competitive advantage, RO=relational orientation with supplier, GPR=green product

5.2 Discussion of structural model and hypothesis testing results

The estimates and model fit for the SEM model are shown in Table 5.1. The model is not very good fit, with the TLI<0.90, the RMSEA is >0.08, the CMIN/DF is >3.0 and the chi-square is $p<0.05$. However, all of the paths are significant at $p<0.01$ except for the path from GrT to CA, which is not significant.

Table 5.1:
SEM model for hypothesis testing

			B	S.E.	P	b
GrT	<---	IGO	0.84	0.04	***	0.80
GSD	<---	GrT	0.58	0.05	***	0.62
GSD	<---	RO	0.26	0.04	***	0.18
GSD	<---	IGO	0.18	0.05	0.002	0.19
GPR	<---	GSD	0.56	0.06	***	0.58
GPR	<---	GrT	0.32	0.05	***	0.36
CA	<---	GSD	0.31	0.07	***	0.42
CA	<---	GrT	0.02	0.05	0.72	0.03
CA	<---	GPR	0.34	0.07	***	0.44
$\chi^2(6)=250.29$, p=0.00, CFI=0.94, TLI=0.81, RMSEA=0.30, CMIN/DF=18.73						

GrT=green training, IGO=internal green orientation, GSD=green supplier development, CA=competitive advantage, RO=relational orientation with supplier, GPR=green product innovation; B=unstandardized beta, b=standardized beta; ***p<0.001

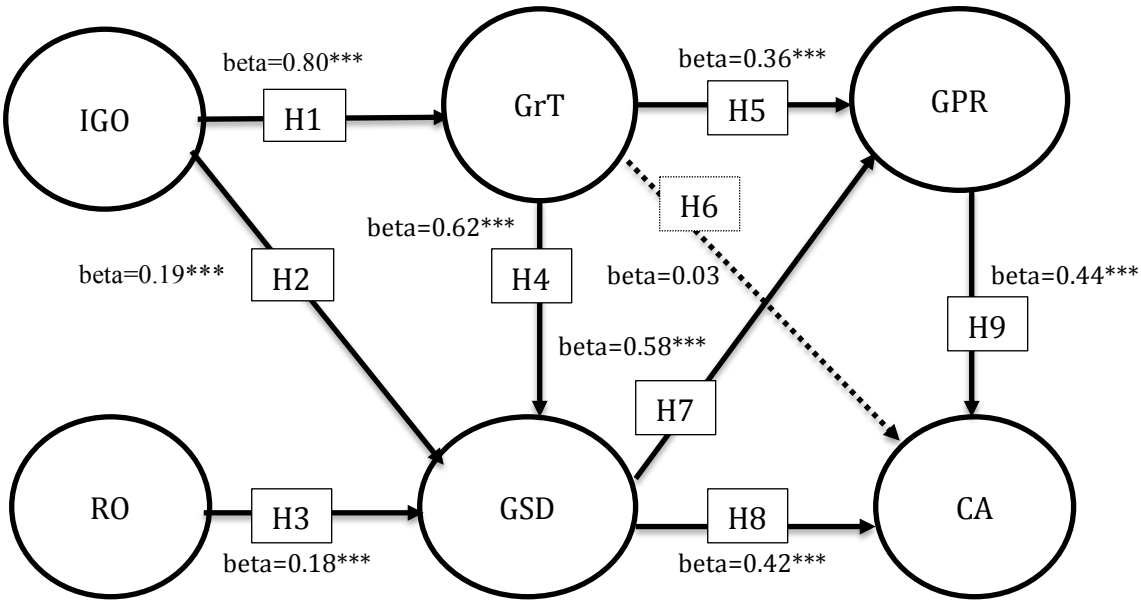

Figure 5-2: Structural Model Results, GrT=green training, IGO=internal green orientation, GSD=green supplier development, CA=competitive advantage, RO=relational orientation with supplier, GPR=green product innovation

5.2.1 Discussion of hypothesis results

Hypothesis 1 states*: Firms' green orientation is positively related to their implementation of green training.* The path in this model was significantly positively associated (beta=0.80, $p<0.001$), indicating that this hypothesis was supported.

Strategic green orientation choice made by manufacturing firms is important for their competitive advantage. So, that led to implement important functions (e.g. green training) that would help to successful improve and green innovation (e.g. green product innovation) and improve the firm's competitive advantage as showing in this study.

Most of manufacturing firms have been recognized their impact on environment, and are beginning to recognize that successful firms emphasize the prevention and avoidance of negative environmental impacts, whereas less successful firms implement reactionary environmental controls, and green orientation is positively related to educate employees on green practices.

The second hypothesis was *Firms' green orientation is positively related to their implementation of green supplier development programs.* This hypothesis was also supported, as, IGO was significantly positively associated with GSD (beta=0.19, $p<0.01$).

While it is impartment to implement internal training on green practices for firms' employees, the green orientation of the firm will also be emphasized through development of partnership with green suppliers that will support, provide and implement positive environmental initiatives/practices. That means, greening the supply chain in critical for firms' green innovation and competitive advantage.

Hypothesis 3 stated that *Firms' relational orientation with supplier is positively related to their implementation of green supplier development programs.* The path from RO to GSD was significant and positive (beta=0.18, $p<0.001$), thus, hypothesis 3 was supported. This means it is important to build trust, commitment and support the relationship with suppliers. Commitment from both parts is crucial for green supplier development programs since it takes long time to reach the benefits.

The fourth hypothesis was *Firms' green training implementation is positively related to their green supplier development programs implementation.* There was a positive and significant relationship between GrT and GSD (beta=0.62, $p<0.001$). It is expected that when a firms educate its employees and train them on green practice that would be reflected on their behave and practices when they deal with suppliers. So, when a firm sends their employees to the supplier's site that would help to transfer the green knowledge and skills.

Hypothesis four was supported. Hypothesis five was *Firms' green training implementation is positively related to their green innovation.* The path from GrT to GPR was positive and significant (beta=0.36, $p<0.001$), so this hypothesis was also supported.

Hypothesis six was *Firms' green training implementation is positively related to their competitive advantage.* The path from GrT to CA was positive (beta=0.03), however, it was not significant ($p>0.05$), so this hypothesis was not supported. The seventh hypothesis stated *Green supplier development program implemented by manufacturing firms is positively related to the manufacturing firms' green innovation.*

This hypothesis was supported, as the path from GSD to GPR was positive (beta=0.58) and significant ($p<0.001$).

The eighth hypothesis stated *Green supplier development program implemented by manufacturing firms is positively related to the manufacturing firms' competitive advantage.* Since the path from GSD to CA was positive (beta=0.42) and significant ($p<0.001$), this hypothesis was supported. Finally, hypothesis nine was *Firms' green innovation is positively related to their competitive advantage.* This hypothesis was also supported as the path from GPR to CA was positive and significant (beta=0.44, $p<0.001$).

5.3 Revised Structural Model

Two revised models were run. In the first model, the green training factor was removed from the model and in the second revised model green supplier development was removed from the model.

5.3.1 Results of the revised structural model

The first revised model showed a not good fit with a CMIN/DF>3.0, a TLI<0.90, RMSEA>0.08 and a significant chi-square value. All of the parameter estimates in the model were significant at $p<0.001$.

Table 5.2:

Revised SEM model #1 (removal of green training)

			B	S.E.	P	b
GSD	<---	RO	0.65	0.08	***	0.44
GSD	<---	IGO	0.47	0.05	***	0.47
GPR	<---	GSD	0.85	0.03	***	0.90
CA	<---	GSD	0.32	0.06	***	0.43
CA	<---	GPR	0.35	0.06	***	0.45

$\chi^2(4)=53.53$, p=0.00, CFI=0.95, TLI=0.88, RMSEA=0.25, CMIN/DF=13.38

IGO=internal green orientation, GSD=green supplier development, CA=competitive advantage, RO=relational orientation with supplier, GPR=green product innovation; B=unstandardized beta, b=standardized beta; ***p<0.001

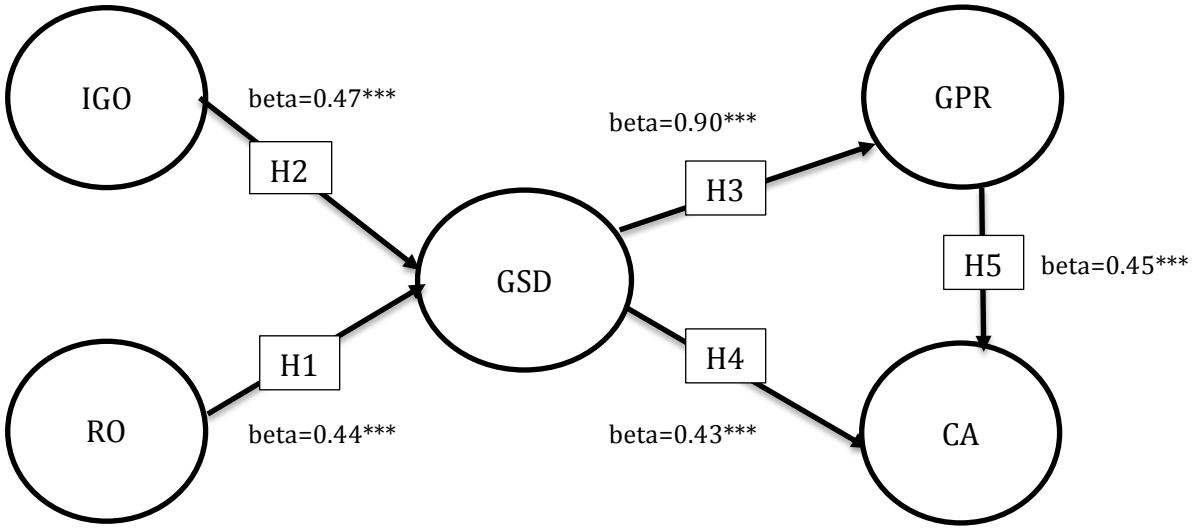

Figure 5.3: Revised Structural Model # 1 Results, IGO=internal green orientation, GSD=green supplier development, CA=competitive advantage, RO=relational orientation with supplier, GPR=green product innovation; B=unstandardized beta, b=standardized beta; ***p<0.001

The second revised model is shown in Table 5.3. This is not good fitting model, with the CFI and TLI <0.90, RMSEA>0.08, CMIN/DF>3.0 and the chi-square is <0.05. All of the parameter estimates are statistically significant.

Table 5.3:

Revised SEM model #2 (removal of green supplier development)

			B	S.E.	P	b
GrT	<---	IGO	0.84	0.04	***	0.80
GPR	<---	GrT	0.79	0.03	***	0.87
CA	<---	GPR	0.51	0.06	***	0.65
CA	<---	GrT	0.16	0.06	0.01	0.22

$\chi^2(5)=122.10$, p=0.00, CFI=0.89, TLI=0.77, RMSEA=0.34, CMIN/DF=24.48

GrT=green training, IGO=internal green orientation, CA=competitive advantage, RO=relational orientation with supplier, GPR=green product innovation; B=unstandardized beta, b=standardized beta; ***p<0.001

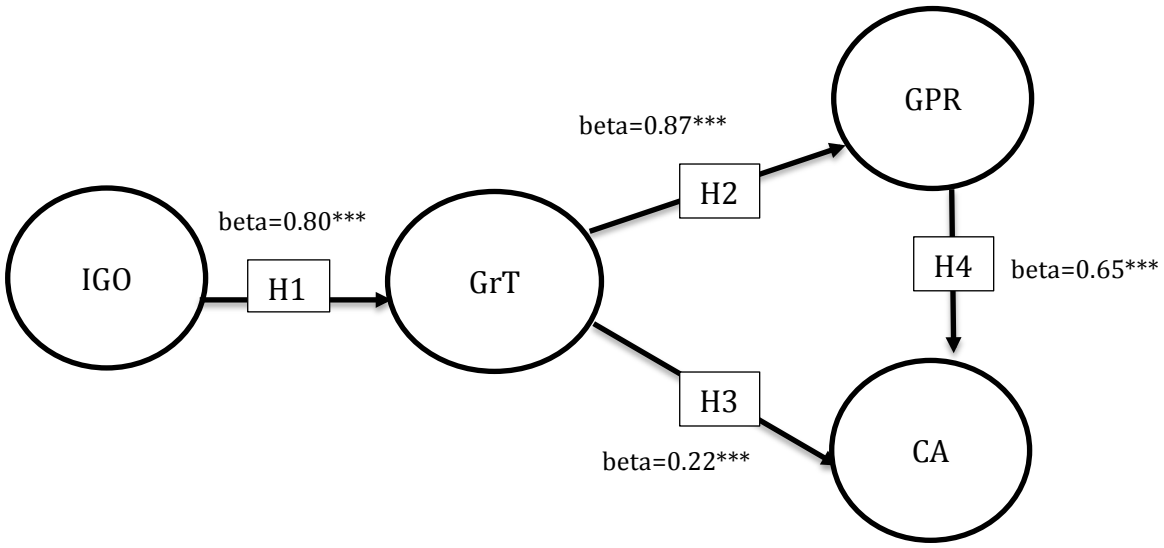

Figure 5.4: Revised Structural Model # 2 Results, IGO=internal green orientation, GrT=green training, CA=competitive advantage, RO=relational orientation with supplier, GPR=green product innovation

5.3.2 Discussion of new paths in the revised structural model

Of the two revised models, revised model #1 was the best fitting model compared to the original SEM model and the revised model #2. All of the paths in revised model #1 were significant and the beta estimates were higher than they were in the original SEM model. In the original SEM model, the path from GrT to CA was not significant; in revised model #2, this path did reach statistical significance and the beta value was improved from 0.03 to 0.22 ($p<0.05$).

5.4 Testing for Common Method Bias

The common method bias can be tested with Harman's single factor test (Harman,1976, Andersson and Bateman, 1997). A factor analysis can be run without rotation and extracting a single factor. If the single factor accounts for most of the variance, than there is presence of common method variance (Podsakoff, et al. 2003). The items from these data accounted for 43.42% of the variance, indicating that common method variance is not a concern.

5.5 Chapter Summary

The original SEM model showed that all of the hypotheses were supported except hypothesis 6. Removal of the green supplier development path changed the statistical significance of green training to competitive advantage from non-significant to significant; however the revised model was a poorer fit. The best fitting model was the one where green training was removed from the model.

Chapter 6

Contributions, Limitations and Future Research

This chapter discusses the academic contribution of the study, contribution to practice, limitations, and lastly the scope for future research.

6.1 Academic Contributions

This unique study examined how manufacturing firms manage environmental sustainability (greening) while also developing green training and green supplier development programs. A comprehensive model was theorized and tested to explore the relationships between several constructs, including green supplier development, green innovation, green orientation, relational orientation, green training and competitive advantage.

The study adds to existing literature on issues of environmental operations management and green HR management. It studies the relationship between green supplier development and green training and how these impact green innovation as well as a manufacturing firm's competitive advantage. Second, it examines the strategic choice of the manufacturing firm toward green training and green supplier development by studying green orientation and relational orientation with supplier. Third, the study is

one of the first to explore possible relationships that may exist between environmental supply chain issues, HR factors, and green innovation in a manufacturing firm context.

This study also adds to the literature for two more main reasons, the first being that four separate theories were integrated into a single model and the second being that the instrument was developed based on several different existing literatures and combined into a singular measurement tool.

The four theories included in the main model include, NRBV, KBV, and Strategic Choice Theory, and Social Capital Theory. Studies predominantly test a single theory, but using a combination of theories to build a single model is novel. This study claims that it is important to combine NRBV along with the knowledge-based view (KBV) theories to provide greater clarity on the green knowledge transfer internally and externally within the supply chain. So, it is important to establish of such relationship between a manufacturing firm and a supplier in the supply chain, which promote positive supplier development in terms of their green abilities and skills. This study also confirm the applications of strategic choice theory and social capital theory, where it support the firm's need to reconsider and reposition itself relative to the issues they want to address. It confirms the importance of building strong trust, commitment, relationship configuration, and similar understandings and ideologies with the key suppliers.

The constructs in the final model are well established in the literature, thus, using these constructs in combination to determine whether the outcomes of Green Innovation and Competitive Advantage are indeed affected by Internal Green Training, Green Supplier Development, Green Orientation and Relational Orientation is an interesting application of work that has already been done. The results of the SEM show that 8 out of

9 of the proposed associations in the model were statistically significant, except for the association between green training implementation and competitive advantage, which was supported in the revised model.

The literature introduces two levels of green orientation, internal and external (Banerjee, 2002). The results of this study indicate that these may actually be a single construct. The correlation between these two constructs is extremely high at 0.91, and a factor analysis with both the IGO and EGO items show a single factor solution, with very high factor loadings of 0.80 and above, further indicating that there may only be a single level of green orientation rather than two. It could be called "Strategic Green Orientation".

The relational orientation factor, while important, actually showed the lowest factor loadings of all of the factors, indicating that this factor probably needs to be redefined in this population.

6.2 Contributions to practice

The overarching conclusion from these analyses is that 9 constructs examined are highly correlated, indicating the possibility when a company is committed to environmental sustainability; they do so in all facets. Manufacturing firms can achieve a competitive advantage over their competitors by devising and implementing green orientation strategies that address environmental concerns. So, managers need to clearly recognize the importance of green issues within their business strategies and operations. In addition, as well known, a manufacturing company does not always control all aspects of

production. Therefore, managers need to build a strong trust, commitment, and support key suppliers relationship. Trust and commitment are two important elements or sub-constructs of relational orientation with supplier. The strong relationship that develops between manufacturing firm (e.g., buyer or customer) and the suppliers is one that includes trust, and commitment. Building a strong relationship with suppliers needs some criteria that differ from company to another but it is important to consider this strategy.

The study examined models regarding the environmentally friendly practices certain companies chose, and although they focus on different aspects of environmental sustainability, the models show that the impacts of these practices have similar outcome. Therefore, the implication of using such construct when considering the environmental sustainability of a company, not all of the "green" factors need to be considered because they all have similar predictive value. So, it is important to pay attention to other factors.

This study helps manufacturing firms managers to better understand the importance of their firms' strategic choice to go green because that will develop their firms' green product innovation and sustainable competitive advantage. That leads them to focus on internal functions (e.g. green training) and their supply chain by developing green programs for key suppliers. Such employee education and training programs are particularly important, because the employees' familiarity with green practices will enable more effective implementation of sustainable development in their respective firms; thus, increasing the competitive advantage of the said firm. Focusing on both, internal green training and green supplier development, improve the firm's capabilities in green innovation and sustainable competitive advantage.

6.3 Limitations

The main limitation of this research is the multi-collinearity of the constructs, with the constructs highly correlated at 0.80 and above. This makes the interpretation of the results harder, but does raise the issue that (1) manufacturing firms that engage in one type of "greening" engage in other types of "greening" and (2) the subjects sampled were a homogenous group. The issue of multi-collinearity brings to bare the issue with adapting measures from separate entities into a single tool. Even though a single measure may have acceptable validity, when used in combination with other measures, problems can arise.

From a sampling frame perspective, the limitation in this study is that the respondents are self-selected and may not be representative of the population of all manufacturing firms. In addition, this study is measuring the perceptions of employees. There is the potential for respondents to provide incomplete surveys or answers that are not truthful.

In terms of the quality of responses, it is acknowledged that respondents' perception may be influenced by the extent in which they are familiar with the organizational performance and extent of self-reporting biases.

6.4 Scope for future research

The model in this study is an important and unique one. So, future research would include creating a larger and more diverse sample that would augment the study of this model, for example using other industries (e.g. service industry) to see how they compare to the manufacturing industry. Another interesting research option would be to apply the study on globe manufacturing firms. That means collect data from global manufacturing firms not only the US firms to see the difference. It is also important for future research to add more constructs to the model. These constructs should not focus on green practices only but on other non-green practices.

Future research could study how do manufacturing firms develop their suppliers in terms of green and how does that effect suppliers performance regarding environmental and financial performance. It also important to add more drivers factors that could be important in green supplier development programs. One key antecedent that represents the buyer firms' perspective is the supplier strategic alignment. Steven and Merklein (2013) defined strategic airline alliances for improve carbon intensity of their activates as "long-term collaborative agreements between at least two carriers to cooperate on a substantial level with the declared intention to improve competitiveness and enhance overall performance (Iatrou and Alamdari, 2005; Morrish and Hamilton, 2002)".

Supplier strategic alignment links a supplier and a buyer on the dimensions of SC strategy. Therefore, Supplier strategic alignment for green defined as the level of agreement with a supplier regarding the relative strategic importance and declared

intention to enhance competitiveness and improve green products and processes. Supplier strategic alignment is unique and critical construct in terms of green supplier development framework.

In addition, there is a need to recognize the factors that reinforce or hinder the positive influence of green supplier development programs on a supplier's green performance development, e.g. supplier's absorptive capacity. Absorptive capacity is "the ability to recognize the value of new information, assimilate it, and apply it to commercial ends" (Cohen & Levinthal, 1990; Wagner, 2012). It plays a role in efficient interorganizational learning (Grant, 1996b; Malhotra, Gosain, & Sawy, 2005), as it refers to how efficiently an organization can add new knowledge to existing knowledge (Grant, 1996b, p. 111). It is important to study the moderating effect of supplier's absorpitive capacity. This means that the partner must be able to assimilate and apply the knowledge he receives to the firm's products and sustainable performance. Therefore, if the supplier has the ability to exploit and assimilate the green-related information that was transferred between the firms, that would mean a stronger relationship between the green supplier development and the supplier's green performance.

Sustainability issues in manufacturing industry are huge and complex. So, it is important to consider the complexity in supply chain as well because manufacturing firms indirectly are connected to second tier of suppliers and third and so on. Therefore, future research could be focus on manufacturing-supplier-customer triads in manufacturing business.

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Appendix A

A Survey of Linking Green Training and Green Supplier Development for Sustainable Business Advantages in Manufacturing Firms Context

The College of Business and Innovation, University of Toledo, OH, US

You are invited to participate in a University of Toledo doctoral dissertation research survey. We highly encourage you to fill the following questionnaire and thank you in advance for your responses.

Research Purpose:

This research mainly focuses on manufacturing firms and how to manage environmental sustainability (greening) throughout, while developing green training and green supplier development programs. The main objective of this research is to investigate the relationships between green orientation, relational orientation with supplier, green (environmental) training, green supplier development, and the sustainable business advantages, including green innovation and competitive advantage improvement. In other words, how can a manufacturing firm develop capabilities through green employees training and green supplier development programs in order to improve its green innovation and gain a sustainable competitive advantage?

The survey is divided into seven (7) sections, for each question, please select the answer that best fits your view on that topic. We estimate that it will take you approximately 10-15 minutes to complete the survey.

We are interested only in your opinion. The information you provide will be kept confidential and only will be summarized in a data report.

Thank you for your help and cooperation. With your assistance, this study will investigate the green training and green supplier development programs and it related to green innovation and competitive advantage improvement in manufacturing firms' context.

Questions:

If you have any questions about the research at any time, please do not hesitate to contact Badr A. Alreshidi, (PhD Candidate) at 001-419-450-9558 (US), or by email: Badr.Alreshidi@rockets.utoledo.edu

Section 1: Green Orientation

The following statements describe typically the extent to which your company recognizes the importance of the environmental issues of its business operations from both internal and external perspectives. Please check the circle beneath the number that best indicates the extent of your agreement with each statement, using the following scale:

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree

Code	Internal Green Orientation	1	2	3	4	5	6	7
IGO1	Our Firm has clear policies promoting environmental awareness in all functional area.	o	o	o	o	o	o	o
IGO2	Our Firm identifies protection of the natural environment as a high-priority activity.	o	o	o	o	o	o	o
IGO3	Our Firm Takes initiatives to ensure that employees realize the importance of natural environment protection.	o	o	o	o	o	o	o
IGO4	Our Firm Identifies environmental protection as its corporate responsibility.	o	o	o	o	o	o	o
	External Green Orientation							
EGO1	Our Firm Realizes the impact of environmental sustainability on their financial well-being.	o	o	o	o	o	o	o
EGO2	Our Firm Understands that its survival is contingent on the protection of the natural environment.	o	o	o	o	o	o	o
EGO3	Our Firm Recognizes the importance to address the environment requirements of the external stakeholders.	o	o	o	o	o	o	o
EGO4	Our Firm Clearly recognizes the environmental requirements of the external stakeholders.	o	o	o	o	o	o	o
EGO5	Our Firm Clearly recognizes environmental footprints of their operations.	o	o	o	o	o	o	o

Section 2: Relational orientation with Supplier

The following statements describe typically the extent to which a firm's tendency to develop and use of relational ties with suppliers based on the relational dimension of social capital theory. Please check the circle beneath the number that best indicates the extent of your agreement with each statement, using the following scale:

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree

Code	Relational orientation with Supplier	1	2	3	4	5	6	7
RO1	**In your relationship with the key supplier**, the degree of mutual trust is high	o	o	o	o	o	o	o
RO2	**In your relationship with the key supplier**, commitment of the top management to relationship development is high	o	o	o	o	o	o	o
RO3	**In your relationship with the key supplier**, support of the top management to relationship development is high	o	o	o	o	o	o	o
RO4	**In your relationship with the key supplier**, collective problem-solving with the supplier is high	o	o	o	o	o	o	o

Section 3: Green Training

The following statements describe typically the extent to which your company implements planned and systematic efforts and programs to modify or develop environmental-related knowledge, skills and attitudes through learning experiences toward environmental issues. . Please check the circle beneath the number that best indicates the extent of your agreement with each statement, using the following scale:

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree

Code	Green Training	1	2	3	4	5	6	7
GrT1	In Our Firm Employees are frequently provided with training on methodologies and procedures for eco-design, LCA, Recycling/reusing of materials, and disposal of production waste.	o	o	o	o	o	o	o
GrT2	In Our Firm Sufficient amount of trainings on environmental issues are provided to the employees.	o	o	o	o	o	o	o
GrT3	In Our Firm Every employee in this facility has the opportunity to receive training on environmental issues.	o	o	o	o	o	o	o
GrT4	In Our Firm I am content with the environmental training for employees at our facility.	o	o	o	o	o	o	o
GrT5	In Our Firm, The employees are training regularly on environmental issues.	o	o	o	o	o	o	o
GrT6	In Our Firm , The employees use their environmental training effectively.	o	o	o	o	o	o	o
GrT7	In Our Firm , Employees have several chances of using their environmental training.	o	o	o	o	o	o	o

Section 4: Green Supplier Development

The following statements describe typically the extent to which your company in their efforts undertaken of environmental sustainability activities that involving direct interaction between the firm and its key suppliers to measure and improve the products or services they receive from their suppliers in terms of environmental sustainability. . Please check the circle beneath the number that best indicates the extent of your agreement with each statement, using the following scale:

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree

Code	Green Supplier Development	1	2	3	4	5	6	7
GSD1	Our firm Communicates with its suppliers timely and regularly on sustainability related issues.	o	o	o	o	o	o	o
GSD2	Our firm Engages in close cooperation with a limited number of suppliers for the greening of our supply chain.	o	o	o	o	o	o	o
GSD3	Our firm choses to develop instead of abandoning suppliers if they fail to meet environmental standards.	o	o	o	o	o	o	o
GSD4	Our firm Personnel visit the premises of the suppliers to help them better their sustainable practices.	o	o	o	o	o	o	o
GSD5	Our firm Provide the supplier's employees with environmental training (i.e. Eco-design, Recycling/Reuse, and LCA).	o	o	o	o	o	o	o
GSD6	Our firm Involve with the supplier in eliminating non-value added activities existing in their process.	o	o	o	o	o	o	o
GSD7	Our firm Engages the supplier to participate in our green product design and development process.	o	o	o	o	o	o	o

Section 5: Green Innovation.

The following statements describe typically your company's green innovation. Please check the circle beneath the number that best indicates **the rate of change of your firm relative to your major competitors over the last three years**, using the following scale:

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree

Code	Green process innovation	1	2	3	4	5	6	7
GPI1	Our firm frequently innovatively updates manufacturing processes to protect against contaminations.	o	o	o	o	o	o	o
GPI2	Our firm frequently innovatively updates manufacturing processes to adhere to the environmental law standards.	o	o	o	o	o	o	o
GPI3	Our firm frequently utilizes innovative technologies in manufacturing processes to conserve energy.	o	o	o	o	o	o	o
GPI4	Our firm frequently innovatively updates manufacturing equipment in manufacturing processes to reduce energy use.	o	o	o	o	o	o	o

	Green product innovation							
GPRI1	Our firm frequently emphasizes on developing new eco-products using innovative technologies to improve their package.	o	o	o	o	o	o	o
GPRI2	Our firm frequently emphasizes on developing new eco-products using innovative technologies to reduce construction complications.	o	o	o	o	o	o	o
GPRI3	Our firm frequently emphasizes on developing new eco-products using innovative technologies to enable easy component recycling.	o	o	o	o	o	o	o
GPRI4	Our firm frequently emphasizes on developing new eco-products using innovative technologies to enable easy decomposition of their materials.	o	o	o	o	o	o	o
GPRI5	Our firm frequently emphasizes on developing new eco-products using innovative technologies to utilize natural materials.	o	o	o	o	o	o	o
GPRI6	Our firm frequently emphasizes on developing new eco-products through innovative technologies to reduce waste related damage as much as possible.	o	o	o	o	o	o	o
GPRI7	Our firm frequently emphasizes on developing new eco-products through innovative technologies to conserve maximum energy as possible.	o	o	o	o	o	o	o
	Green managerial innovation							
GMI1	Our firm's management frequently redefine operation and production processes to ensure internal efficiency that can help to implement green practices	o	o	o	o	o	o	o
GMI2	Our firm's management frequently re-designing and improving product or service to obtain new environmental criteria or directives	o	o	o	o	o	o	o
GMI3	Our firm's management frequently uses novel management systems to manage eco-innovation.	o	o	o	o	o	o	o
GMI4	Our firm's management frequently collects information on eco- innovation trends.	o	o	o	o	o	o	o

Section 6: Competitive advantage

The following statements describe typically the improvement of competitive advantage objectives. Please check the circle beneath the number that best indicates ***the rate of change of your firm relative to your major competitors over the last three years***, using the following scale:

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree

Code	Competitive advantage improvement	1	2	3	4	5	6	7
CA1	Our product sales have been increased.	o	o	o	o	o	o	o
CA2	Our product cost has been reduced.	o	o	o	o	o	o	o
CA3	Our product or services quality has been improved.	o	o	o	o	o	o	o
CA4	Our products can be produced faster than before.	o	o	o	o	o	o	o
CA5	Our capability of responsiveness to changes in the market has been improved.	o	o	o	o	o	o	o
CA6	The corporate image of the company is better than that of the competitors.	o	o	o	o	o	o	o
CA7	The company is more capable of R&D than the competitors.	o	o	o	o	o	o	o

Section 7: General Questions

The following questions are about general information of your company and yourself. Please check the blank box before an appropriate option as it applies to your company. (Please estimate if necessary)

1. What industry you work in? (Qualifying question)

o Manufacturing Industry
o Other (please specify): _____

2. Your present job title (Please check the closest title which applies):

o Chief Executive Officer (CEO)/President
o Vice president
o Director
o Manager
o Other (please specify): _____

3. Your present job function (Please check the closest function which applies):

o Corporate Executive
o Manufacturing Engineering
o Quality Assurance/Control
o Product Design/ R&D
o Purchasing
o Manufacturing Production
o Sales/ Marketing
o Transportation/Logistics/Distribution
o Other (please specify): _____

4 . How many years did you work in your company?

□ <= 3 year □ 3-10 years □ 10-15 years □ 15-20 years □ >20 years

5. Please indicate the number of employees of your company (firm size)?

. o <100
. o 101-250
. o 251-500
. o 501-1000
. o >1000

6. Please indicate the annual revenues $ (in Millions) of your firm.

o <$10
o $10 -50
o $51-100
o $101-500
o >$500

7. The age of your company is:
□ <= 1 year □ 2-5 years □ 6-10 years □ 11-15 years □ 16-20 years
□ >=21

8. Please indicate the Standard Industrial Classification (SIC) code that best describes your primary business.
o SIC 30: Rubber and miscellaneous plastic products
o SIC 34: Fabricated Metal Products
o SIC 35: Industrial machinery and equipment
o SIC 36: Electronic and other electric equipment
o SIC 37: Transportation equipment
o SIC 38: Instruments and Related Products
o Other (Please specify): _____